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Waterford 3

W3F1-2016-0031

July 21, 2016

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
11555 Rockville Pike
Rockville, MD 20852

Subject: Notification of Full Compliance with EA-12-049, Order Modifying Licenses With Regard To Requirements for Mitigating Strategies for Beyond-Design-Basis External Events
Waterford Steam Electric Station, Unit 3 (Waterford 3)
Docket No. 50-382
License No. NPF-38

References:

1. NRC Order Number EA-12-049, "Order to Modifying Licenses With Regard To Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012 (ADAMS Accession No. ML12054A736)

2. Waterford Steam Electric Station, Unit 3 letter to NRC, "Request for Relaxation from NRC Order EA-12-049, "Order to Modifying Licenses With Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated August 31, 2015 (ADAMS Accession No. ML15243A243)

3. NRC letter to Waterford Steam Electric Station, "Waterford Steam Electric Station, Unit 3 – Relaxation of the Schedule Requirements for Order EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" dated October 4, 2015 (ADAMS Accession No. ML15245A344)

Dear Sir or Madam:

On March 12, 2012, the Nuclear Regulatory Commission (NRC) issued NRC Order EA-12-049, (Reference 1) to Entergy Operations, Inc. (Entergy). The Order was effective immediately and directed Waterford Steam Electric Station, Unit 3 (Waterford 3), to develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities in the event of a beyond-design-basis external event. Reference 1 required full implementation of mitigating strategies for beyond design basis external events no later than two refueling cycles after submittal of the Overall Integrated Plan (OIP) or December 31, 2016, whichever comes first. Waterford 3 requested relaxation of the required implementation date in Reference 2. The NRC granted schedule relaxation until May 31, 2016 in Reference 3.

This letter, along with its attachments, provides the notification required by Section IV.C.3 of the Order that full compliance with the requirements described in Attachment 2 of the Order has been achieved for Waterford 3. The attachments to this letter provide summaries of how the compliance requirements were met, the completion status for all of the FLEX Audit open and confirmatory items, and the Final Integrated Plan.

This letter contains no new NRC commitments. Should you have any questions concerning the content of this letter, please contact John Jarrell, Regulatory Assurance Manager, at (504) 739-6685.

I declare under penalty of perjury that the foregoing is true and correct. Executed on July 21, 2016.

Sincerely,

MRC/AJH

Attachments:
1. Order EA-12-049 Compliance Summary
2. NRC Interim Staff Evaluation Open or Confirmatory Items Summary
3. Summary Responses to Open/Pending Items in FLEX Audit Report
4. References
5. Final Integrated Plan for Order EA-12-049

cc: Attn: Director, Office of Nuclear Reactor Regulation
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Attachment 1

W3F1-2016-0031

Waterford Steam Electric Station, Unit 3,

Order EA-12-049 Compliance Summary

Waterford Steam Electric Station, Unit 3,
Order EA-12-049 Compliance Summary

1. Background

On March 12, 2012, the NRC issued NRC Order EA-12-049, Order Modifying Licenses With Regard To Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, (Reference 1) to Entergy Operations, Inc. (Entergy). The Order was effective immediately and directed Waterford Steam Electric Station, Unit 3 (Waterford 3), to develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool cooling capabilities in the event of a beyond-design-basis external event. The Order required compliance prior to plant startup from the second refueling outage following submittal of the Overall Integrated Plan (OIP) or by December 31, 2016, whichever comes first. Waterford 3 requested relaxation of the required implementation date in Reference 2. The NRC granted schedule relaxation until May 31, 2016 in Reference 3.

Waterford 3 developed an Overall Integrated Plan (Reference 6), documenting the diverse and flexible strategies (FLEX) in response to Reference 1.

The compliance date for Waterford 3 was May 26, 2016. The NRC staff requested that the compliance report be submitted within 60 days of the compliance date. The information provided herein documents Waterford 3's full compliance with NRC Order EA-12-049.

2. Open Item Resolution

Entergy submitted the Waterford 3 Overall Integrated Plan (OIP) by letter dated February 28, 2013 (Reference 6). By letters dated November 25, 2013 and October 6, 2015 (References 7 & 8), the NRC provided the Interim Staff Evaluation (ISE) and July 2015 Audit Report. Attachment 2 contains summary responses to the Open and Confirmatory items listed in the ISE. The Open items remaining following the July 2015 audit are listed below:

a. ISE Open Items
   i. OI 3.2.4.2.B — Effects of elevated battery room temperatures

b. ISE Confirmatory Items
   i. CI 3.1.1.3.A — Seismic hazards of non-robust internal flooding sources
   ii. CI 3.2.3.A — Review analysis of containment functions during ELAP

c. Audit Questions/Open Items
   i. AQ 24 — Justify plant equipment credited during ELAP
   ii. SE 3 — Discuss how guidance, strategies, administrative controls and training will be developed and implemented
   iii. SE 7 — Discuss impact of MOHR SFPI failures

iv. SE 8 Provide evaluation of environmental qualifications of containment electrical equipment

v. SE 18 Justify alternate approach for using installed spent fuel pool cooling pumps.

vi. SE 24 Discuss transition to Phase 3 generators during flooded conditions

vii. SE 25 Provide evaluation of robustness of "N" storage building

viii. SE 26 Protection of SFP cable conduits

ix. SE 27 Justify single suction source alternative to NEI 12-06 3.2.2

d. Licensee Identified Open items – None

A summary of the response to each of the remaining Audit Open items is provided in Attachment 3. The Open items listed above are Complete, pending NRC closure and do not affect the compliance of Waterford 3 to Order EA-12-049.

3. Milestone Schedule

All activities on the Milestone Schedule for Waterford 3 are Complete

Milestone	Completion Date
Submit Overall Integrated Plan	Feb 2013
Submit Six Month Updates:	
Update 1	Aug 2013
Update 2	Feb 2014
Update 3	Aug 2014
Update 4	Feb 2015
Update 5	Aug 2015
Update 6	Feb 2016
Perform Staffing Analysis	June 2015
Modifications:	
Engineering and Implementation	
N-1 Walkdowns	May 2014
Design Engineering	March 2015
Implementation Outage	Nov 2015
On-Line Modification Scope	April 2016
On-site FLEX Equipment	
Purchase	March 2016

Milestone	Completion Date
Procure	April 2016
Off-site FLEX Equipment	
Develop Strategies with RRC	June 2015
Install Off-Site Delivery Station (if Necessary)	Not Necessary
Procedures	
Create Waterford FSGs	March 2016
Create Maintenance Procedures	April 2016
Training	
Develop Training Plan	May 2015
Implement Training	February 2016

4. Order EA-12-049 Compliance Elements Summary

The elements identified below for Waterford 3 as well as the Overall Integrated Plan (Reference 6), the 6-Month Status Reports (References 9 through 14) and additional docketed correspondence, demonstrate compliance with Order EA-12-049.

a. Strategies – Complete

Waterford 3 strategies are in compliance with Order EA-12-049. All Open items, Confirmatory Items, and NRC Audit Items have been addressed.

b. Modifications – Complete

The modifications required to support the FLEX strategies for Waterford 3 have been installed in accordance with the station design control process.

c. Equipment – Procured and Maintenance & Testing - Complete

The equipment required to implement the FLEX strategies for Waterford 3 has been procured in accordance with NEI 12-06 (Reference 4), Section 11.1 and 11.2, received at Waterford 3, initially tested and performance verified as recommended in accordance with in NEI 12-06, Section 11.5, and is available for use.

d. Protected Storage – Complete

The storage facilities required to implement the FLEX strategies for Waterford 3 have been completed and provide protection from the applicable site hazards. The equipment required to implement the FLEX strategies for Waterford 3 is stored in its protected configuration.

e. Procedures – Complete

FLEX Support Guidelines (FSGs), for Waterford 3 have been developed, and integrated with existing procedures. The FSGs and affected existing procedures have been verified and are available for use in accordance with the site procedure control program.

f. Training – Complete

Training for Waterford 3 has been completed in accordance with an accepted training process as recommended in NEI 12-06 Section 11.6.

g. Staffing – Complete

The staffing study for Waterford 3 (Reference 15) has been completed in accordance with the 10CFR50.54(f) letter (Reference 17). The NRC has reviewed the Phase 2 staffing study and concluded that Waterford 3's Phase 2 staffing submittal adequately addresses the response strategies needed to respond to a Beyond-Design-Basis External Event (BDBEE) using Waterford 3 procedures and guidelines. This is documented in NRC letter dated December 1, 2015 (Reference 16).

h. National SAFER Response Centers – Complete

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

i. Validation – Complete

Waterford 3 has completed performance of validation in accordance with industry developed guidance to assure required tasks, manual actions and decisions for FLEX strategies are feasible and may be executed within the constraints identified in the Overall Integrated Plan (OIP) (Reference 6) and the Final Integrated Plan (FIP) (provided in Attachment 5) for Order EA-12-049.

j. FLEX Program Document – Established

The Waterford 3 FLEX Program Document has been developed in accordance with the requirements of NEI 12-06.

5. References

References are presented in Attachment 4 to this letter (W3F1-2016-0031).

Attachment 2

W3F1-2016-0031

Waterford Steam Electric Station, Unit 3,

NRC Interim Staff Evaluation Open or Confirmatory Items Summary

Interim Staff Evaluation Open Items	
3.1.3.A (CLOSED in NRC Audit Report (Reference 8))	Wind Hazard Screening - The licensee's response fails to consider the warning time offered by a hurricane storm for pre-staging FLEX equipment. In addition, as described in NEI 12-06, Section 7.2.2, hurricanes can have a significant impact on local infrastructure, e.g., downed trees and flooding that should be considered in the interface with off-site resources. <u>Waterford 3 Response</u> Hurricane Prep procedure EN-FAP-EP-010, "Severe Weather Response" and OP-901-521 "Severe Weather and Flooding" provide extensive actions to take advantage of any available hurricane warning time. Depending on the severity of an incoming storm or flood, the site takes considerable actions up to and including conducting a plant shutdown followed by a cooldown to Mode 5, with consideration for pre-planned actions to relocate specific "N+1" FLEX equipment to the NPIS. At least one set of FLEX equipment is protected from all hazards ("robust" per NEI 12-06) and is pre-staged by design. A debris removal assessment was performed to evaluate the potential for downed trees and other debris. Waterford 3 (WF3) has included debris removal equipment within the N+1 Storage Building. Additionally, a plan for helicopter deployment of equipment and personnel has been developed should the site be rendered otherwise inaccessible by the event.
3.2.1.1.B (CLOSED in NRC Audit Report (Reference 8))	CENTS - Justify conformance with the limitations of the use of CENTS by providing the CENTS-calculated value of the centered one-hour moving average of the flow quality at the top of the SG tubes, which corresponds to the maximum void fraction of 0.2 in SG tubes as conditions used to define termination of single phase natural circulation, and confirming that the value is less than the limit specified in the white paper dated September 24, 2013 for use in defining the onset of reflux being. <u>Waterford 3 Response</u> Vendor document LTR-TDA-13-20 (Reference 20) developed a method to aid in defining a flow quality at the top of the SG U-tubes which can be used to describe the onset of reflux cooling. The method involves calculating a centered moving average of the flow quality and then assigning a maximum quality of 0.10 to that moving average. The maximum flow quality of 0.10 ensures that the liquid flow into the cold half of the U-tubes is at least 9 times the steam flow which would condense on the tubes walls in the cold half of the tubes. Thus, the liquid flow through the tubes is sufficient to prevent any significant stratification of solutes in the cold half of the SG tubes and the loop cold legs. The time at which the flow quality reaches 0.1 may be different for the different SGs within the NSSS. For purposes of the ELAP event analyzed in WCAP-17601-P (Reference 21), the time at which the first SG reaches reflux cooling conditions is used to define the time of reflux cooling for the entire NSSS.

Interim Staff Evaluation Open Items	
3.2.1.2.A (CLOSED in NRC Audit Report (Reference 8))	RCP Seal Leakage - Justification of less than 15 gpm per RCP seal leakage in analysis. <u>Waterford 3 Response</u> The OIP (Reference 6) initially indicated that RCP seal leakage was "…no greater than approximately 58 gpm in phase 1." This value is outside the upper bound limitation (60 gpm total) the NRC placed on Combustion Engineering Designed Plants as stated in Waterford 3's ISE (Reference 7). In the second six month update submitted February 28, 2014 (Reference 10), Entergy indicated that "…The total seal leakage assumed in the current analysis is no greater than 60 gpm." The assumed RCP seal leakage used in the analysis conforms with NRC's guidelines.
3.2.1.2.B (CLOSED in NRC Audit Report (Reference 8))	RCP generic seal questions (Responses to parts e, f and g previously accepted by NRC in Reference 7) a. Discuss the analysis used to determine the RCP seal normal maximum leakage rate of 58 gpm, and address adequacy of the analysis including computer code/methodology and assumptions used. The RCP seal leakage testing data used to support the assumed leakage rate should be applicable to the Waterford RCP seals (with respect to the seal material, design and seal cooling systems) and ELAP conditions (in terms of the temperature and pressure) for an extended period consistent with the ELAP coping time. b. Address the applicability of the information in Section 4.4.2 of WCAP-17601, Rev. 0, which states that "It has been shown that the probability of seal failure greatly increases when there is less than 50°F of subcooling in the Cold Legs." If it is applicable, confirm whether a procedure step is available or not for operators to maintain the cold leg fluid temperature with subcooling of greater than 50 °F. If the procedure step is not available, provide justification. c. Address the applicability of assumption 2 on page 4-35 of WCAP-17601, which states that "Once RCP seal failure occurs, the leakage flow path characteristics remain constant for the rest event." If assumption 2 is not applicable, justify the non-applicability. If it is applicable, address the adequacy of the assumption throughout the ELAP event with consideration of the information in Section 4.4.2 of WCAP-17601 quoted in above item b. Also, address the effects of the assumption on the calculated RCP seal leakage rates during the ELAP event. d. Section 6.7 of WCAP-17601 states that "any seal temperature excursions above 500 °F are cause for concern and need to be minimized. The upper seal stages and vapor seal should remain intact if CBO and pressure protocol is initiated soon after an ELAP. Maintaining the seal stages below 350 °F should allow plant operators to minimize leakage to containment."

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h. If it is intended to credit significant improvement for ELAP related to the isolation of CBO lines, confirm that CBO isolation procedures, human factors requirements, and equipment qualifications are applicable to the ELAP event and are able to be achieved within the time frames described in section 5.3.1 of WCAP-16175.
i. Discuss how the analysis calculates the pressure-dependent RCP seal leakage rates. If the analysis uses the equivalent size of the break area based on the initial total RCP leakage rate of 58 gpm to calculate the pressure-dependent RCP seal leakage rates during the ELAP, discuss whether the size of the break area is changed or not in the analysis for the ELAP event. If the size is changed, discussed the changed sizes of the break area and address the adequacy of the sizes. If the break size remains unchanged, address the adequacy of the unchanged break size throughout the ELAP event in conditions with various pressure, temperature (considering that the seal material may fail due to an increased stress induced by cooldown) and flow conditions that may involve two-phase flow which is different from the single phase flow modeled for the RCP seal tests that are used to determine the initial total RCP seal leakage rate of 58 gpm.
<u>Waterford 3 Response</u>
a. In the second six month update submitted February 28, 2014 (Reference 10), Entergy indicated that “…The total seal leakage assumed in the current analysis is no greater than 60 gpm.”
The pressure dependent model used in support of WF3 ELAP analysis is the CENTS model. The CENTS model applies flow modeling for any flow out of the Reactor Coolant System through leaks or relief valves and is based on standard critical flow correlations. The specifics of the model are proprietary. The applicable RCP seal failure and leak rate analysis for the WF3 station is that associated with WCAP-17601-P (Reference 21). WCAP-17601-P and vendor document entitled “Westinghouse Response to NRC Generic Request for Additional Information (RAI) on Reactor Coolant Pump (RCP) Seal Leakage in Support of the Pressurized Water Reactor Owners Group (PWROG)” (Reference 22) were submitted to the NRC for its review. Based on the NRC review, the NRC staff placed certain limitations for CE plants. This limitation states that the RCP seal initial maximum leakage rate should be greater than or equal to the upper bound expectation for the seal leakage rate for the ELAP event (15 gpm/seal) discussed in the PWROG white paper addressing the RCP seal leakage for CE plants and the RCP leakage assumed in the analysis described in WCAP-17601-P. Based on this limitation, the value of 60 gpm total (15 gpm/seal) assumed in the current analysis is bounded by upper bound expectation for the seal leakage rate used in the analysis and approved by the NRC.
b. Reference 22 presents that the core delta-T during the early stages of natural circulation is generally 40°F to 50°F, meaning that the current operator actions will typically provide the required 50°F of sub-cooling margin at the RCP seals located on the cold legs. Short time survivability of the RCP seals is handled the same way as the current SBO strategy. Long-term survivability is maintained by a plant cooldown and depressurization.
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Interim Staff Evaluation Open Items	
	c. The pressure dependent model used in support of WF3 ELAP analysis is the CENTS model. The CENTS model applies flow modeling for any flow out of the Reactor Coolant System through leaks or relief valves and is based on standard critical flow correlations. The specifics of the model are proprietary. The applicable RCP seal failure and leak rate analysis for the WF3 station is that associated with WCAP-17601-P. WCAP-17601-P and Reference 22 were submitted to the NRC for its review. Based on the NRC review, the NRC staff placed certain limitations for CE plants. This limitation states that the RCP seal initial maximum leakage rate should be greater than or equal to the upper bound expectation for the seal leakage rate for the ELAP event (15 gpm/seal) discussed in Reference 22 addressing the RCP seal leakage for CE plants and the RCP leakage assumed in the analysis described in WCAP-17601-P. Based on this limitation, the value of 60 gpm total (15 gpm/seal) assumed in the current analysis is bounded by upper bound expectation for the seal leakage rate used in the analysis and approved by the NRC. d. The WF3 primary coolant pump seals are Flowserve Byron-Jackson Type N-9000 4 stage seal assemblies. These seal assemblies contain ethylene propylene elastomers. These types of elastomeric materials are capable of withstanding high temperatures in excess of 550°F for extended duration without change in service properties. Section 6.7 of WCAP 17601 is highlighting the concern with respect to high service temperature conditions on seal properties and the potential for elastomeric failure modes associated with “thermal binding” and “extrusion” (and, concerns for “heat checking” of the seal faces). The net effect of the plant cooldown will be to reduce RCS pressure and temperature, such that the final temperature in the cold legs will reach 400°F. The plant cooldown is initiated at 2 hours into the event and will be conducted in two steps. By so doing, the heating effects to the seal and its elastomers are significantly reduced and long term seal sustainability is optimized. Any temperature rate of rise will be gradual, will be progressive throughout the stages (lower stage heats up first) and will occur over an extended period of time. Since WF3 is expected to initiate a cooldown at 2 hours into the event, all stage temperatures are expected to be maintained below the elastomeric materials service properties of 550°F. h. The modeling of a 15 gpm per RCP leakage rate represents an upper bound expectation for the ELAP event. Each controlled bleed-off (CBO) line from the RCPs has a flow limiting check valve set to actuate at a flow rate of 10 to 15 gpm (WCAP-16175-P-A, Section 3.3). Therefore, by assuming 15 gpm through each check valve, the maximum RCP seal leakage flow is assumed. It is conservatively assumed that there has been no isolation of the CBO in the WF3 ELAP analysis. Failure of the excess flow check valves is not considered applicable to an ELAP event based on Section 3.2 of the NEI guidance document NEI 12-06. It is stated that all “installed equipment that is designed to be robust with respect to design basis external events is considered available.” Given that the excess flow check valves perform a design function, it is within the bounds of the guidance to assume all check valves perform their function without failure during an ELAP. i. The pressure dependent model used in support of WF3 ELAP analysis is the CENTS model. The CENTS model applies flow modeling for any flow out of the Reactor Coolant System through leaks or relief valves and is based on standard critical flow correlations. The specifics of the model are proprietary. The applicable

Interim Staff Evaluation Open Items	
	RCP seal failure and leak rate analysis for the WF3 station is that associated with WCAP-17601-P. WCAP-17601-P and Reference 22 were submitted to the NRC for its review. Based on the NRC review, the NRC staff placed certain limitations for CE plants. This limitation states that the RCP seal initial maximum leakage rate should be greater than or equal to the upper bound expectation for the seal leakage rate for the ELAP event (15 gpm/seal) discussed in the PWROG white paper addressing the RCP seal leakage for CE plants and the RCP leakage assumed in the analysis described in WCAP-17601-P. Based on this limitation, the value of 60 gpm total (15 gpm/seal) assumed in the current analysis is bounded by upper bound expectation for the seal leakage rate used in the analysis and approved by the NRC.
3.2.1.3.A (CLOSED in NRC Audit Report (Reference 8))	Decay Heat -Assumption 4 on page 4-13 of WCAP-17601 states that decay heat is per ANS [American Nuclear Society] 5.1-1979 + 2 sigma, or equivalent. Address the applicability of assumption 4 to Waterford. If the ANS 5.1-1979 + 2 sigma model is used in the Waterford ELAP analysis, address the adequacy of the use of the decay heat model in terms of the plant-specific values of the following key parameters: (1) initial power level, (2) fuel enrichment, (3) fuel burnup, (4) effective full power operating days per fuel cycle, (5) number of fuel cycles, if hybrid fuels are used in the core, and (6) fuel characteristics (addressing whether they are based on the beginning of the cycle, middle of the cycle, or end of the cycle). If a different decay heat model is used, describe the specific model and address the adequacy of the model and the analytical results. <u>Waterford 3 Response</u> The ELAP analyses performed for WF3 in WCAP-17601-P Rev 1 (Reference 21) and CN-SEE-II-13-3, Rev 2 (Reference 23) implemented the ANS 5.1-1979 decay heat curve with two sigma uncertainty and included the effects of neutron capture and long term actinides (Westinghouse CN-OA-02-13, Rev 5, Section 4.4 developed in Westinghouse 25/26/27-AS95-C-015, Rev 3). 25/26/27-AS95-C-015 was originally created for Palo Verde Nuclear Generating Station but it is applicable to all plants, including WF3, that remain within the limits established with respect to power level, fuel enrichment, fuel burnup, operating cycle length, fuel characteristics, and the use of hybrid fuel. It also states that the decay heat curve is applicable up to the following limits: 1. Power level up to 4070 MWt 2. Fuel enrichments up to and including 5.0 weight percent 3. Fuel burnups up to 73,000 MWD/MTU 4. Up to a 24 month operating cycle with a 90% overall capacity factor 5. Not applicable to hybrid fuel 6. Fuel characteristics are based on the entire fuel cycle The initial power level for the WSES-3 analysis is 100% or 3716 MWt (CN-OA-02-13, Table 2-1). Fuel enrichment at WF3 is less than 5.0 weight percent per federal law and there is no hybrid fuel in the WF3 core. The operating cycle for WF3 is 18 months and fuel burnup does not surpass 73,000 MWD/MTU. The curve used in Reference 21 for the WF3 analyses is applicable and conservative.

Interim Staff Evaluation Open Items	
3.2.1.8.A (CLOSED in NRC Audit Report (Reference 8))	Core Sub-Criticality- Regarding boron mixing, the NRC staff has not yet accepted the PWROG [Pressurized Water Reactor Owners Group] position paper on boron mixing. Therefore, additional technical justification will be needed to resolve this issue, both generically and on a plant-specific basis. <u>Waterford 3 Response</u> To avoid reflux cooling, the FLEX RCS makeup occurs at least one hour prior to the two-phase loop flow rate decreases below the loop flow rate corresponding to single-phase natural circulation. Therefore, the boron mixing criteria are met. The analysis also demonstrates indefinite subcritical condition maintained with RCS temperature at or above 400°F with no credit for additional boration.
3.2.4.2.A (CLOSED in NRC Audit Report (Reference 8))	Ventilation - Adequacy of ventilation in the control room to protect energized equipment throughout the entire ELAP event, especially if the ELAP is due to high temperature hazard. <u>Waterford 3 Response</u> In order to keep temperatures below the established acceptance criteria of 110°F, operator actions at 30 minutes are required (load shedding, opening selected doors) in accordance with current SBO procedures. Additional operator actions are taken at 4 hours (opening additional doors) and later using a fan connected to a FLEX diesel powered generator at 13 hours to supply air to the Main Control Room through door D259. A 15,000 CFM fan was selected for this application. The results of the analysis (Reference 26) determined that the control room will remain below 110°F following an ELAP by establishing forced ventilation by 13 hours.
3.2.4.2.B (OPEN)	Ventilation- Effects of elevated temperatures in the battery room, especially if the ELAP is due to a high temperature hazard. <u>Waterford 3 Response</u> The 3A-S and 3B-S battery rooms are adjacent to the respective switchgear rooms. The switchgear room heat-up evaluations are applied to the battery rooms which conclude no room cooling is required. The 3AB-S battery room is not credited beyond its initial 4 hours per existing SBO analysis and therefore room cooling is not required for that room. Calculation ECS14-004 (Reference 28) concludes that the rooms/areas do not exceed the equipment limits following an ELAP event. The only manual actions specified in the calculation are associated with opening several doors 2 hours after the initiation of the ELAP event to establish passive ventilation. At this time, the rooms/areas are all below the 110 degree F limit for habitability.
3.2.4.2.C (CLOSED in NRC Audit Report (Reference 8))	Ventilation - Hydrogen concentration in the battery rooms during recharging <u>Waterford 3 Response</u> The battery rooms require ventilation to prevent the accumulation of hydrogen gas while the batteries are being charged during Phases 2 and 3. Ventilation is provided via repowering the existing battery room exhaust fans (SVS-MFAN-0006A(B) for

Interim Staff Evaluation Open Items	
	train A batteries or SVS-MFAN-0005A(B) for Train B batteries). By repowering only the exhaust fan, a slight negative pressure will be drawn on the room, purging whatever hydrogen is generated via the normal discharge to atmosphere (Reference 29)
3.2.4.2.D (CLOSED in NRC Audit Report (Reference 8))	Ventilation - Loss of ventilation and any potential impacts on the necessary equipment in the TDEFW pump room. <u>Waterford 3 Response</u> Due to the FLEX actions required in the area surrounding the TDEFW pump, the RAB -35' el. was evaluated for operator accessibility. Calculation ECS14-003 (Reference 27) indicates the maximum temperature over the first 72 hours is 103°F around the TDEFW pump. The GOTHIC analysis concludes the temperature in the area will continue to rise as the event progresses. Part of this is based on the conservative modeling assumption that the majority of the GOTHIC conductors act as insulating boundary conditions. However, ventilation/cooling is expected to be required after 120 hours to protect the FLEX operating equipment. One method to reestablish room cooling in Phase 3 in this area is to repower the Essential Chiller and corresponding room coolers with the NSRC 4160V Diesel Generator.
3.2.4.4.A (CLOSED in NRC Audit Report (Reference 8))	Lighting - Review the licensee's assessment of the habitability/accessibility requirements to ensure lighting is appropriately addressed. <u>Waterford 3 Response</u> Lighting panels for high priority areas will be repowered by the Phase 2 FLEX diesel generator. Diesel powered lighting towers are stored in the "N+1" storage building and can be deployed if required. Portable flashlights, that are normal equipment supplied to station operators (per Reference 30), may be required for work in some areas of the plant (limited to indoor areas where lighting was not determined to be vital). In addition, high powered light emitting diode (LED) flashlights are stored in FLEX JOBOXs. (Reference 31)
3.2.4.8.A (CLOSED in NRC Audit Report (Reference 8))	Electrical Power Sources/Isolation and Interactions- Provide a summary of the sizing calculations used to determine the adequacy of the FLEX generators used to power plant electrical equipment. <u>Waterford 3 Response</u> The "N" FLEX diesel has been sized to accommodate the following simultaneous loads: • Charging Pump • Motor-driven FLEX Core Cooling Pump • Component Cooling Water Make-up Pump • Battery Charger • Battery Room Exhaust Fan • Fuel Oil Transfer Pump • Lighting

Interim Staff Evaluation Open Items	
	• SIT Isolation Valves (intermittent) • Additional Emergency Plan Communications equipment A detailed sizing calculation is given in calculation ECE14-003 (Reference 32). The results indicate that a 400kW diesel generator is acceptable for providing power to the necessary FLEX loads during Phase 2. Calculation ECE14-003 also addresses loading for the NSRC Phase 3 4160V Generator. The results indicate that the NSRC 4160V Generator is acceptable for providing power to the identified Phase 2 and Phase 3 loads. The following loads have been identified as potentially being repowered by this 4160V generator per this report: • Battery Charger 3A1-S and Battery Room Exhaust Fans • Charging Pump – to provide redundancy to FLEX 480V DG • Component Cooling Makeup Pump • LPSI Pump 'A' and system valves • CCW Pump 'A' • DCT fans 1-SA through 15-SA - (15 installed and 9 protected), • Essential Chiller [compressor, oil pump and chilled water pump], • Room coolers for the LPSI pump, CCW pump, EFW pump, CVC pump and SDC heat exchanger, • Air handling units and exhaust fan for the Main Control Room, • Air handling units and exhaust fans for the H&V Fan room, and • Additional intermittent loads have been evaluated for the operation of valves, and are bounded by Safety Injection system MOVs. • Containment Fan Cooler – (slow speed to reduce the loading on the NSRC 4160V Generator.)
3.2.4.10.A (CLOSED in NRC Audit Report (Reference 8))	Load Reduction to Conserve DC Power - The licensee's Integrated Plan on Page 7 identifies dc load shed at hour 1 and 4. With regard to the load shedding of the dc bus in order to conserve battery capacity: a. Provide the dc load profile for the mitigation strategies to maintain core cooling, containment, and SFP cooling during all modes of operation. In your response, describe any load shedding that is assumed to occur and the actions necessary to complete each load shed. Also provide a detailed discussion on the loads that will be shed from the dc bus, the equipment location (or location where the required action needs to be taken), and the required operator actions necessary and the time to complete each action. In your response, explain which functions are lost as a result of shedding each load and discuss any impact on defense-in-depth strategies and redundancy. b. Identify any plant components that will change state if vital ac or dc power is lost or de-energized during the load shed. c. Provide the minimum voltage that must be maintained and the basis for the minimum voltage on each battery/dc bus during each Phase under all MODES of operation (consider the impact of reduced loading as a result of load shedding).

Interim Staff Evaluation Open Items	
	<u>Waterford 3 Response</u> a & b Within 30 minutes following an SBO, operators reduce battery loads for all three trains by opening breakers located in power distribution panels located in the switchgear rooms. When an ELAP is declared within 1 hour following an SBO, operators will further reduce battery loading on either the 'A' or 'B' Train based on the train selected for power to mitigate the ELAP. The loads to shed (i.e., deep load shed) are identified in FLEX Support Guidelines (FSGs) and are located in the power distribution panels as discussed for SBO. The deep load shed is to be completed within 120 minutes following the SBO. With loads shed required by SBO within 30 minutes and the FLEX deep load shed completed by 120 minutes, a battery duration of 12.5 hours is expected assuming a minimum battery voltage of approximately 108V (ECE14-004 and ECE14-005, References 33 and 34). After the deep load shed, no immediate actions are required to maintain the plant safe and stable. Plant components required to maintain the plant safe and stable 'fail-safe' following a loss of power. A summary of the considerations depending on the train selected for the deep load shed include the following: • Differences in available instrumentation systems exist dependent on selection of extended load shed train. For monitoring RCS temperature and level, CETs and RVLMS are available during Phase 1 if the B train is the selected. If A Train is selected, RCS temperature and level will be monitored by the RCS Hot Let RTDs and Pressurizer Level for Phase 1. In addition, CSP level indication must be monitored locally following a deep load shed on the 'A' Train. • For either Train selected for the deep load shed, manual control of EFW flow control valves will be required within 4 hours for the valves powered by the non-deep load shed batteries. The EFW flow control valves are equipped with local handwheels. • The timeline for local manual ADV control is dependent on the train selected for the deep load shed. If the B Train is selected, local manual control of ADV 'A' is required within 4 hours and 10 hours for ADV 'B'. If the A Train is selected, local manual control of ADV 'A' is required prior to opening its control power breaker during the deep load shed and 4 hours for ADV 'B'. • For either Train selected for the deep load shed, manual control of TDEFW pump will be required within 4 hours as the 'AB" train of batteries that provide control power are expected to be depleted. • Depending on train selected, the opposite train MCC is repowered by the FLEX Diesel Generator using an electrical cross-connect to power the MCC from the energized MCC. • Control power can be restored to place a Charging Pump in service ('A' or 'B depending on Train selected) after the FLEX Diesel Generator is available. The above considerations are included in the FSGs. Additional details on the impact of the deep load shed are provided in the supporting calculations (References 33 and 34)

Interim Staff Evaluation Open Items	
	c. Calculation ECE14-004 (Reference 33) calculates for battery 3A-S that the minimum voltage that must be maintained after load shedding for FLEX is 108V (or 1.80V per cell). Calculation ECE14-005 (Reference 34) calculates for battery 3B-S that must be maintained after load shedding for FLEX is 107.4V (or 1.79V per cell). The minimum voltage drop was calculated by using the same methodology as existing plant SBO calculations ECE91-058 and ECE91-059 (References 33 and 34) by ensuring that the downstream loads will have sufficient voltage. In addition, the calculated minimum voltage at the batteries considers the reduced load due to shedding. The results show that the station batteries have a minimum runtime of 12.5 hours assuming the SBO load shed is completed by 30 minutes and the FLEX deep load shed is completed by 2 hours post loss of power.

Interim Staff Evaluation Confirmatory Items	
3.1.1.1.A (CLOSED in NRC Audit Report (Reference 8))	Seismic Protection - Licensee to ensure that: 1) seismic interactions to ensure equipment is not damaged by non-seismically robust equipment or structures for portable equipment that will be stored outside; 2) how large FLEX equipment such as pumps and power supplies stored inside seismic structures is appropriately secured to protect them during a seismic event; and, 3) where other portable equipment such as hoses and power cables would be stored to assure proper protection from a seismic event. <u>Waterford 3 Response</u> 1) All new FLEX equipment is stored in the N+1 Storage Building in a manner consistent with the sliding and rocking evaluation. (ECC14-039, Reference 36). The N+1 Storage Building itself is designed to ASCE 7-10 (EC 51386). 2) All new FLEX equipment and storage boxes are seismically restrained (EC 51387 and EC 48415). 3) All cables and hoses necessary for the Phase 2 FLEX strategy (with an additional 10% or longest individual segment spare length) are stored within racks that are seismically restrained within the NPIS (which includes the RAB, FHB, and RB), which is a seismic Category I structure.
3.1.1.2.A (CLOSED in NRC Audit Report (Reference 8))	Seismic Deployment - Protection of the connection points for Reactor Coolant System (RCS) inventory control during the final phase is yet to be determined (TBD). <u>Waterford 3 Response</u> For maintaining RCS Inventory Control in Phase3, the NSRC HP Injection Pump can be used with hoses run to the RAB -35' el. and connected to the FLEX connections on HPSI 'A' and 'A/B' piping within the RAB. The RAB is a robust structure for all applicable external hazards. The HPSI system is a Seismic Category I, safety related quality class 2 system. The new FLEX piping and valves that directly interface with the existing system

Interim Staff Evaluation Confirmatory Items	
	are designed per ASME Section III, Class 2 to be consistent with existing plant design. The RAB is a robust structure for all applicable external hazards.
3.1.1.2.B (CLOSED in NRC Audit Report (Reference 8))	Seismic Protection - Protection of the tow vehicle used to move the spare or "N+1" FLEX generator. (Also tied into to the ability to move equipment in the flooding context discussed in Section 3.1.2.2 and wind protection for the vehicle discussed in Section 3.1.3.2) <u>Waterford 3 Response</u> Per NEI 12-06, at least one set of each FLEX equipment is to be protected from all extreme external hazards applicable to the site. For Waterford 3, the minimum equipment required to support the FLEX safety functions ("N" set) is stored within the NPIS, a seismic Category I structure robust for severe storms with high winds (including tornado wind loads and missiles), external flooding up to +30' MSL, ice, and extreme high temperatures. The majority of the spare equipment, along with the towing/debris removal equipment, is stored within the "N+1" storage building, a commercially procured storage facility designed to meet ASCE 7-10. NEI 12-06 Section 5.3.1 states that large portable FLEX equipment should be secured as appropriate and that it should be evaluated and protected from seismic interactions as to ensure that unsecured components do not damage the equipment. Seismic movement calculation ECC14-039 (Reference 36), for the "N+1" FLEX equipment housed in the FLEX "N+1" storage building provides the separation distance of the equipment within the building to ensure that they will not interact with each other during a seismic event. Given notice of an impending extreme external hazard (e.g., a hurricane warning or Mississippi River levels slowly rising to potential flood level), pre-planned actions are taken to relocate specific "N+1" FLEX equipment to the NPIS such that it is provided additional protection from the hazard (Reference 19)
3.1.1.3.A OPEN	Seismic Procedural Interface - Seismic hazards associated with large internal flooding sources that are not seismically robust and do not require ac power, and the use of ac power to mitigate ground water in critical locations. <u>Waterford 3 Response</u> Due to the WF3 FLEX strategy's reliance upon mounted equipment within the RAB, potential sources of flooding were reviewed for internal flooding impacts to the strategy. Water sources identified that could cause internal flooding within the RAB are listed and assessed for robustness within WF3-CS-15-00009 (Reference 41). The limiting flood rate for the sources that could not be evaluated as robust is 62 gpm per ECM15-004 (Reference 42). At this flood rate, the FLEX strategy could be impacted within 28 hours. In order to mitigate this flooding impact, the primary strategy is to utilize a pre-staged sump pump. As an alternate strategy, the flooding sources are to be isolated via their associated isolation valves. If internal flooding is identified following a seismic event, the installed FLEX air powered sump pump can be placed into service near Floor Drain (FD) Sump #10

Interim Staff Evaluation Confirmatory Items	
	by 28 hours (Reference 43). The pump will take suction from the sump and hoses will be routed from the discharge of the pump to a manifold on the RAB -35' el. which discharges to the suction of the CCW MU pump. This alignment allows for transfer of the flood water to either the suction of the FCCP, TDEFW, or CCW MU pumps or to the WCT basin. The compressed air to run the pump will come from an existing SBO air compressor, permanently staged on the RAB +21' el. by the Emergency Diesel Generators, which will be moved to the Q-deck. The air compressor provides adequate air flow and pressure to drive the pump. (The air compressor is diesel driven. The compressor will be fueled from the feed tanks and replenished on an ongoing basis utilizing the fuel nozzle deployed to the Q-deck The pre-staged pump and air compressor (along with connection hardware) are located inside the RAB and NPIS and are fully protected against all applicable external events.
3.1.1.4.A (CLOSED in NRC Audit Report (Reference 8))	Seismic Off site resources - The licensee has not yet identified the local staging area and method of transportation to the site. <u>Waterford 3 Response</u> For non-persistent flooding events, the on-site equipment staging location for Phase 3 NSRC equipment will be in the plant parking lot. Confirmatory Item 3.1.2.2A discusses staging for persistent flooding events.
3.1.2.2.A (CLOSED in NRC Audit Report (Reference 8))	Flooding Deployment- Implementation of flooding persistence into their FLEX strategies for pre-event staging of FLEX equipment. <u>Waterford 3 Response</u> Due to WF3's unique flooding situation, the FLEX strategy is designed to protect at least one set of FLEX equipment from the effects of external flooding by pre-staging the FLEX equipment within the flood-protected areas of the NPIS. The "N" set of FLEX equipment is stored in the NPIS to ensure it is protected from all extreme external hazards.(Reference 26) The pre-staged FLEX equipment includes: • FLEX Core Cooling Pump; • Onsite FLEX Water Transfer Pump (backup to NSRC pump); • FLEX Diesel Generator; and • FLEX Diesel Fuel Transfer Pump. Pre-planned strategies have been developed to provide reasonable protection of the "N+1" set for the predictable external events with pre-warning (i.e., floods and hurricanes). OP-901-521 "Severe Weather and Flooding," Off Normal Procedure (Reference 19) contains guidance on implementing these pre-planned actions. For the long term persistence and delivery of Phase 3 equipment and supplies, a memorandum of understanding has been issued with the Louisiana Governor's office of Homeland Security and Louisiana national guard for helicopter support. Helicopter deliveries of supplies, personnel and NSRC equipment will be made to the RAB roof staging area.

Interim Staff Evaluation Confirmatory Items	
3.1.2.3.A (CLOSED in NRC Audit Report (Reference 8))	Flooding Procedural Interface- Deployment of portable equipment in flooded conditions not incorporated into flood procedures or the need to deploy temporary flood barriers and extraction pumps necessary to support deployment. <u>Waterford 3 Response</u> The procedural interfaces identified in NEI 12-06 Section 6.2.3.3 are not applicable because WF3 protects an N set of equipment from external flooding without the need for temporary flood barriers. Additionally, all FLEX connection points are protected from external flooding. Reference 19 contains guidance on implementing the pre-planned actions to consider relocating select N+1 equipment to inside the RCA based for events that have pre-warning (i.e. hurricanes, river flooding)
3.1.3.2.A (CLOSED in NRC Audit Report (Reference 8))	Wind Deployment - Whether procedures and programs will include taking proactive actions such as testing, connecting, and readying exposed portable equipment to reduce the potential for wind impacts. <u>Waterford 3 Response</u> The site takes considerable actions depending on the severity of an incoming storm or flood, up to and including conducting a plant shutdown followed by a cooldown to Mode 5. At least one set of FLEX equipment is protected from all hazards (“robust” per NEI 12-06) and is pre-staged by design. OP-901-521 (Reference 19) provides direction to operations to implement proactive actions for expected wind events.
3.2.1.1.A (CLOSED in NRC Audit Report (Reference 8))	CENTS - Verify the use of CENTS in the ELAP analysis for Waterford is limited to the flow conditions before reflux boiling initiates. This includes providing a justification for how the initiation of reflux boiling is defined. <u>Waterford 3 Response</u> The results of the site-specific ELAP analysis (Reference 25) determined that RCS make-up at a rate of 25 gpm within 17 hours of the initiation of the event will prevent the transition to reflux cooling. Since the RCS make-up is initiated at approximately 12.5 hours at 44 gpm make-up capacity, the reflux cooling condition will be avoided. The model used for determination of RCS response was based on that used in the generic analysis in WCAP-17601, Section 5.3.2 (Reference 21). A WF3 site specific ELAP analysis was performed utilizing the Combustion Engineering Nuclear Transient Simulation (CENTS) code (Reference 25). The CENTS code was considered acceptable by the NRC for ELAP analyses in NRC Letter from Jack R. Davis (NRC) to Jack Stringfellow (PWROG), dated October 7, 2013 (ADAMS Accession No. ML13276A555) The response to Open item 3.2.1.1 B provides description of how initiation of reflux boiling is determined.

Interim Staff Evaluation Confirmatory Items	
3.2.1.4.A (CLOSED in NRC Audit Report (Reference 8))	Initial Values for Key Plant Parameters and Assumptions- Review analysis of UHS [Ultimate Heat Sink] (licensee open item OI5) <u>Waterford 3 Response</u> In the fourth 6 month update (Reference 12), Entergy indicated that the FLEX strategy extends Phase 2 coping by continuing to feed the SGs with either the NSRC equipment or the FLEX Water Transfer Pump. Phase 3 does not rely on the active components comprising the UHS (CCW pumps, DCT/WCT fans) with the exception that it may be used for containment cooling late in Phase 3 (approximately 5 days). However, this heat load is relatively small where the UHS can easily remove it with minimal fan capacity. FLEX strategy does not require establishment of shutdown cooling where the heat loads would be significantly higher.
3.2.3.A OPEN	Containment Functions Strategies - Review the results of the finalized containment analysis associated with open item OI2 of the Integrated Plan, which shows that containment functions will be (potentially) restored and maintained in response to an ELAP event. <u>Waterford 3 Response</u> For plant modes with SGs available, the containment MAAP analysis (Reference 44) demonstrates that containment temperature and pressure limits are not challenged during the first five days following a ELAP. It also concludes that containment spray is not required as part of the FLEX strategy. However, containment cooling is required to be established in approximately five days to ensure the availability of instrumentation. Containment cooling can be established by repowering a containment fan cooler (CFC) and necessary UHS equipment, if available, utilizing the NSRC 4160V Generator. If UHS equipment is not available, once through cooling could be established to the CFC utilizing the NSRC LP/MF pump taking suction from the Mississippi River and supplying flow to the CFC's CCW supply and return headers. For plant modes with SGs unavailable, a containment vent will be established within 6 hours post ELAP. With the containment vent established, containment temperature and pressure design limits are not exceeded.
3.2.4.4.B (CLOSED in NRC Audit Report (Reference 8))	Communications - Confirm that upgrades to the site's communications systems have been completed. <u>Waterford 3 Response</u> EC 47846, Rev 0, "Fukushima E-Plan communications" is complete and included the following: - Installed additional handheld radios and satellite phones in TSC - Installed UPS and cable for backup power for the handheld and satellite phone docking stations in various locations. - Installed FLEX power backed radio charger - Installed backup power Batteries/UPS/ FLEX power for Maintenance and Operations.

<table>
<tr><th colspan="2">Interim Staff Evaluation Confirmatory Items</th></tr>
<tr><td>3.2.4.5.A
(CLOSED in NRC Audit Report (Reference 8))</td><td>Protected and Internal Locked Area Access- Verify access plans are incorporated into FLEX strategies.

<u>Waterford 3 Response</u>
Security key rings are part of the standard gear/equipment of operators with duties in the plant (outside the main control room) as stipulated in Reference 45. There are no areas requiring access that are rendered inaccessible in the event of a loss of power.</td></tr>
<tr><td>3.2.4.6.A
(CLOSED in NRC Audit Report (Reference 8))</td><td>Personnel Habitability - Review the licensee's assessment of the habitability/accessibility requirements in all critical areas.

<u>Waterford 3 Response</u>
<u>Main Control Room</u>
In addition to the operator actions taken at 30 minutes in accordance with current SBO procedures, the Main Control Room BDBEE analysis (ECS14-002, Reference 26) resulted in additional operator actions being taken at 4 hours (opening additional doors) and later using a fan connected to a FLEX diesel powered generator at 13 hours to supply air to the Main Control Room through door D259. By establishing forced ventilation by 13 hours, the analysis determined that the control room will remain below 110°F following an ELAP.

<u>Switchgear Rooms A & B</u>
Due to the FLEX actions required in the switchgear rooms during the first 12 hours following the event, habitability temperature was determined over this initial timeframe (Reference 28). Switchgear ‘B’ reaches 109°F at 12 hours for the primary strategy. Switchgear ‘A’ reaches 110°F at 12 hours for the alternate strategy. These temperatures are acceptable for operator actions. Once the switchgear is repowered in Phase 2, the rooms will begin to heat-up further, however at this point continuous occupancy is not expected and therefore forced ventilation is not required. Re-entry to the area remains possible considering limited stay times at the elevated temperature conditions.

<u>Battery Rooms A & B</u>
The battery rooms require ventilation to prevent the accumulation of hydrogen gas while the batteries are being charged during Phases 2 and 3. Ventilation is provided via repowering the existing battery room exhaust fans,
The 3A-S and 3B-S battery rooms are adjacent to the respective switchgear rooms. The switchgear room heat-up evaluation results are applied to the battery rooms which conclude no room cooling is required.

<u>RAB -35’ Elev.</u>
The FCCP, charging pumps, CCW MU pump and TDEFW pump will be utilized at various times during the FLEX strategy. All of these pumps are located on the -35’ Elev. of the RAB. The area heat-up calculation (ECS14-003, Reference 27) determined that forced ventilation would not be required for well beyond 72 hours.</td></tr>
</table>

Interim Staff Evaluation Confirmatory Items	
	Due to the FLEX actions required in the area surrounding the TDEFW pump, the RAB -35' Elev. was evaluated for operator accessibility. The calculation indicates the maximum temperature over the first 72 hours is 103°F around the TDEFW pump and 104°F in the hallway outside the charging pump rooms. If Train A charging pump is used for RCS injection during Phase 2, Door 252 will be propped open to provide passive ventilation. <u>RAB -35' Elev Wing Area</u> The -35' Elev. wing area contains the rigid suction hoses necessary to establish a gravity drain path from WCT basin A to the TDEFW pump (or FCCP). The heat load is minimal in this room and it remains accessible to allow for the connection of the hoses. <u>RAB +46' Elev Diesel Fuel Oil Feed Tank Area</u> The diesel fuel oil feed tanks are located on the RAB +46' Elev. within enclosures accessed via doorways to the roof. Manual actions are required within the rooms to begin diesel fuel oil replenishment approximately 24 hours after the start of the event. The room remains accessible for the connection of hoses. <u>RAB +41' Elev "N" Enclosure</u> The new FLEX diesel generator enclosure on the RAB +41' Elev. has been evaluated for room heat-up considerations Passive ventilation is provided to ensure the FLEX diesel generator will remain functional for the duration of the BDBEE response. <u>Fuel Handling Building</u> Deployment of hoses are required to provide the option for direct make-up into the SFP as well as SFP spray functionality. These hose runs will be completed prior to time to boil of 12 hours, 45 minutes under normal operating conditions. Excessive steam accumulation in the FHB is prevented by propping open the SFP doors to establish a vent path.
3.2.4.7.A (CLOSED in NRC Audit Report (Reference 8))	Water Sources -Verify the evaluation of the suction path from the TDEFWP to the WCTs [Wet Cooling Towers] through a non-running ACCWS [Auxiliary Component Cooling Water System] pump post-ELAP confirms it is viable. <u>Waterford 3 Response</u> The strategy of drawing WCT basin water through a non-running ACCWS pump was changed to establish a gravity drain path directly to the suction of the TDEFW pump, bypassing the non-running ACCWS pump. The associated modifications to implement this strategy were installed via EC 51887 and completed on 1/22/16.

Interim Staff Evaluation Confirmatory Items	
3.2.4.7.B (CLOSED in NRC Audit Report (Reference 8))	Water Sources - Description of how the licensee would get water from the Mississippi River to the FLEX pumps. <u>Waterford 3 Response</u> Water inventory management for Phase 3 utilizes NSRC equipment. The NSRC will provide diesel-driven water transfer pumps that are capable of providing make-up from either the Mississippi River or surrounding flood water. In a non-flood BDBEE, the NSRC LP/HF Pump will be utilized to transfer water from the Mississippi River to the WCT basins, RWSP, and SFP. The NSRC LP/HF Pump will be deployed near the Mississippi River with hoses routed from the pump back to the plant. The system will be utilized in conjunction with the water treatment system and mobile boration systems to provide indefinite make-up water for use by the FLEX strategies. The NSRC LP/HF Pump is capable of providing sufficent flow (5000 gpm), to provide SFP and RCS makeup as well as decay heat removal for core cooling. There are also onsite FLEX Water Transfer Pumps as backups, if required
3.2.4.8.B (CLOSED in NRC Audit Report (Reference 8))	Electrical Power Sources/Isolation and Interactions - Licensee to provide the level of detail of the FLEX instrumentation to ensure that electrical equipment remains protected (from an electrical standpoint- e.g., power fluctuations). Also, confirm electrical isolation to ensure that the portable/FLEX diesel generators are isolated from Class 1 E diesel generators to prevent simultaneously supplying power to same Class 1 E bus. <u>Waterford 3 Response</u> _Appropriate controls for the equipment are implemented in FSG-05 ("Initial Assessment and FLEX Equipment Staging") Attachment 3 to ensure compliance with NEI 12-06 section 3.2.2.13. Connection points and other permanent modifications are designed in accordance with approved design practices to ensure no adverse effects during normal operation. At the onset of the ELAP, Class 1E EDGs are unavailable to supply the Class 1E busses. The FLEX generator is used in response to an ELAP in Phase 2 and could also be used in Phase 3. FSG-05 Attachment 3 provides guidance for connecting the FLEX generator to the selected 1E 480 V bus. Additionally, repowering the Class 1E 4160 V electrical buses is covered in EOP OP-902-009 (Emergency Operating Procedures Standard Appendices) Attachment 12-B and is accomplished manually. No automatic sequencing or automatic repowering of the buses is utilized.
3.2.4.9.A (CLOSED in NRC Audit Report (Reference 8))	Portable Equipment Fuel - Diesel fuel oil supply for the diesel driven pump and how continued operation to ensure core cooling is maintained. Diesel fuel oil supply (e.g., fuel oil storage tank volume, supply pathway, etc.) for the FLEX generators and how continued operation to ensure core and SFP cooling is maintained indefinitely (i.e., Phase 2 and 3).

Interim Staff Evaluation Confirmatory Items	
	<u>Waterford 3 Response</u> Per NRC ISE (Reference 7) this confirmatory item is specific to fuel replenishment for the FLEX Diesel Generator and the EFW Secondary Diesel Pump mentioned in the Waterford 3 Overall Integrated Plan (Reference 6). The FLEX strategy no longer utilizes an EFW Secondary Diesel Pump, therefore the response to Confirmatory Item 3.2.4.9 is limited to fuel replenishment provisions for continued operation of the FLEX Diesel Generator. Per ECM14-006 (Reference 46), the total Phase 2 FLEX equipment fuel consumption rate for the Waterford 3 FLEX strategy is 0.69 gpm for required equipment which is conservatively increased to 15 gpm to account for miscellaneous loads which are not required for the Phase 2 strategies. The diesel fuel oil storage tanks contain a minimum of 39,300 gallons of diesel fuel each. The diesel fuel oil feed tanks contain a minimum of 339 gallons each (Reference 47). Therefore, the site has a minimum inventory of diesel fuel oil on site to maintain the FLEX consumption rate for approximately 40 days from either train of the Diesel Generator fuel oil storage and transfer system. NSRC equipment brought in during Phase 3 will increase the fuel consumption rate, and therefore to ensure adequate diesel fuel is available for FLEX, diesel fuel truck service (or air lift in the case of a persistent flood) will be established by 72 hours following the start of the BDBEE. <u>FLEX Diesel Generator</u> The FLEX Diesel Generator is equipped with a 400 gallon tank to allow for initial operation prior to implementing the diesel fuel replenishment strategy. To accommodate routine testing and maintenance of the FLEX Diesel Generator, the tank minimum volume is 330 gallons (approximately 12 hours of operation). With the FLEX Diesel Generator being placed into service by 12 hours following the start of the BDBEE, the fuel replenishment strategy would need to be implemented prior to 24 hours following the start of the BDBEE. The diesel fuel strategy consists of repowering an existing diesel fuel oil transfer pump and level instrumentation associated with the feed tank. This will transfer fuel from the diesel fuel oil storage tanks (DFOSTs) to the diesel fuel oil feed tanks. The diesel fuel oil transfer pump motor is controlled during an event from the associated EDG control panel. These loads will be repowered by the FLEX Diesel Generator and will allow the feed tank level instruments to automatically control the transfer pump. Vent valve EGF-121A(B) on the diesel oil feed tank to the Emergency Diesel Generator (EDG) will be used as the supply connection for the FLEX Diesel Fuel Transfer Pump which will be staged outside of the feed tank rooms. The discharge of the FLEX Diesel Fuel Transfer Pump will be routed to a manifold that will have discharge connections to the FLEX Diesel Generator, Q-deck (RAB +21' el. West Side), and a short discharge hose to allow refueling of the FLEX Diesel Fuel Transfer Pump. The FLEX Diesel Fuel Transfer Pump will be controlled locally on the RAB +46' el. outside of the feed tank rooms. Once nozzles are in place and ready for fueling, the pump will be started to supply fuel. Hosing will be routed to the Q-deck (RAB +21' el. West Side) in order to replenish

Interim Staff Evaluation Confirmatory Items	
	the on-site FLEX Water Transfer Pump and FLEX sump pump air compressor. All credited diesel powered FLEX equipment is capable of being refueled while operating.
Cer3.2.4.9.B (CLOSED in NRC Audit Report (Reference 8))	Portable Equipment Fuel - Discuss how fuel quality will be maintained. Waterford 3 Response The fuel oil for FLEX equipment will be maintained similarly to the fuel oil stored in the site's emergency diesel generator fuel oil storage tanks (FOSTs). Site procedure CE-002-030 (Reference 51), will be revised to incorporate maintaining the FLEX equipment fuel oil requirements which will include sampling the fuel oil for water/Sediment, kinematic viscosity, and cloud point. Acceptance criteria will follow the guidance of ASTM D 975 for ULSD No. 2 fuel oil (No. 2-D, S15 column of ASTM D 975).

Attachment 3

W3F1-2016-0031

Waterford Steam Electric Station, Unit 3,

Summary Responses to Open/Pending Items in FLEX Audit Report

Summary Responses to Open/Pending Items in FLEX Audit Report

Audit Item Reference	Item Description
OI 3.2.4.2.B	Ventilation- Effects of elevated temperatures in the battery room, especially if the ELAP is due to a high temperature hazard. Waterford 3 Response Response provided in Attachment 2
CI 3.1.1.3.A	Complete internal flood analysis and make available for NRC review on the e-portal. Waterford 3 Response Response provided in Attachment 2
CI 3.2.3.A	Containment Functions Strategies - Review the results of the finalized containment analysis associated with open item OI2 of the Integrated Plan, which shows that containment functions will be (potentially) restored and maintained in response to an ELAP event. Waterford 3 Response Response provided in Attachment 2
AQ 24	List the safety and non-safety related (portable and plant installed) systems or equipment that are credited in the ELAP analysis for consequences mitigation, and for all the systems or equipment, discuss the associated design safety functions and justify the listed systems or equipment are available and reliable to provide the design functions on demand during the ELAP.

Audit Item Reference	Item Description
	Waterford 3 Response The following systems, components, and structures (SSCs) with their design attributes are credited by the FLEX strategy:

System	Components	Design Attributes
Electrical Distribution (AC and DC)	31 Switchgears, 311 Motor Control Centers, Static Uninterruptible Power Supplies, Station Batteries and Battery Charger	Safety Related, Seismic Cat I (FLEX Tie-Ins – Robust per NEI 12-06)
Emergency Feedwater (EFW)	TDEFW, Valves, Piping and Instrumentation	Safety Related, Seismic Cat I * (FLEX Tie-Ins – Robust per NEI 12-06)
Main Steam (MS)	Main Steam Isolation Valves, Atmospheric Dump Valves, Steam Admission Valves and Piping	Safety Related, Seismic Cat I *
Reactor Coolant System	Rx Vessel, Piping and Instrumentation	Safety Related, Seismic Cat I
Steam Generator (SG)	Steam Generators and Instrumentation	Safety Related, Seismic Cat I
Chemical and Volume Control (CVC)	Pump, Piping and Valves	Safety Related, Seismic Cat I
Condensate Makeup (CMU)	CCW MU pump, Condensate Storage Pool, Piping and Valves	Safety Related, Seismic Cat I (FLEX Tie-In – Robust per NEI 12-06)
Auxiliary Component Cooling Water (ACCW)	Wet Cooling Tower Basin, Piping and Valves	Safety Related, Seismic Cat I * (FLEX Tie-In – Robust per NEI 12-06)
Circulating Water (CW)	Piping and Valves	Non Safety Related, Non-Seismic (not credited for flood or seismic events)
Safety Injection (SI)	Safety Injection Tanks (SITs), SIT Isolation Valves, Refueling Water Storage Pool, Instrumentation and Piping	Safety Related, Seismic Cat I (FLEX Tie-Ins – Robust per NEI 12-06)

Audit Item Reference	Item Description		
	Spent Fuel Pool (SFP)	Pool, Piping and Instrumentation	Non Safety Related, Seismic Cat I (Instrumentation per Order EA-12-51)
	FLEX	Core Cooling Pump, 480V Diesel Generator, Diesel Fuel Oil Transfer Pump, Sump Pump, SBO compressor, Spray Nozzles, Water Transfer Pump (backup only), Portable Fan, JOBOXs	Non Safety Related, Robust per NEI 12-06
	Other systems (Fuel Oil, Nitrogen Gas, Feedwater, Plant Protection System, Excore Instrumentation)	Fuel Oil Tanks, N2 Accumulators, Main Feed Isolation Valve, Piping and Instrumentation	Safety Related, Seismic Cat I
	Nuclear Plant Island Structure	(Containment Building, Shield Building, Reactor Auxiliary Building and Fuel Handling Building)	Seismic Cat I (Containment Building – Safety Related)
	HVAC (Phase 3 only)	Essential Chiller, Room Coolers, Containment Fan Cooler, Piping and Valves	Safety Related, Seismic Cat I
	Component Cooling Water (CCW) – (Phase 3 only)	Pump, Dry Cooling Tower (DCT), DCT Fans (missile protected only), Piping and Valves	Safety Related, Seismic Cat I *
	* Piping and valves exposed to potential missile strikes have been previously evaluated (using TORMIS) and determined to not require physical protection as the probability of occurrence of a tornado generated missile strike is sufficiently small. In addition, an intervening structure evaluation was performed for FLEX demonstrating that affected components have reasonable missile protection		

Audit Item Reference	Item Description
SE 3	Discuss how the plant specific guidance, mitigation strategies and the associated administrative controls and training program will be developed and implemented. <u>Waterford 3 Response</u> EN-OP-201-08 (Reference 50) describes the FLEX training program. Utilizing the systematic approach to training (SAT) process to identify the training population, method, and frequency of the training, multiple training materials and activities were prepared, assigned, and delivered to support the FLEX project ongoing at WF3. As an overview, all site personnel were required to take two INPO developed Computer Based Training modules for initial introductions to FLEX requirements and strategies (Plateau FCBT-ERTD-FLEX-INITIAL and FCBT-ERTD-FLEX-ADVANCED delivered through NANTEL). For the site specific response portions of the FLEX project, the SAT analysis determined that initial Operations' training consisted of classroom training on FLEX basics, FSG implementation, and FLEX modifications. Initial ERO training provided personnel with an introduction to the FLEX concept and an overview of the FLEX Strategies. In addition, shift personnel designated to operate the debris removal equipment received practical experience on the equipment's operation and demonstrated the skills required to successfully clear debris from the staging areas and haul paths.
SE 7	Please describe the impact of recent MOHR's SFPI equipment failures (failure of the filter coil (or choke) in particular) on the Waterford SFP level instrument. Also, any actions/measures Waterford plans to implement to address this equipment failure. <u>Waterford 3 Response</u> Response provided in Attachment 2 to W3F1-2016-0001, "Completion of Required Action by NRC Order EA-12-051, Commission Order Modifying License w ith Regard to Reliable Spent Fuel Pool Instrumentation" dated January 18, 2016. [ADAMS Accession No. ML16018A014]
SE 8	Provide an evaluation of the environmental qualification of containment electrical equipment as well as the atmospheric relief valves showing that the equipment will be functional for the ELAP mission time. <u>Waterford 3 Response</u> It has been demonstrated through review of the environmental qualification testing and associated analysis that the containment electrical equipment being credited for use in response to a BDBEE will operate in an ELAP environment and will remain functional during the projected BDBEE ELAP mission time. (Reference 44) The Atmospheric Relief Valves, referred to as Atmospheric Dump Valves (ADV) at WF3, are located outside in an open air environment so elevated temperature and pressure are not a concern.

Audit Item Reference	Item Description
SE 18	Provide additional justification for the alternate approach to NEI 12-06 involving the use of installed spent fuel pool cooling pumps. <u>Waterford 3 Response</u> Waterford 3 uses an alternate approach for SFP makeup, crediting the installed Component Cooling Water Makeup (CCW MU) pumps for hardened, hose and spray makeup to the Spent Fuel Pool. The CCW MU system is an existing system capable of supplying makeup to the spent fuel pool with either of two redundant Safety-Related pumps. The piping and components are Seismic Category I and each pump is supplied power from an independent train of the stations Class 1E switchgear, MCC-311A(B). All SSCs of the CCW MU system are located within the Nuclear Plant Island Structure and are fully protected from all applicable external events. Station procedures contain the guidance for use of CCW MU for Spent Fuel Pool makeup, and the operators are fully trained on use of the system in this capacity. Additionally, the redundant trains of CCW MU can be isolated from each other on the discharge side by using CMU-511A(B) and on the suction side by using CMU-502A(B). The existing SFP makeup piping is a common discharge line from CMU-511A(B) on the RAB -35’ to the SFP.
SE 24	Guidance for transitioning from Phase 2 DGs to Phase 3 Turbine Generators (FSG5 Attachment 21) did not address deployment during flooded conditions. <u>Waterford 3 Response</u> FSG-005 “Initial Assessment and FLEX Equipment Staging”, Attachment 20 “Staging Phase 3 NSRC Equipment” contains guidance for staging the Phase 3 National SAFER Response Center (NSRC) equipment for both flooded and non-flooded conditions.

Audit Item Reference	**Item Description**
SE 25	Provide an evaluation for the robustness of the "N" storage Building and the room beneath where electrical connection panel is located. <u>Waterford 3 Response</u> The new 'N' Building is a seismic class I, reinforced-concrete, tornado-missile-protected structure located on the RAB roof at EL. +41 ft. The "N' Building is designed so the new structural loads induced by the enclosure and new equipment stored within do not stress the existing RAB structure beyond acceptable limits. The enclosure includes the following design features: • Two new concrete walls, one new concrete roof, two existing RAB walls, and existing concrete floor (EL. +41 ft. roof) • Concrete topping slab over the existing roof • Scab wall over the existing RAB east wall (FDG Enclosure west wall) • Core bores in existing and new concrete • Personnel access through a fire-rated, pressure door • Removable steel plates in new concrete roof • Sliding steel doors inside all exterior enclosure openings for equipment protection from environmental intrusion • New tornado missile protection • Architectural features including waterproofing, roof curbing, and fall protection • 120V electrical power provided from the plant's lighting and 120V systems for lighting, ventilation, and auxiliary loads associated with the FDG • Exhaust fan for forced ventilation • Intake and exhaust louvers • Fire Damper (FDG Enclosure north wall) • Existing fire detection system modified to support new detection devices installed in the enclosure • A manual portable fire extinguisher EC 48145 provides additional details and supporting justification. To facilitate the FLEX Diesel Generator (FDG) tie-in to the 31 switchgear (31A or 31B), the FDG electrical tie-in panel was installed in the room below the 'N' building. This room contains non-safety, non-seismic HVAC equipment that may fall and damage or prevent accessibility to the FDG electrical tie-in panel following a seismic event. To protect the FDG Electrical tie-in panel from a seismic event, structural steel protective frames were installed to protect the electrical panel and the room entrance from any potential falling HVAC ductwork. This modification was included as part of the 'N' building modification EC 48145.

Audit Item Reference	Item Description
SE 26	During the site audit walkdown, the NRC staff noticed that the SFPI cable conduits at EL. 21' of the FHB were installed side by side for a portion of the routing. Provide completed design that includes protection to this portion of the conduit routing as described to the NRC staff during the on-site audit.. Waterford 3 Response Response provided in Attachment 2 to W3F1-2016-0001, "Completion of Required Action by NRC Order EA-12-051, Commission Order Modifying License with Regard to Reliable Spent Fuel Pool Instrumentation" dated January 18, 2016. [ADAMS Accession No. ML16018A014]

Audit Item Reference	Item Description
SE 27	The licensee plans to use a single installed suction source and connection point for the FLEX Core Cooling pump and the CCW makeup pumps (used for spent fuel pool cooling). The staff considers this an alternative to NEI 12-06 Section 3.2.2. Specifically, Table D-1 provides guidance on primary and alternate connections and states that injection points are, “required to inject through separate divisions/trains, i.e., should not have both connections in one division/train. “While the licensee has multiple injection paths for core cooling downstream of the FLEX manifold, all cooling water delivery paths must be routed through the single WCT outlet and connection point. Therefore, both the primary and alternate methods share a common connection. <u>Waterford 3 Response</u> The WF3 FLEX suction source strategy is diverse providing cross connection capability to any one of three sources at any time through the FLEX portable equipment manifold. Therefore, WF3 does not consider its suction source strategy for the FLEX Core Cooling pump or the CCW makeup pumps as an alternative to NEI 12-06 Section 3.2.2. Each of the three suction sources are sufficiently designed as rugged sources expected to be fully available during and following a Beyond Design Basis Event. In the unlikely event that any single suction source is compromised, the flow path can be realigned to either of the remaining two sources to provide water inventory to the suction of the pumps satisfying the reactor core cooling, Reactor Coolant System (RCS) makeup or spent fuel pool makeup key safety functions. While not specifically considered part of the strategy (because all three sources and interconnecting piping are considered to be fully available during the BDBEE), makeup could be provided to any of the three sources from other surviving non-robust water sources, the infinite inventory Mississippi River or surrounding flood waters if the external event is the flood event. Considerable time exists within the strategy such that existing guidance in the FSGs and actions developed with assistance from augmented staff could provide the needed support for alignment of alternate makeup capabilities should this need arise. Furthermore, the exposed ACCW suction and WCT cross-connect piping that supports the WF3 strategy is reasonably protected from wind borne missiles. In summary, the WCT and its SSCs used in the WF3 FLEX strategy are reasonably protected and designed as rugged structures and components and will be available following a BDBEE to support its qualification as a robust source. The WF3 FLEX suction source strategy is inherently diverse and defense in depth exists to support makeup from any of the three suction sources utilized in the strategy in the unlikely event the WCT source were postulated to fail.

Attachment 4

W3F1-2016-0031

Waterford Steam Electric Station, Unit 3,

References

References

The following references support the information described in Attachments 1 through 3.

<u>Correspondence and Guidance Documents</u>

1. NRC Order Number EA-12-049, "Order to Modify Licenses With Regard To Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012
(ADAMS Accession No. ML12054A736)

2. Waterford Steam Electric Station, Unit 3 letter to NRC, "Request for Relaxation from NRC Order EA-12-049, "Order to Modifying Licenses With Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated August 31, 2015
(ADAMS Accession No. ML15243A243)

3. NRC letter to Waterford Steam Electric Station, "Waterford Steam Electric Station, Unit 3 – Relaxation of the Schedule Requirements for Order EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events" dated October 4, 2015
(ADAMS Accession No. ML15245A344)

4. Nuclear Energy Institute (NEI) 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0, dated August 2012 (ADAMS Accession No. ML12221A205)

5. NRC Interim Staff Guidance JLD-ISG-2012-01, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," Revision 0, dated August 29, 2012
(ADAMS Accession No. ML12229A174)

6. Waterford Steam Electric Station, Unit 3 letter to NRC, "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," dated February 28, 2013
(ADAMS Accession No. ML13063A266)

7 NRC Letter, "Waterford Steam Electric Station, Unit 3- Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Order EA-12-049," dated November 22, 2013
(ADAMS Accession No. ML 13220A402)"

8. NRC Letter, "Waterford Steam Electric Station, Unit 3 – Report for the Audit Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Pool Instrumentation Related to Orders EA-12-049 and EA-12-051" dated October 6, 2015
(ADAMS Accession No. ML 15272A398)

9. Waterford Steam Electric Station, Unit 3 letter to NRC, “First Six Month Status Report for Implementation of Order EA-12-049, Commission Order Modifying License With Regard To Requirements for Mitigation Strategies for Beyond-Design-Basis External Events” dated August 28, 2013
(ADAMS Accession No. ML13241A281)

10. Waterford Steam Electric Station, Unit 3 letter to NRC, “Second Six Month Status Report for Implementation of Order EA-12-049, Commission Order Modifying License With Regard To Requirements for Mitigation Strategies for Beyond-Design-Basis External Events” dated February 28, 2014
(ADAMS Accession No. ML14059A085

11. Waterford Steam Electric Station, Unit 3 letter to NRC, “Third Six Month Status Report for Implementation of Order EA-12-049, Commission Order Modifying License With Regard To Requirements for Mitigation Strategies for Beyond-Design-Basis External Events” dated August 28, 2014
(ADAMS Accession No. ML14241A270)

12. Waterford Steam Electric Station, Unit 3 letter to NRC, “Fourth Six Month Status Report for Implementation of Order EA-12-049, Commission Order Modifying License With Regard To Requirements for Mitigation Strategies for Beyond-Design-Basis External Events” dated February 26, 2015
(ADAMS Accession No.ML15057A548)

13. Waterford Steam Electric Station, Unit 3 letter to NRC, “Fifth Six Month Status Report for Implementation of Order EA-12-049, Commission Order Modifying License With Regard To Requirements for Mitigation Strategies for Beyond-Design-Basis External Events” dated August 27, 2015
(ADAMS Accession No.ML15239B353)

14. Waterford Steam Electric Station, Unit 3 letter to NRC, “Sixth Six Month Status Report for Implementation of Order EA-12-049, Commission Order Modifying License With Regard To Requirements for Mitigation Strategies for Beyond-Design-Basis External Events” dated February 24, 2016
(ADAMS Accession No ML16055A232)

15. Waterford Steam Electric Station, Unit 3 letter to NRC “Response to March 12, 2012, Request for Information (RFI) Pursuant to Title 10 of the Code of Federal Regulation 50.54(f) Regarding Recommendations of the Near-Term Task Force (NTTF) Review of Insights from the Fukushima Dia-ichi Accident, Enclosure 5 Recommendation 9.3, Emergency Preparedness – Staffing, Requested Information Items 1, 2, and 6 – Phase 2 Staffing Assessment”, dated June 16, 2015
(ADAMS Accession No. ML15167A476)

16. NRC Letter, “Waterford Steam Electric Station, Unit 3- Response Regarding Phase 2 Staffing Submittals Associated with Near-Term Task Force recommendation 9.3 Related to the Fukushima Dai-Ichi Nuclear Plant Accident,” dated December 1, 2015
(ADAMS Accession No. ML 15320A339)

17. NRC Letter, 10CFR50.54(f), "Request for Information Pursuant to Title 10 of the Code of Federal Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force review of Insights from the Fukushima Dai-ichi Accident," Recommendation 9.3, dated March 12, 2012 (ADAMS Accession No ML2073A348).

Calculations, Procedures & Vendor Documents

18. EN-FAP-EP-010, R1, “Severe Weather Response”
19. OP-901-521 Off-Normal Procedure, “Severe Weather and Flooding”
20. LTR-TDA-13-20, R0, “Westinghouse Response to NRC Generic Request for Additional Information (RAI) on CENTS Code in Support of the Pressurized Water Reactor Owner’s Group (PWROG)(PA-ASC-1187), dated November 2013
21. WCAP-17601 R1, “Reactor Coolant System Response to the Extended Loss of AC Power Event for Westinghouse, Combustion Engineering and Babcock & Wilcox NSSS Designs,” dated January 2013
22. “Westinghouse Response to NRC Generic Request for Additional Information (RAI) on Reactor Coolant Pump (RCP) Seal Leakage in Support of the Pressurized Water Reactor Owners Group (PWROG)”, dated August 16, 2013
23. CN-SEE-II-13-3, Rev 2, “Waterford Steam Electric Station Unit 3 Reactor Coolant System Inventory, Shutdown Margin, and Modes 5 and 6 Boric Acid Precipitation Control Analyses to support the Diverse and Flexible Coping Strategies (FLEX), dated September 01, 2014
24. WCAP-16175, “Model for Failure of RCP Seals Given Loss of Seal Cooling in CE NSSS Plants”, dated March 2007
25. LTR-SCC-14-008, “Recommended Responses to Entergy PWR Nuclear Plants OIP Audit Questions”, dated April 14, 2014
26. ECS14-002, “WF3 FLEX Main Control Room BDBEE Heat-up Analysis,” Revision 1
27. ECS14-003, “WF3 FLEX Reactor Auxiliary Building -35’ elevation BDBEE Heat-up Analysis” (EC55190)
28. ECS14-004, Rev. 1, “WF3 FLEX Switchgear and DC Equipment Rooms BDBEE Heat-up Analysis”
29. WF3-SA-14-00002, Rev. 2, “Waterford 3 FLEX Strategy Development” (EC55190)
30. EN-OP-115-01, “Operator Rounds”
31. Waterford 3 Final Integrated Plan (see Attachment 5)
32. ECE14-003, “FLEX Strategy – Portable Diesel Generator System Sizing “ (EC55190)
33. ECE14-004, “Battery 3A-S “A” Train Calculation for FLEX Event”

34. ECE14-005, “Battery 3B-S “B” Train Calculation for FLEX Event”
35. OP-902-005, Emergency Operating Procedure, Station Blackout Recovery Procedure
36. ECC14-039, “Sliding and Rocking Evaluation of FLEX N+1 Storage Building Equipment (EC48142)
37. ECC14-024, “FLEX Diesel Generator Anchorage”
38. ECC14-030, “FLEX Cable Reel Storage Rack Analysis and Support Calculation”
39. ECC14-033, “FLEX Non-collapsible Hose Storage Rack Design and Support Calculation”
40. ECC14-051, “FLEX Diesel Fuel Pump Transfer Pump Support Calculation“
41. WF3-CS-15-00009, “Beyond Design Basis External Event Internal Flooding Evaluation of Non-Seismic Water Sources” (EC55190)
42. ECM15-004, “Waterford 3 FLEX Internal Flooding Calculation”
43. ECM15-005, “Waterford 3 FLEX Sump Pump Sizing”
44. ECS14-001, “WF3 FLEX Containment MAAP Analysis” (EC 48142)
45. OI-042-000, Operating Instruction “Watch Station Processes”
46. ECM14-006, “FLEX Diesel Fuel Transfer Pump Sizing Calculation” (EC55190)
47. W3-DBD-002, “Emergency Diesel Generator and Automatic Load Sequencer Design Basis Document”
48. ECP13-002, “Analysis of Diesel Fuel Oil Storage Tank Vent Lines 7EG6-27 and 28” (EC35963)
49. ECP13-003, “Analysis of Diesel Fuel Oil Storage Tank Vent Lines 7EG3-25 and 26” (EC35963)
50. EN-OP-201-08, “Waterford 3 FLEX Program Document”
51. CE-002-030, Technical Procedure “Maintaining Diesel Fuel Oil”

Attachment 5

W3F1-2016-0031

Waterford Steam Electric Station, Unit 3,

Final Integrated Plan for Order EA-12-049

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Title:	WATERFORD STEAM ELECTRIC STATION UNIT 3 FINAL INTEGRATED PLAN	REPORT NO.:	ENTGWF081-REPT-001
		REVISION:	1
		Client:	Entergy
		Project Identifier:	ENTGWF081

Item	Cover Sheet Items	Yes	No
1	Does this Project Report contain any open assumptions, including preliminary information that require confirmation? (If **YES**, identify the assumptions.)	☐	☒
2	Does this Project Report supersede an existing Project Report? (If **YES**, identify the superseded Project Report.) **Superseded Project Report No.** ____________	☐	☒

Scope of Revision:

Revised to "certify" the FIP for use in compliance letter submittal to the NRC.

Revision Impact on Results:

N/A

Safety-Related ☐		Non-Safety-Related ☒	
Originator*:	Dora Garcia	Dora H. Garcia	7/20/2016
Reviewer*:	Michael Cymbor	[signature]	7/20/2016
Analysis Reviewer:	Michael Cymbor	[signature]	7/20/2016
Approver:	Jared Monroe	[signature]	Date: 7/20/2016

*Signature indicates understanding that this document will be submitted to the NRC under oath or affirmation by the client, consistent with Entergy procedure EN-LI-106, Attachment 9.5.

PROJECT REPORT REVISION STATUS

REVISION	DATE	DESCRIPTION
0	7/13/2016	Initial Issue
1	7/20/2016	Certified Document

ATTACHMENT REVISION STATUS

ATTACHMENT NO.	NO. OF PAGES	REVISION	ATTACHMENT NO.	NO. OF PAGES	REVISION

FINAL

INTEGRATED

PLAN

DOCUMENT

WATERFORD STEAM ELECTRIC STATION

Unit 3

July 2016

Table of Contents

1. Background

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

The United States (US) Nuclear Regulatory Commission (NRC) assembled a Near-Term Task Force (NTTF) to advise the Commission on actions the US 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 3.1) 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.

Based on NTTF Recommendation 4.2, the NRC issued Order EA-12-049 (Reference 3.2) on March 12, 2012 to implement mitigation strategies for beyond-design-basis external events (BDBEEs). The order provided the following requirements for strategies to mitigate BDBEEs:

1. Licensees shall develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities following a BDBEE.

2. 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.

3. Licensees must provide reasonable protection for the associated equipment from external events. Such protection must demonstrate that there is adequate capacity to address challenges to core cooling, containment, and SFP cooling capabilities at all units on a site subject to the Order.

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

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

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

- Phase 1 - The initial phase requires the use of installed equipment and resources to maintain or restore core cooling, containment and spent fuel pool cooling capabilities.
- Phase 2 - The transition phase requires providing sufficient, portable, on-site equipment and consumables to maintain or restore these functions until they can be accomplished with resources brought from off-site.
- Phase 3 - The final phase requires obtaining sufficient off-site resources to sustain those functions indefinitely.

NRC Order EA-12-049 (Reference 3.2) required licensees of operating reactors to submit an overall integrated plan, including a description of how compliance with these requirements would be achieved by February 28, 2013. The Order also required licensees to complete implementation of the requirements no later than two refueling cycles after submittal of the overall integrated plan or December 31, 2016, whichever comes first.

The Nuclear Energy Institute (NEI) developed guidance NEI 12-06 (Reference 3.3), which provides guidelines for nuclear stations to assess extreme external event hazards and implement the mitigation strategies specified in NRC Order EA-12-049. The NRC issued Interim Staff Guidance JLD-ISG-2012-01 (Reference 3.4), dated August 29, 2012, which endorsed NEI 12-06 with clarifications on determining baseline coping capability and equipment quality.

NRC Order EA-12-051 (Reference 3.5) required licensees to install reliable SFP instrumentation with specific design features for monitoring SFP water level. This order was prompted by NTTF Recommendation 7.1 (Reference 3.1).

NEI 12-02 (Reference 3.6) provided guidance for compliance with Order EA-12-051. The NRC determined that, with the exceptions and clarifications provided in JLD-ISG-2012-03 (Reference 3.7), conformance with the guidance in NEI 12-02 is an acceptable method for satisfying the requirements in Order EA-12-051.

2. NRC Order 12-049 – Mitigation Strategies (FLEX)

2.1 General Elements

2.1.1 Assumptions

The assumptions used for the evaluations of Waterford Steam Electric Station, Unit 3 (WF3) ELAP/loss of ultimate heat sink (LUHS) event and the development of diverse and flexible coping strategies (FLEX) are stated below.

Assumptions are consistent with those detailed in NEI 12-06, Section 3.2.1 (Reference 3.3). Analysis has been performed consistent with the recommendations contained within the Executive Summary of the Pressurized Water Reactor Owners Group (PWROG) Core Cooling Position Paper (Reference 3.69) and the assumptions from that document are incorporated into the plant-specific analytical bases.

The initial plant conditions are assumed to be the following:

- Prior to the event the reactor has been operating at 100 percent rated thermal power for at least 100 days, or has just been shut down from such a power history.
- At the time of the postulated event, the reactor and supporting systems are within normal operating ranges for pressure, temperature, and water level for the appropriate plant condition. All plant equipment is either normally operating or available from the standby state as described in the plant design and licensing basis.

Initial Conditions:

- No specific initiating event is used. The initial condition is assumed to be a loss of off-site power (LOOP) for the plant site. The LOOP is assumed to result from an external event that affects the off-site power system either throughout the grid or just at the plant with no prospect for recovery of off-site power for an extended period.
- All installed sources of emergency on-site AC power and station blackout (SBO) alternate AC power sources are assumed to be not available and not imminently recoverable.

- Cooling and make-up water inventories contained in systems or structures with designs that are robust with respect to seismic events, floods, and high winds, and associated missiles are available. Per NEI 12-06, robust is defined as a design of a structure, system or component (SSC) that either meets the current plant design basis for the applicable external hazards or has shown by analysis or test to meet or exceed the current design basis.

- Normal access to the ultimate heat sink (UHS) is lost, but the water inventory in the UHS remains available and robust piping connecting the UHS to plant systems remains intact.

- Fuel for FLEX equipment stored in structures with designs which are robust with respect to seismic events, floods and high winds and associated missiles, are available.

- Permanent plant equipment that is contained in structures with designs that are robust with respect to seismic events, floods, high winds, and associated missiles are available.

- Other equipment, such as portable AC power sources, portable back up DC power supplies, spare batteries, and equipment for 10CFR50.54(hh)(2), may be used provided it is reasonably protected from the applicable external hazards and has predetermined hookup strategies with appropriate procedural guidance and the equipment is stored in a relative close vicinity of the site.

- The installed Class 1E electrical distribution systems, including inverters and battery chargers, remain available provided they are protected consistent with current station design.

- No additional events (including security events) or failures are assumed to occur immediately prior to or during the BDBEE.

Reactor transient:

- Following the loss of all AC power, the reactor automatically trips and all rods are inserted.

- The main steam system valves (such as main steam isolation valves (MSIVs), turbine stops, atmospheric dumps, main steam safety valves (MSSVs), etc.) necessary to maintain decay heat removal functions operate as designed.

- Safety/Relief Valves (SRVs) or power operated relief valves (PORVs) initially operate in a normal manner, as required by the reactor coolant system (RCS) conditions.
- No independent failures, other than those causing the ELAP/LUHS event, are assumed to occur in the course of the transient.

Reactor coolant inventory loss:

- Normal system leakage.
- Losses from letdown unless automatically isolated or until isolation is procedurally directed.
- Losses due to reactor coolant pump seal leakage.
- RCS make-up capability is assumed to be required at some point in the extended loss of AC power condition for inventory and reactivity control.

The initial SFP conditions are:

- All initially intact boundaries of the SFP remain intact, including the liner, gates, transfer canals, etc.
- Although sloshing may occur during a seismic event, the initial loss of SFP inventory does not preclude access to the refueling deck around the pool.
- SFP cooling system is intact, including attached piping.
- SFP heat load assumes the maximum design basis heat load.

Containment isolation valves:

- It is assumed that the containment isolation actions delineated in current station blackout coping capabilities are sufficient.

In addition to the boundary conditions from NEI 12-06 given above, the following site specific assumptions were applied in establishing the baseline coping capabilities.

- It is expected that WF3 will declare the ELAP within approximately 60 minutes in order to enable actions which place the plant outside of the current design and licensing basis.
- The SFP is assumed to have two different decay heat loads, depending on when the event occurs. As the core cannot be both off-loaded to the SFP and in the reactor core, it is prudent to base the response depending on the location of the fuel. This practice has been discussed in NEI FAQ 2013-05 (Reference 3.38). Based on the proposed answer to the FAQ, the SFP make-up equipment is selected/sized to ensure adequate make-up flow to remove the bounding design basis maximum heat load. Timing for when actions around the SFP and the time by which make-up must be started are calculated dependent on the initial conditions of the plant (NEI FAQ 2013-03, Reference 3.39).
- The turbine-driven emergency feedwater (TDEFW) pump is immediately relied upon for Phase 1 core cooling in response to the BDBEE. The TDEFW pump is capable of maintaining steam generator (S/G) level as long as steam is available for the turbine. The Phase 2 FLEX core cooling pump (FCCP) is capable of maintaining S/G level once the FLEX electric source of power for the pump has been placed into service, the safety injection tanks (SITs) isolated, and a cooldown to 400°F completed.
- Consistent with 10 CFR 50.54(x), a licensee may take reasonable action that departs from a license condition or a technical specification in an emergency when this action is immediately needed to protect the public health and safety and no action consistent with the license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent. Declaration of an ELAP event will place the plant outside of the existing design basis, allowing emergency actions to protect public health and safety and may place the plant in a condition where it cannot comply with certain Technical Specifications, and, as such may warrant invocation of 10 CFR 50.54(x).

- Staffing is initially assumed to be at the minimum level when the event occurs. A staffing assessment has been performed and concluded that minimum shift staffing is sufficient to execute all required initial and transition phase actions (Reference 3.66 and 3.67).

2.2 <u>Strategies</u>

The objective of the FLEX strategies is to establish an indefinite coping capability in order to 1) prevent damage to the fuel in the reactors, 2) maintain the containment function and 3) maintain cooling and prevent damage to fuel in the SFP using installed equipment, on-site portable equipment, and pre-staged off-site resources. This indefinite coping capability will address an ELAP – loss of off-site power, emergency diesel generators and any alternate AC source, but not the loss of AC power to buses fed by station batteries through inverters – with a simultaneous loss of access to the UHS. 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 pre-determined strategies (FLEX strategies) that are focused on maintaining or restoring key plant safety functions. The FLEX strategies are not tied to any specific damage state or mechanistic assessment of external events. Rather, the strategies are developed to maintain the key plant safety functions based on the evaluation of plant response to the coincident ELAP/LUHS event. A safety function-based approach provides consistency with, and allows coordination with, existing plant emergency operating procedures (EOPs). FLEX strategies are implemented in support of EOPs using FLEX Support Guidelines (FSGs).

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

- Phase 1 – Initially cope by relying on installed plant equipment. During the initial coping period, only installed plant equipment and the normal station operating staff are used to maintain the essential functions of core cooling, containment integrity, and SFP cooling. The duration of Phase 1 at WF3 is expected to be approximately 8 hours.

- Phase 2 – Transition from installed plant equipment to FLEX equipment. During the transition phase, FLEX equipment is deployed by the on-shift personnel to maintain essential functions. Phase 2 durations begin once the Phase 2 equipment is deployed and operating to meet plant needs. Phase 2 equipment and strategies will continue to be used until no longer required. This could be in as little time as 24 hours (earliest availability of Phase 3 equipment from off-site per NEI 12-06 (Reference 3.3) or the Phase 2 equipment could be used indefinitely.

- Phase 3 – Obtain additional capability and redundancy from off-site equipment and resources until power, water, and shutdown cooling systems are restored. For the long term (indefinite) phase, off-site FLEX equipment from the National Strategic Alliance for FLEX Emergency Response (SAFER) Response Center (NSRC) is deployed to maintain essential functions. Phase 3 durations begin once off-site equipment is deployed and operating to meet plant needs. Phase 3 equipment is assumed to be available to be placed into service as early as 24 hours after the BDBEE or as late as 72 hours after the BDBEE.

The specific duration of each phase is established based on prudent and realistic response times for the station staff to mobilize and implement applicable strategies in a manner that does not inhibit the emergency response. These times ensure that substantial margin exists in maintaining or restoring core cooling, containment, and SFP cooling to accommodate the many unknowns associated with BDBEE.

The strategies described below are capable of mitigating an ELAP/LUHS resulting from a BDBEE by providing adequate capability to maintain core cooling, containment, and SFP cooling capabilities at WF3. 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 to protect the public health and safety. The EOPs have been revised, in accordance with established EOP change processes, to indicate and identify appropriate entry into an ELAP.

2.3 Reactor Core Cooling and Heat Removal Strategy (Modes 1-4)

The steam generators are assumed to be available during Modes 1 through 4.

Phase 1 core cooling and heat removal strategy relies upon natural circulation in the RCS through the steam generators. The existing TDEFW pump will provide feedwater from the condensate storage pool (CSP) to the S/Gs. Steam generated within the S/Gs is exhausted directly to the atmosphere via the atmospheric dump valves (ADVs).

During Phase 1, an initial plant cooldown and depressurization is performed to protect the reactor coolant pump (RCP) seals to minimize RCS leakage. This cooldown and depressurization will also enable SIT injection for reactivity control and to maintain natural circulation within the RCS.

DC bus load shedding ensures station Class 1E battery life is extended beyond 12 hours. Prior to depletion of the selected train of station Class 1E batteries, a FLEX diesel generator is placed in service on the associated Class 1E AC bus to repower the credited FLEX Phase 2 equipment.

At Phase 2, suction to the TDEFW pump is transferred to the wet cooling tower (WCT) basin. After the FLEX diesel generator is placed in service, SITs are isolated to preclude nitrogen cover gas injection into the RCS, and a charging pump is placed into service to maintain RCS inventory during the second plant cooldown. The charging pump also provides boron addition to ensure adequate shutdown margin is maintained.

The Phase 2 strategy utilizes a permanently staged, electrically-driven FCCP to back up the TDEFW pump. The pump is capable of operation after the FLEX diesel generator is placed into service, the SITs are isolated, and the second plant cooldown is completed.

A high level Phase 3 strategy is to repower shutdown cooling (SDC) components from a larger FLEX generator provided by the NSRC. The primary strategy is to extend Phase 2 of the strategy until such a time that the plant enters a recovery phase and on-site electrical equipment is restored.

2.3.1 Phase 1 Strategy

Following an ELAP/LUHS event, the reactor will trip and the plant will initially stabilize at no-load RCS temperature and pressure conditions, with reactor decay heat removal via steam release to the atmosphere through the ADVs. Natural circulation of the reactor coolant system will develop to provide core cooling and the TDEFW pump will provide flow from the CSP to the steam generators.

The Phase 1 strategy for reactor core cooling and heat removal relies upon installed plant equipment and water sources for EFW supply to the steam generators. The main component associated with this strategy is the TDEFW pump. The suction source for the TDEFW pump will initially be the CSP. Make-up is provided to both S/Gs symmetrically. The TDEFW pump flow is throttled to maintain level in the S/Gs, thus ensuring decay heat is adequately removed.

The EFW control valves necessary to throttle TDEFW pump flow are equipped with safety class accumulators to extend automatic operation on the credited control valves to 10 hours (Reference 3.68). For the non-credited control valves, manual control must be taken prior to 4 hours due to the potential that the opposite train battery will reach minimum voltage (Reference 3.68). The EFW isolation valves must remain open for the duration of the use of the TDEFW pump. The EFW control and isolation valves are located on the reactor auxiliary building (RAB) +46’ Elev. roof and are equipped with handwheels to allow manual operation (Reference 3.68). The RAB +46’ Elev. roof is covered by missile grating and above the maximum flood height (Reference 3.68). The travel path is within the RAB structure, which is protected from all external hazards and therefore, the valves are accessible.

Steam generated through the removal of decay heat from the reactor is discharged to the atmosphere utilizing the ADVs. The ADVs are also located on the RAB +46’ Elev. roof (Reference 3.68). Steam flow through the valve body assembly is adjustable with battery backed control power and 10 hours of nitrogen gas backup to both ADVs (Reference 3.68). Due to potential for loss of control of the other ADV once the opposite train battery reaches minimum voltage in approximately 4 hours, manual control must be taken locally at this ADV before 4 hours after the event. The ADVs can be manually operated using either the handwheels or the local pneumatic control stations on the RAB +46’ Elev. roof (Reference 3.68).

The initial RCS cooldown is commenced 2 hours following the event at a rate of approximately 50°F/hr and it is completed by approximately 4 hours from the initiation of the event. A cooldown is performed to minimize RCP seal leakage, initiate SIT injection, and maintain natural circulation within the RCS. The initial plant cooldown is stopped at an RCS cold leg temperature of approximately 456°F. This RCS temperature ensures passive RCS make-up to maintain natural circulation and shutdown margin until the SITs are isolated during Phase 2 to preclude nitrogen injection (Reference 3.16).

Following event initiation, the decay heat removal and depressurization is accomplished via the TDEFW system utilizing the CSP for a water source to supply feedwater to the S/Gs. The total amount of S/G make-up required within the first 72 hours is approximately 700,000 gallons (Reference 3.11). As this volume is greater than the available volume within the CSP, a gravity feed will be established from the WCT basins to continue use of the TDEFW pump for core cooling. The CSP has a minimum required inventory of 187,000 gallons and a capacity of up to 208,523 gallons. Using the minimum available CSP volume of 187,000 gallons at the start of the event, assuming the RCS is initially cooled down to 456°F, the S/Gs can be supplied with water for approximately 8 hours. Following depletion of the CSP, a gravity drain will be established from the WCT basins to the TDEFW pump during Phase 2, providing access to an additional 273,500 gallons of water, extending the available minimum inventory to cool down the plant and remove decay heat throughout Phase 2. These water sources (CSP and WCT basins) are robust for all applicable extreme external hazards. Once the inventory of these two sources is depleted, the refueling water storage pool (RWSP), or the inventory of the circulating water intake (CWI) piping will be utilized as water sources for core cooling (Section 2.3.7.1).

RCS – RCS inventory control is maintained by minimizing RCP seal leakage and ensuring passive borated water injection from the SITs. Controlled bleed-off is isolated early (containment isolation valve fails closed on loss of power or instrument air) (Reference 3.17). The RCS is cooled down and depressurized to a cold leg temperature of 456°F. RCS leakage is assumed to be through the RCP seals (See Section 2.3.8). The passive injection of borated water from the SITs ensures adequate shutdown margin and RCS natural circulation until 17 hours from the initiation of the event, at which point RCS make-up is required. To prevent transition into reflux cooling, RCS make-up should be provided within 17 hours from the start of the event (Reference 3.16). For reactivity control, the passive injection from the SITs is adequate to maintain shutdown margin greater than 1.0 $\%\Delta\rho$ at an RCS temperature of 400°F (See Section 2.3.9).

Electrical/Instrumentation – Load stripping of non-essential loads will begin within 30 minutes after the ELAP/LUHS and will complete within 120 minutes into the event. This extended load shedding will extend the required Phase 1 FLEX functions for at least 12.5 hours following the event (See Section 2.3.11). The Class 1E station batteries are relied upon to provide power to critical instrumentation necessary to monitor the plant conditions (see Section 2.3.6). The TDEFW pump and ADV are available as all components are powered from the batteries or the battery backed 120 VAC buses. In addition, power is maintained to the EFW control and isolation valves. Operation of the TDEFW pump, EFW control and isolation valves, and ADVs is transferred to local manual operation as limited by electrical and control air/nitrogen supply. Local operation for these EFW valves and ADV is available via accessible handwheels on RAB +46’ Elev.

2.3.2 Phase 2 Strategy

The primary strategy extends operation of the TDEFW pump, as it is expected that sufficient steam pressure is available to drive the EFW pump turbine. The WCT basins are utilized as the suction source until approximately 38 hours when the basins’ inventory is exhausted. At this point, the WCT basins will either be refilled by gravity draining the CWI piping into the basins, or suction of the TDEFW pump is transferred to the RWSP in the event CWI piping is not available (flooding or seismic events).

Phase 2 also includes capability for reactor core cooling from a pre-staged FLEX pump (FLEX core cooling pump - FCCP) to provide feedwater to the S/Gs in the event that the TDEFW pump fails or when sufficient steam pressure is no longer available to drive the TDEFW pump turbine. An electrically-driven, pre-staged pump capable of providing the required feed rate to the steam generators can be used once the second plant cooldown to 400°F is completed and the TDEFW pump is no longer available. Hoses are provided to connect the suction of the FCCP to the available source of feedwater (CSP, WCT basins, or RWSP) and the discharge of the pump to the primary or alternate FLEX connection on the EFW system piping. The FCCP is powered by the FLEX diesel generator which is placed in service by 12 hours following the event.

Prior to commencing the second plant cooldown, isolation of the SITs is required in order to prevent nitrogen injection into the RCS which could interfere with natural circulation of the RCS. A cross-tie between the motor control centers (MCCs) is utilized to allow for repowering the SIT isolation valves from either electrical train. Once the SITs are isolated, a charging pump is placed into service to support the second plant cooldown at approximately 50°F/hr. Once the final cooldown target of 400°F in the cold legs is reached, the FCCP can then be placed into service if required.

RCS - The RCS inventory control and long term sub-criticality, involves the use of the RWSP or BAMTs inventory through a repowered charging pump. RCS make-up is initiated approximately 12.5 hours following the ELAP/LUHS event using one of three charging pumps.

Suction for the charging pump will come from either the RWSP or BAMTs via existing system alignment capabilities. The charging pumps are aligned to provide make-up directly to the RCS. The charging pumps are repowered from the FLEX diesel generator utilizing either the 31A or 31B switchgear.

In Modes 5 and 6, the FCCP is utilized for RCS make-up through new FLEX tie-ins on the high pressure safety injection (HPSI) discharge piping. The FCCP is connected to a new FLEX suction tie-in on the RWSP drain line to provide borated water to the RCS. The FCCP is powered from an electrical panel located adjacent to the charging pump cubicles.

Electrical/Instrumentation – A FLEX diesel generator is pre-staged inside the RAB above expected flood heights and the required power cables are stored near or in the switchgear rooms for deployment. The FLEX diesel generator is capable of supplying power to either battery charger that powers the DC electrical train selected for extended load shed. Once the battery charger is repowered in 12 hours from the FLEX diesel generator, DC power for controls and instrumentation continues to be available to support the RCS core cooling safety function.

Only one train of the station batteries undergoes the deep load shed to extend battery life to 12.5 hours. Once the FLEX diesel generator is supplying the battery charger for the battery train selected for the extended load shed, additional loads may be reloaded onto the battery charger as desired provided the battery charger voltage output is maintained above the minimum DC bus voltage.

The FLEX diesel generator has been sized to accommodate the following simultaneous loads:

- charging pump
- motor-driven FCCP
- component cooling water make-up pump
- battery charger
- battery room exhaust fan
- fuel oil transfer pump
- lighting

- SIT isolation valves (intermittent)
- additional emergency plan communications equipment

A detailed sizing calculation has been performed (Reference 3.50) and the results indicate that a 400kW diesel generator is acceptable for providing power to the necessary FLEX loads.

2.3.3 Phase 3 Strategy

The Phase 3 strategy for core cooling and decay heat removal will be to continue the Phase 2 strategy by using the S/Gs and in-service Phase 2 equipment until such a time that additional equipment and resources are available to transition the plant onto other cooling systems if desired or needed.

In Phase 3, available inventory in the credited water supplies will be exhausted to support core heat removal and inventory control. Make-up water from the Mississippi River is required to continue to maintain these safety functions. To process the river water, an NSRC-supplied water treatment system is deployed in line with a FLEX or NSRC water transfer pump to provide clean water for RCS and/or S/G make-up. The NSRC-supplied mobile boration system is utilized to replenish and maintain the RWSP with borated water.

In a non-flood BDBEE, the NSRC low pressure/high flow (LP/HF) pump is utilized to transfer water from the Mississippi River to the WCT basins, RWSP, and SFP. The NSRC LP/HF pump is deployed near the Mississippi River with hoses routed from the pump back to the plant. The system is utilized in conjunction with the water treatment and mobile boration systems to provide indefinite make-up water for use by the FLEX strategies. The NSRC LP/HF pump is capable of providing the flow required (Reference 3.57) to support the combined flow demands for decay heat removal, SFP make-up, and RCS make-up.

In persistent flooding events, the NSRC LP/HF pump and the NSRC submersible pump are staged on the RAB roof to allow for make-up from the surrounding flood water to the WCT basins, RWSP, and SFP. The FLEX water transfer pumps (FWTPs) have similar capabilities and provide additional redundancy.

The NSRC will provide a S/G make-up pump that is capable of meeting the flow demands to continue heat removal via the steam generators. If use of the pump is desired/required, hoses would be routed to the existing FLEX tie-ins on the EFW system. Suction for the NSRC S/G make-up pump is provided by the NSRC water treatment skid either by using a submersible pump from the RAB +69’ roof, or at ground elevation.

For maintaining RCS inventory control, the NSRC high pressure (HP) pump can be used with the high pressure safety injection tie-in connections (Section 2.3.5.4).

Phase 3 strategies involve the use of a 4160V gas turbine generator from the NSRC. The potential loads to be powered by the Phase 3 gas turbine generator are a containment fan cooler, one low pressure safety injection (LPSI) pump, one component cooling water (CCW) pump, and dry cooling tower (DCT) fans. In addition, an essential chiller is powered up to provide room cooling for the LPSI pump, CCW pump and SDC heat exchanger. This load list assumes the Phase 2 diesel generator is connected to the 31B switchgear and that 31B and 31AB are connected. The Phase 3 gas turbine generator is assumed to be connected to the 4160 VAC 3A bus. If Train A is selected for the initial phases, then the bus designators would change to the opposite train. Load monitoring and coordination is required before energizing the Phase 3 gas turbine generator and before starting any major load or restoring power to any motor control center. If power from the Phase 3 gas turbine generator is restored to the switchgear, all interlocks and protective features (except for switchgear lockout related trips) for the loads is disabled prior to connecting or loading the NSRC generators onto the 480V AC switchgear bus to prevent non-essential automatic starting or tripping functions from de-energizing the switchgear.

The primary and alternate Phase 3 generator locations are in two separate areas. For non-persistent flooding events, the on-site equipment staging location (“Staging Area B”) for Phase 3 NSRC equipment is in the plant parking lot as depicted on Figure 1. For persistent flooding events, NSRC equipment is transported by helicopter from the off-site staging location to the plant site. Equipment could be landed on the RAB roof +69’ Elev. (“Alternate Staging Area B”) (Figure 6).

2.3.4 Systems, Structures, Components

2.3.4.1 Nuclear Plant Island Structure

The nuclear plant island structure (NPIS) is a reinforced concrete box structure with solid exterior walls. The NPIS is the common structure of the Reactor Containment Building (RCB), RAB and the Fuel Handling Building (FHB). All seismic Category I structures, safety-related systems and components are housed in the NPIS. All exterior doors and penetrations below Elev. +30.0 ft. MSL which lead to areas containing safety-related equipment are watertight. The NPIS protects the required credited FLEX SSCs from all applicable external hazards.

2.3.4.2 Emergency Feedwater System

The EFW system is a seismically qualified system. This system contains a turbine driven EFW pump and two motor driven EFW pumps. The TDEFW pump will start on an emergency feedwater actuation signal (EFAS) and will provide flow at a predetermined low S/G level setpoint. The EFAS is part of the plant protection system and is located in the RAB, therefore, is protected from all external events. The TDEFW pump will deliver the required emergency feedwater (EFW) flow to both steam generators through individual air-operated flow control valves (FCVs). Remote control and operation of the FCVs uses instrument air and is backed up by installed nitrogen accumulators if instrument air becomes unavailable. Local operation of the FCVs via handwheels is available. The TDEFW pump and valves are sized to provide the design basis EFW flow requirements and is located in a robust structure (the RAB) designed for protection for applicable design basis external events. The TDEFW pump and valves meet the requirements in NEI 12-06 for protection from all applicable external events. Concerning the wind/tornado missile events, the portion of the EFW system inside the RAB is protected from wind and tornado generated missile loads by the RAB which is designed to withstand the loads associated with the maximum wind or tornado (Reference 3.68). Portions of the steam admission line, EFW discharge piping, and terry turbine exhaust stack have been evaluated for potential tornado missile strikes and determined not to require physical protection as the probability of occurrence of a tornado generated missile strike is sufficiently small (Reference 3.18). Additionally, the exposed portions of the EFW system required for FLEX strategies have been determined to be reasonably protected (Reference 3.58) from applicable missiles by virtue of their location, construction characteristics and surrounding structures that intervene with a missile's flight path.

2.3.4.3 Atmospheric Dump Valves

During an ELAP/LUHS event, reactor decay heat is removed from the S/Gs for an indefinite time period by depressurizing the S/Gs via the ADVs. The ADVs are safety related valves and are located on the RAB +46' Elev. roof. Steam flow through the valve body assembly is adjustable with battery backed control power and 10 hours of nitrogen gas backup to the valve operator (Reference 3.68). The ADVs can be manually operated using either the handwheels or the local pneumatic control stations. The ADVs meet the requirements in NEI 12-06 for protection from all applicable external events. The ADV exhaust stacks are exposed to tornado missiles on the RAB +69' Elev. roof. Similar to the TDEFW steam and EFW lines, the ADV exhaust stacks have been determined to be reasonably protected from applicable missiles by virtue of their location, construction characteristics and surrounding structures that intervene with a missile's flight path.

2.3.4.4 Safety Injection System

The SITs provide initial passive injection into the RCS which maintains natural circulation allowing for effective core cooling utilizing the S/Gs. The SITs contain borated water and are pressurized with nitrogen gas. The SITs are isolated to preclude nitrogen injection at approximately 12.5 hours. The SITs and the isolation valves are seismically qualified component located completely inside the containment building. Therefore, these components are fully protected and qualified for all applicable external events.

During Modes 5 and 6, RCS injection is required to provide coolant to the RCS to match boil-off. The FCCP can be aligned to provide injection to the RCS via safety injection piping. The safety injection system is a seismically qualified system, located completely within the containment and reactor buildings. Therefore, the safety injection piping is fully protected and qualified for all applicable external events.

2.3.4.5 Charging Pumps/Piping System

The WF3 FLEX strategy for maintaining RCS inventory control relies upon repowering an installed charging pump. This strategy is considered acceptable as an alternative per NEI 12-06 FAQ 2013-06 (Reference 3.37).

The charging pumps and associated piping are seismically qualified. The pumps are located on the -35’ elevation of the RAB and each pump is independently separated from the other within its own pump cubicle. As the RAB is protected against high winds, tornado missiles, and external flooding, the charging pumps and associated piping are considered robust for all external hazards. Internal flooding has been investigated and no sources of non-seismic piping have been identified for the flood zone that the pumps are located within. Therefore, the charging pumps are robust for all extreme external hazards applicable to WF3.

The charging pump will draw suction from the RWSP or the BAMT and supply make-up to the RCS via the normal alignment path, or via an alternate injection path through HPSI. The charging pumps are designed to supply 44 gpm at a discharge pressure of 2350 psig (Reference 3.68). Make-up rate of 25 gpm was sufficient to maintain natural circulation within the RCS and maintain adequate shutdown margin (Reference 3.16). Therefore the charging pumps are sufficient to meet the FLEX RCS inventory control function.

Based on the robust design and adequate performance of the charging pumps, any of the three charging pumps may be credited as the RCS make-up FLEX pump.

2.3.4.6 Class 1E Distribution System

The batteries and the credited AC and DC distribution systems are located inside the seismically qualified RAB structure, therefore, they are protected from all applicable external events. For Phase 1, the station batteries are relied upon to provide power to instrumentation and components to maintain FLEX safety functions. Only one train of the station batteries will undergo deep load shed to extend the battery life to 12.5 hours. During Phase 2, the FLEX diesel generator is capable of supplying power to either battery charger that powers the DC electrical train selected for extended load shed. Once the battery charger is repowered from the FLEX generator, DC power will remain available. During Phase 2, limited AC power is provided to the necessary credited equipment by the FLEX diesel generator.

2.3.4.7 Condensate Storage Pool

The primary source of emergency feedwater is the CSP. The CSP is located inside the RAB structure, therefore, meets the requirements in NEI 12-06 (Reference 3.3) for protection from high winds and tornado missile strikes, extreme heat, extreme cold, and flooding events.

The CSP is a stainless steel lined reinforced concrete seismically qualified pool located within the RAB. As the CSP is protected from all extreme external hazards, it is considered a robust source of water (see Section 2.6.3).

The CSP is able to provide water to the TDEFW pump or FCCP for use in feeding the S/Gs. The CSP has an available inventory of approximately 187,000 gallons.

2.3.4.8 Refueling Water Storage Pool

The RWSP is a stainless steel lined concrete compartment located inside the RAB, therefore, is protected from all applicable external events. As the RWSP is a seismically qualified structure and is protected from all extreme external hazards, it is considered a robust source of borated water (see Section 2.6.3).

The RWSP provides borated water for make-up to the RCS. Water from the RWSP may be utilized for S/G make-up as well depending upon the external event. Negligible impacts to heat transfer performance would result from the limited use of borated water for S/G make-up (Reference 3.20).

The available inventory of the RWSP is approximately 420,800 gallons.

2.3.4.9 Wet Cooling Tower Basins/Auxiliary Component Cooling Water Suction Piping

The WCT basins A and B contain 348,200 gallons combined. The basins can be cross-tied by opening the WCT cross connection isolation valves. While the WCT basins combine to hold a minimum 348,200 gallons, only 273,500 gallons are available for suction off of one basin utilizing the cross-tie between the two basins and utilizing the FLEX strategy's credited auxiliary component cooling water (ACCW) suction line. The WCT basins are seismically qualified located within the NPIS, therefore, they are considered robust. A portion of the WCT cross-connect piping and ACCW suction line are exposed to wind-generated missiles from above. These exposed portions have been determined to be reasonably protected (Reference 3.58) from applicable missiles by virtue of their location and the presence of intervening structures.

2.3.4.10 Battery Room Ventilation System

The battery rooms will require ventilation to prevent the accumulation of hydrogen gas while the batteries are being charged during Phases 2 and 3. Ventilation is provided via repowering the existing battery room exhaust fans. The battery room exhaust fans are seismically qualified and they are located completely within the RAB, therefore, they are protected from all applicable external events.

2.3.4.11 Emergency Diesel Fuel Oil Components

The emergency diesel storage tanks, feed tanks, valves, piping and transfer pumps will be utilized to replenish fuel oil to the FLEX diesel generator and supply fuel to FLEX equipment on the +21' Elev. Q-deck. The emergency diesel fuel oil components are designed to seismically qualified requirements and are protected by the RAB against all applicable external events. The tanks (storage and feed tanks) are enclosed in concrete vaults which are part of the RAB wing area. Each storage tank vault contains the diesel oil transfer pump connected to the tank and its associated piping and valves.

2.3.4.12 Circulating Water Intake (CWI) Piping

The CWI piping is non-seismic, non-safety related piping that runs from the circulating water pumps at the intake platform on the Mississippi River, over the levee, and then underground to the turbine building to supply coolant to the condensers. As the piping is buried underground, the piping is protected from hurricane and tornado winds and missiles. As the valves required to establish the gravity drain require access beyond the plant flood wall, and the CWI piping does not meet the seismic design basis, the inventory within the CWI piping is only credited for non-flood, non-seismic events (Reference 3.68).

2.3.4.13 Nitrogen System

The nitrogen accumulators provide compressed gas to operate the ADVs and the EFW valves following a loss of instrument air caused by an ELAP. The accumulators are seismically qualified and located on the RAB roof under the missile grating, therefore, they are protected from all applicable external events.

2.3.5 FLEX Modifications

2.3.5.1 S/G Make-up Primary and Alternate Connections

The primary connection for S/G make-up via the FCCP is located on the existing EFW A line. This tie-in is installed on the discharge header of the motor driven EFW A pump (Figure 2). A flexible hose is routed from the FCCP discharge to the primary tie-in connection. The primary tie-in connection is located inside the RAB and on the same elevation as the FCCP. Hydraulic analysis of the flowpath from the CSP and WCT basin connections to the primary FCCP discharge connection has confirmed that applicable performance requirements are met. In the event that the primary S/G make-up connection is unavailable, an alternate connection location is provided on an existing EFW B line. This tie-in is installed on the discharge header of the motor driven EFW B pump (Figure 2). A flexible hose can be routed from the FCCP discharge to the alternate tie-in connection. The alternate tie-in connection is located inside the RAB and on the same elevation as the FCCP. Hydraulic analysis of the flowpath from the CSP and WCT basin connections to the alternate FCCP discharge connection confirmed that applicable performance requirements are met (Reference 3.24). Both connections are seismically qualified and located in the RAB, therefore, these connections are fully protected from all applicable external events.

2.3.5.2 WCT Basin Suction Source Connection

A tie-in connection to ACCW system piping on an existing ACCW A line provides a suction source from the WCT basin A to the TDEFW pump or FCCP (Figure 2). As the connection point is located in the reactor building west wing area at Elevation -35’, an intermediate water transfer pipe (see Section 2.3.5.3) is installed between the reactor building wing area and the RAB. Rigid suction hoses are connected between the ACCW A tie-in and the intermediate water transfer pipe and between the intermediate water transfer pipe and the pump (TDEFW or FCCP) being utilized for core cooling. This connection is seismically qualified and located within the RAB, therefore, it is fully protected from all applicable external events.

2.3.5.3 Intermediate Piping Connection

A standalone intermediate pipe was installed between the reactor building -35’ wing area and the RAB -35’ corridor near the TDEFW pump. This intermediate pipe run is required to allow TDEFW suction to be transferred to the WCT basin when the CSP inventory is exhausted. This intermediate pipe (Figure 2) includes piping, supports, and new wall penetrations that penetrate the existing boundary. This connection is seismically qualified and located within the NPIS, therefore, it is protected from all applicable external events.

2.3.5.4 <u>RCS Injection Primary and Alternate Connections Modes 5 and 6</u>

The primary connection for core cooling via the FCCP is located on an existing HPSI A line (Figure 2). This tie-in connection is installed downstream of the HPSI A pump on the discharge header. A flexible hose is routed from the FCCP discharge to the primary tie-in connection. This primary tie-in connection is located on the same -35' elevation as the FCCP. Hydraulic analysis of the flowpath confirmed that applicable performance requirements are met (Reference 3.24). The alternate connection for core cooling via the FCCP is a tie-in to an existing HPSI AB line (Figure 2). This tie-in connection is installed downstream of the HPSI AB pump on the A-AB-B cross-tie piping between valves SI 212A and SI 212B. A flexible hose is routed from the FCCP discharge to the alternate tie-in connection. This alternate tie-in is located inside the RAB and on the same elevation as the FCCP. Hydraulic analysis of the flowpath confirmed that applicable performance requirements are met (Reference 3.24). These connections are seismically qualified and located inside the RAB, therefore, they are protected from all external events.

2.3.5.5 <u>RWSP Suction Connection</u>

A suction connection from the RWSP is installed on the RWSP drain pipe (Figure 2). This connection allows borated water from the RWSP to be supplied to the FCCP for core cooling in Modes 1-4 or for RCS make-up in Modes 5 and 6. This connection is located on the same elevation of the RAB as the FCCP. The connection is seismically qualified and located inside the RAB, therefore, is protected from all external events.

2.3.5.6 <u>TDEFW Pump Suction Connection</u>

A tie-in into the existing TDEFW pump suction line was installed to allow the TDEFW pump to be connected to diverse suction sources for S/G make-up. This tie-in is installed on the flanged spool piece of the TDEFW pump suction header (Figure 2). The new tie-in includes piping, supports, and valves. The EFW AB tie-in is located in the EFW AB pump area inside the RAB. The tie-in connection is seismically qualified and located inside the RAB, therefore, the connection is protected from all applicable external events.

2.3.5.7 Primary and Alternate Electrical Connections for FLEX Diesel Generator

Connection panels for the FLEX diesel generator have been installed near each 31 switchgear on the RAB +21 Elev. Spare circuit breakers have been modified on 480 VAC switchgear buses 31A and 31B to provide power to the switchgear from the FLEX diesel generator (Figure 3). Temporary cable is routed from the FLEX panel to the corresponding switchgear tie-in electrical panel. These connections panels in the respective switchgear rooms are seismically designed. The components that power the switchgear are located within the RAB, therefore, are fully protected from all applicable external events.

2.3.5.8 Electrical Connections for FLEX Core Cooling Pump

The FCCP is powered using one of the three 480 VAC charging pump power supply circuits. Only one of the three charging pumps are utilized in the FLEX strategy for RCS make-up. The modifications allow the FCCP to be powered from the A/B charging pump power supply circuit. This design provides for connection points for the 480 VAC power supply to the FCCP (Figure 4). The electrical connection panels have been designed to be robust, and are located within the RAB, therefore, are fully qualified and protected from all applicable external events.

2.3.5.9 Electrical Cross-Tie to Isolate Safety Injection Tanks

A modification was installed to allow for repowering the SIT isolation valves from either electrical train. The MCC cross-connect is installed to connect power to close the opposite train electrical powered SIT isolation valves to which the FLEX diesel generator is aligned. A new MCC cross-connect is utilized to allow a connection to MCC 3A311 or MCC 3B311 (depending on which train is powered by the FLEX diesel generator) to repower the valves (Figure 5). The electrical equipment and their associated supports for this cross-tie connection are seismically qualified and are located inside the RAB, therefore, are fully protected from all applicable external events.

2.3.5.10 FLEX Diesel Generator Enclosure

The FLEX diesel generator enclosure is a seismic Category I, reinforced-concrete, tornado-missile protected structure located on the RAB roof at +41 ft. Elev. The FLEX diesel generator enclosure provides storage of the “N” FLEX diesel generator and the FLEX diesel generator fuel storage tank. Equipment anchorage and structural integrity/functionality were analyzed to ensure functionality after a design basis safe shutdown earthquake (SSE). A fuel oil fill line to the FLEX diesel generator fuel storage tank was also included as part of this modification. This fill line was designed seismic Category I and missile protected. In addition, a FLEX diesel generator receptacle panel was installed in the heating and ventilation fan room on +21 ft. Elev. of the RAB, below the FLEX diesel generator enclosure. The panel is connected to the FLEX diesel generator with permanent cable and conduit. Portable FLEX diesel generator output cables connect to this receptacle panel similar to the receptacle panels added for the FLEX electrical modifications (Section 2.3.5.7). This enclosure is designed to be protected from all applicable external events.

2.3.5.11 “N+1” FLEX Storage Building

The “N+1” storage building is a commercially procured storage facility designed to meet ASCE 7-10. It is located outside the NPIS on the south side of the plant. Section 2.7 provides a description of this facility.

2.3.6 Key Reactor Parameters

Instrumentation providing the following key parameters is credited for all phases of the reactor core cooling and decay heat removal strategy:

- RCS temperatures are monitored through the use of core exit thermocouples (CETs) and steam generator pressure instruments for the primary extended load shed strategy (Train B). RCS temperatures are monitored by RCS hot leg instruments and steam generator pressure instruments for the alternate extended load shed strategy (train A).

- Steam generator levels are monitored using wide range and narrow level indication instrumentation.

- CSP level indication remains available for the primary extended load shed. For the alternate extended load shed, CSP level can be monitored by measuring the voltage output of the level transmitter(s) with a digital volt meter (supplied equipment for FLEX).

- RCS level and pressure instrumentation is available for either the primary or alternate extended load shed. This includes pressurizer level (Train A only), pressurizer pressure, and/or the reactor vessel level monitoring system (Train B only).

- Wide range containment pressure indication remains available. Containment temperature will not be available. The WF3 FLEX strategies do not rely on containment temperature for decisions.

- Neutron flux monitoring is available using log safety channels.

- DC bus voltage instrumentation remains available to monitor battery capacity.

The above instrumentation is available prior to and after load stripping during Phase 1. Availability during Phases 2 and 3 is as described above and dependent on the strategy selected (primary or alternate) that re-powers the 31A or 31B AC bus including the associated Class 1E battery charger.

The above instrumentation is seismically qualified and located within the NPIS, therefore, is considered protected from all external events.

Portable FLEX equipment is supplied with the local instrumentation needed to operate the equipment. The use of these instruments is detailed in the associated FSGs for use of the equipment. These guidelines are based on inputs from the equipment suppliers, operation experience, and expected equipment function in an ELAP.

2.3.7 Thermal Hydraulic Analyses

2.3.7.1 Water Source Inventory Analysis

Available inventory sources containing over 700,000 gallons can provide support for core cooling and heat removal for a period of 72 hours after the event (Reference 3.11). The FLEX strategy for core cooling utilizes all available on-site inventory (including the RWSP if required) to provide for a coping of at least 72 hours, after which NSRC equipment will be available to provide make-up from the Mississippi River (or elsewhere) to the plant. The use of borated water (RWSP) for feeding the steam generator has insignificant impact on steam generator thermal efficiency (Reference 3.20), therefore, inventory to support core cooling can utilize the RWSP if required. Tables 1 and 2 below identify the timing/inventory usage analysis for each of the event groupings. Table 1 presents the analysis for flood and seismic events while Table 2 presents the analysis for non-flood, non-seismic events (e.g. beyond design basis tornado).

Table 1 Flooding or Seismic Events

	From	To	From	To	From	To	From	To	From
	0	8 hours	8 hours	38 hours	38 hours	72 hours	72 hours	76.9 hours	76.9 hours
Core Cooling	187,000 gallons		273,500 gallons		233,500 gallons		29,400 gallons		100 GPM
	CSP		WCT Basins		RWSP				NSRC via WCT

The 8 hour and 38 hour transitions from CSP to WCT Basins and WCT Basins to RWSP are based on the total water available within the sources.

Table 2 Non-Flood, Non-Seismic Events

	From	To	From	To	From	To	From	To	From
	0	8 hours	8 hours	38 hours	38 hours	72 hours	72 hours	74.8 hours	74.8 hours
Core Cooling	187,000 gallons		273,500 gallons		233,500 gallons		16,800 gallons		100 GPM
	CSP		WCT Basins		CWI via WCT				NSRC via WCT

The 8 hour and 38 hour transitions from CSP to WCT Basins and WCT Basins to CWI via WCT are based on the total water available within the sources.

2.3.7.2 RCS Analysis

The model used for determination of RCS response was based on that used in the generic analysis in WCAP-17601, Section 5.3.2. A WF3 site specific ELAP analysis was performed utilizing the Combustion Engineering Nuclear Transient Simulation (CENTS) code (Reference 3.16). The CENTS code is considered acceptable by the NRC for ELAP analyses in Reference 3.21.

RCS inventory make-up must begin before 17 hours following the onset of the ELAP condition to prevent the transition to reflux cooling. A method to aid in defining a flow quality at the top of the S/G U-tubes was developed and was used to describe the onset of reflux cooling (Reference 3.22). The method involves calculating a centered moving average of the flow quality and then assigning a maximum quality of 0.10 to that moving average. The maximum flow quality of 0.10 ensures that the liquid flow into the cold half of the U-tubes is at least 9 times the steam flow which would condense on the tube walls in the cold half of the tubes. Thus, the liquid flow through the tubes is sufficient to prevent any significant stratification of solutes in the cold half of the S/G tubes and the loop cold legs. The site specific ELAP analysis (Reference 3.16) considered a pressure dependent RCP seal leakage model that assumes a maximum leakage rate of 15 gpm/RCP at normal operating pressure (NOP). The analysis also assumes minimum SIT injection based on SIT volumes/pressures. The results of the analysis determined that RCS make-up at a rate of 25 gpm within 17 hours of the initiation of the event will prevent the transition to reflux cooling. Since the RCS make-up is initiated at approximately 12.5 hours at 44 gpm make-up capacity, the reflux cooling condition is avoided.

Tables 3 and 4 below identify the timing/inventory usage analysis for each of the event groupings. As the seismic, non-flood event would utilize the exact same strategy as a flood event, a separate table has not been provided. Table 3 presents the analysis for flood and seismic events while Table 4 presents the analysis for non-flood, non-seismic events (e.g. beyond design basis tornado).

Table 3 Flooding or Seismic Events

<table>
<tr><td rowspan="2"></td><td>From</td><td>To</td><td>From</td><td>To</td><td>From</td><td>To</td><td>From</td></tr>
<tr><td>0</td><td>17 hours</td><td>17 hours</td><td>72 hours</td><td>72 hours</td><td>76.9 hours</td><td>76.9 hours</td></tr>
<tr><td rowspan="2">RCS Inventory</td><td colspan="2" rowspan="2">Make-up not required</td><td colspan="2">145,200 gallons</td><td colspan="2">12,900 gallons</td><td>44 GPM</td></tr>
<tr><td colspan="4">RWSP</td><td>NSRC via RWSP</td></tr>
</table>

Based on Tables 1 and 3, water replenishment from the Mississippi River (or other resource) should be established by 76.9 hours utilizing NSRC equipment.

Table 4 Non-Flood, Non-Seismic Events

<table>
<tr><td rowspan="2"></td><td>From</td><td>To</td><td>From</td><td>To</td><td>From</td><td>To</td><td>From</td></tr>
<tr><td>0</td><td>17 hours</td><td>17 hours</td><td>72 hours</td><td>72 hours</td><td>74.8 hours</td><td>74.8 hours</td></tr>
<tr><td rowspan="2">RCS Inventory</td><td colspan="2" rowspan="2">Make-up not required</td><td colspan="2">145,200 gallons</td><td colspan="2">7,400 gallons</td><td>44 GPM</td></tr>
<tr><td colspan="4">RWSP</td><td>RWSP / NSRC via RWSP</td></tr>
</table>

Based on Tables 2 and 4, coping could be extended further by crediting the inventory left in the RWSP (approximately 270,000 gallons) or water replenishment from the Mississippi River (or other resource) could be established utilizing NSRC equipment.

2.3.8 Reactor Coolant Pump Seals

WF3 is a Combustion Engineering plant with Flowserve Byron-Jackson Type N-9000 4 stage seal assemblies. These seal assemblies contain ethylene propylene elastomers. These types of elastomeric materials are capable of withstanding high temperatures in excess of 550°F for extended duration without change in service properties. WCAP 17601 (Reference 3.23) highlights the concern with respect to high service temperature conditions on seal properties and the potential for elastomeric failure modes associated with “thermal binding” and “extrusion” (and, concerns for “heat checking” of the seal faces). The net effect of the plant cooldown is to reduce RCS pressure and temperature early in the event. The plant cooldown is initiated at 2 hours into the event and is conducted in two steps. The heating effects to the seal (from RCS temperatures) and its elastomers are significantly reduced below any temperatures of concern in the first step of the cooldown to minimize long term seal degradation. Any temperature rate of rise is gradual, will be progressive throughout the stages (lower stage heats up first) and will occur over an extended period of time. Since WF3 is expected to initiate a cooldown at 2 hours into the event, all stage temperatures are expected to be maintained below the elastomeric materials service properties of 550°F. The maximum seal leakage assumed in the analysis is 15 gpm/seal (60 gpm total).

2.3.9 Shutdown Margin Analysis

Based on the results of the shutdown margin analysis (Reference 3.16), the excess shutdown margin for WF3 is greater than 1.0 %$\Delta\rho$ 24 hours after event initiation when xenon is fully decayed. Thus, no action to provide additional negative reactivity during an ELAP event is necessary. Because passive injection from the SITs provides sufficient shutdown margin early in the event, the boron mixing criteria is met (Reference 3.13).

2.3.10 FLEX Pumps and Water Supplies

2.3.10.1 FLEX Core Cooling Pump

The FCCP acts as a backup to the TDEFW pump during Modes 1-4 for S/G make-up and eventually is the primary means of S/G make-up once steam pressure is no longer sufficient to drive the TDEFW turbine. The pump is sized to provide a minimum of 250 gpm at 250 psi (Reference 3.24). Once the second RCS cooldown to 400°F is completed, this flowrate is more than adequate to maintain RCS core cooling. The FCCP can also be used to provide water to the RCS during Modes 5 and 6 with S/Gs unavailable. For Modes 5 and 6 condition the suction source is the RWSP and injection capability is provided by either of two connections on the high pressure safety injection system through flexible hose and permanent plant piping.

The FCCP is an electric pump that is powered by the FLEX diesel generator. There are two FCCPs available for the site, therefore complying with the N+1 requirement established in NEI 12-06. The “N” FCCP is pre-staged within the RAB by the

TDEFW pump. Required hoses and electrical cables are stored on the same elevation. The RAB is a seismically qualified structure providing full protection against all applicable external events. The “N+1” FCCP is stored in the “N+1” storage building (see Section 2.7). If the “N” FCCP within the RAB becomes unavailable, the “N+1” FCCP can be staged into the plant.

Each FCCP is sized to provide make-up water at the rate of 250 gpm to the S/Gs (and 132 gpm to the RCS during Modes 5 and 6 with S/Gs unavailable). Hydraulic analysis of the flowpath from the WCT to the S/Gs (or from the RWSP to the RCS) has determined that applicable performance requirements are met (Reference 3.24).

2.3.10.2 FLEX Water Transfer Pump (FWTP)

Due to WF3’s unique design and classification as a ‘wet’ site, WF3 has incorporated a contingency capability to make-up water to its credited FLEX inventory sources. The FWTPs can be used to transfer an indefinite supply of water from the Mississippi River or surrounding flood water to the WCT basins and RWSP to supplement the NSRC equipment if desired.

The FWTPs are sized to deliver make-up water to the WCT basin following a BDBEE to meet the flow demands of the FCCP as well as provide SFP make-up or spray. Both FWTPs are capable of providing a total flow of at least 400 gpm. The FWTPs are trailer-mounted, diesel engine driven pumps. One of the FWTP (“N” FWTP) is stored within the RAB. The RAB provides protection to the “N” FWTP for all applicable external events. This “N” FWTP is capable of drawing suction from the surrounding flood waters by routing a suction hose over the flood wall. The pump will discharge to the WCT ‘A’ Basin and can also provide SFP make-up and spray directly to the pool via interconnecting hoses/manifolds stored within the RAB. The interconnecting equipment is stored within the RAB and fully protected from all applicable external hazards.

A second FWTP (“N+1” FWTP) is stored within the “N+1” storage building. This pump could be towed (or air lifted by helicopter) to the Mississippi River and the suction hose routed directly into the river water. Hydraulic analysis determined that the FWTPs are sized to provide a flow rate of 400 gpm (Reference 3.25) via their applicable hose routings.

2.3.10.3 FLEX Internal Flooding Sump Pump

Due to the WF3 FLEX strategy's reliance upon mounted equipment within the RAB, potential sources of internal flooding were reviewed for impacts to the FLEX strategy.

The limiting flood rate for the internal sources is approximately 62 gpm (Reference 3.64). At this flood rate, the FLEX strategy could be impacted within 28 hours (Reference 3.64) if mitigating actions are not taken. In order to mitigate this flooding impact, a portable sump pump has been installed to protect the FLEX credited equipment. As an additional strategy, the flooding sources are to be isolated via their associated isolation valves.

In the event internal flooding is detected, a pre-staged portable, air powered sump pump can be placed into service (Reference 3.65) by 28 hours. This permanently mounted pre-staged pump takes suction from the sump (floor drain (FD) sump #10) and hoses are routed from the discharge of the pump to a manifold on the RAB -35' Elev. This alignment allows for transfer of the flood water to either the suction of the FCCP, TDEFW pump, or CCW MU pumps or to the WCT basin. The compressed air to run the pump comes from an existing SBO air compressor, permanently staged on the RAB +21' Elev. and deployed to the Q-deck. Once the source of internal flooding has been exhausted or isolated, the sump pump and air compressor can be secured. The pre-staged pump and air compressor (along with connection hardware) are located inside the RAB and NPIS and are fully protected against all applicable external events.

2.3.10.4 FLEX Diesel Fuel Transfer Pump (FDFTP)

The FDFTP are small diesel-driven pumps used in conjunction with a re-powered safety-related emergency diesel generator fuel transfer pump to refuel the pre-staged diesel-driven FLEX equipment. This combination of equipment is capable of delivering fuel from either of the on-site safety-related emergency diesel generator feed tanks to the pre-staged diesel-driven FLEX equipment utilized in the strategy. One pump and requisite connection equipment are stored in the RAB and are fully protected from all applicable external events. The FDFTP and requisite connection equipment can be deployed and controlled locally at the RAB +46' Elev. outside of the feed tank rooms. A second pump ("N+1") is stored in the "N+1" storage building. The FDFTPs are sized to provide at least a flow rate of 15 gpm via the applicable hose routings.

2.3.10.5 EFW Water Supplies

Condensate Storage Pool (CSP)

The CSP provides an EFW water source at the initial onset of the event. The CSP is a seismic Category I structure located within the NPIS, therefore, is fully protected from all applicable external events. The CSP volume is maintained at 92% level per technical specifications, which provides approximately 187,000 gallons of usable inventory (Reference 3.68).

Wet Cooling Tower Basins (WCT)

The WCT basins meet the requirements in NEI 12-06 for protection from all applicable external events as described in Section 2.3.4.9. While the WCT basins combine to hold a minimum 348,200 gallons, only 273,500 gallons are available utilizing the cross-tie between the two basins (approximately 15,000 gallons below the cross-tie piping will not gravity drain) and utilizing the FLEX installed tie-in connection located on the ACCW "A" pump suction line (60,000 gallons below the high point in the suction piping is not credited).

Refueling Water Storage Pool (RWSP)

The RWSP is credited as a usable source of water to make-up to the S/Gs for flood and seismic events. It utilizes the EFW system to supply RWSP water for core cooling via the FCCP or TDEFW pump. Use of borated water within the steam generators has been evaluated to verify acceptable heat transfer is maintained (Reference 3.20).

Circulating Water Intake (CWI)

There are approximately 250,584 gallons of water within the CWI piping to supply the WCT basins by gravity feed when the WCT basin inventory is exhausted (Reference 3.27). This takes into account siphoning over a high point in the intake piping connection to the WCT basin cross-connect piping. Gravity feed capability to the basins exceeds the flow rates required to support the FLEX safety functions. The CWI piping is non-seismic, non-safety related piping that runs from the circulating water pumps at the intake platform on the Mississippi River, over the levee, and then underground to the turbine building to supply coolant to the condensers. As the piping is buried underground, the piping is protected from hurricane and tornado winds and missiles. Since the valves required to establish the gravity drain require access beyond the plant flood wall, and the CWI piping does not meet the seismic design, the inventory within the CWI piping can only be credited for non-flood, non-seismic events.

Mississippi River

Water from the Mississippi River is utilized during Phase 3 to maintain core cooling. The Mississippi River contains water that is high in suspended solids that over time could impact the capability of the steam generators to remove heat from the RCS (Ref. 6.24, Table 3-5). Therefore, a water treatment system delivered from the NSRC is deployed at WF3 in line with the NSRC LP/HF pump (Section 2.3.3).

2.3.10.6 Borated Water Supplies

The sources of borated water credited for use during a BDBEE are discussed below.

Refueling Water Storage Pool (RWSP)

The RWSP is located inside the RAB, therefore, meets the requirements in NEI 12-06 for protection from all applicable external events (see Section 2.3.4.8). The RWSP contains borated water with a minimum concentration of 2050 ppm boron. The borated water inventory available following a BDBEE is approximately 420,800 gallons. The RWSP inventory is the source of borated water during Phase 2 for an event occurring while the plant is in Modes 1-4 with the steam generators available. In Modes 5 and 6 with the steam generators unavailable, the FCCP can be aligned to take suction from the RWSP to provide injection to the RCS via the installed tie-in connection in the HPSI piping.

Boric Acid Make-up Tanks (BAMTs)

The BAMTs are safety-related and seismically qualified component (Reference 3.19). These tanks are located within the RAB, therefore, they are protected against all applicable external events. The BAMTs contain highly concentrated borated water utilized for reactivity control during plant operation. The exact concentration and minimum volume requirements are dependent upon the plant mode and the status of the RWSP. Given the variable nature of the BAMTs and relatively minimal water inventory (12,300 gallons maximum combining both tanks), the FLEX borated inventory analyses are based upon use of the RWSP only. The BAMTs may be utilized for RCS make-up if available and could extend RCS make-up capability.

2.3.11 Electrical Analysis

WF3 battery capability for FLEX requires the existing SBO loads shed within 30 minutes and an extended FLEX load shed by 120 minutes on either battery train 3A-S or 3B-S. Battery duration calculations were performed in accordance with the IEEE-485 guidance as outlined in the NEI white paper on extended battery duty cycles (Reference 3.29 as endorsed by the NRC (Reference 3.30)) for both each battery train to determine the timeline for FLEX diesel generator deployment. The calculations determined battery capacity to last 12.5 hours for the train of batteries that undergoes the extended load shed (References 3.31 and 3.32).

Although the extended (ELAP) load shed is only performed on one train of Class 1E batteries (primary or alternate), performance of the SBO load shed strategy (References 3.33 and 3.34) given in the EOPs ensures at least 4 hours of coping (Reference 3.35) on the opposite train of Class 1E batteries (3A-S, 3B-S and 3AB-S).

The ELAP extended load shed battery capacity was calculated to be 12.5 hours for either train of Class 1E batteries. This time exceeds the deployment time of the FLEX diesel generator (12 hours) which provides at least 30 minutes of margin to ensure the battery chargers are re-powered and functioning.

The FLEX diesel generator is pre-staged and permanently installed within an enclosure built on the RAB +41' roof (Section 2.3.5.10). The enclosure houses the diesel generator and a 400 gallon fuel tank. Cables required to place the FLEX diesel generator into service are stored within the RAB +21' Elev. on cable spools that are seismically robust per the guidance of NEI 12-06. The FLEX receptacle panels used to connect the 480 VAC switchgear (3A31-S or 3B31-S) to the FLEX diesel generator are permanently installed within the RAB and constructed as seismically robust per the guidance of NEI 12-06. The 480 VAC switchgear's corresponding FLEX receptacle panel is connected to the FLEX diesel generator's receptacle panel using two cables per phase plus one ground cable. Once the connections are made, the corresponding breaker must be closed prior to the FLEX diesel generator startup.

The enclosure which houses the pre-staged FLEX diesel generator is designed and constructed to equivalent seismic standards of the RAB, is located within the confines of the NPIS and above any postulated design basis flood levels. As such, the FLEX diesel generator and all associated connection equipment is robust and protected from all applicable external events.

A second ("N+1") FLEX diesel generator is stored in the "N+1" storage building. WF3 has developed pre-planned deployment strategies to further protect the "N+1" diesel generator for those events with predictable forewarning (e.g., hurricanes and river flooding) and for the unlikely failure of the "N" unit during normal plant operations.

2.4 Spent Fuel Pool Cooling/Inventory

The primary FLEX strategy and sequence of events is based upon an event with the plant operating in Modes 1-4 with the S/Gs available and a nominal spent fuel load in the SFP. For Modes 5 and 6, the SFP FLEX strategy assumes a full core off-load heat load as it is the limiting initial SFP configuration.

2.4.1 Phase 1 Strategy Modes 1-4

Phase 1 of the SFP cooling strategy is to rely on the initial liquid inventory of the SFP. The SFP is designed in such a manner that the pool cannot be drained by a break in any connected lines (Reference 3.68). The initial conditions per NEI 12-06 state that pool gates installed remain intact. The initial SFP level is required to be at least 23 feet over the top of irradiated fuel assemblies seated in the storage racks per Technical Specifications.

The decay heat load of the SFP during normal operating conditions begins at a higher value at beginning of cycle and decays to a relatively low value by the end of an operating cycle. The decay heat loads assumed for the SFP were based on conservative partial core off-loads (Reference 3.36).

Given an initial pool temperature of 120°F, and a pool decay heat load at 25 days following previous cycle shutdown, the SFP will not begin to boil until 12.86 hours (Reference 3.36). Actions required to occur within the SFP area are accomplished prior to time to boil being reached. These actions are:

- Stage FLEX hose over the top of the SFP from the entrance of the SFP stairwell
- Set up the two spray nozzles
- Run FLEX hose from the entrance of the SFP stairwell to the SFP deck manifold and then to spray nozzles
- Run hose from the FHB stairwell to the Q-deck
- Prop open the SFP area doors to establish a vent path:
    - Door D187 provides the initial path from the SFP area to the stairwell
    - Door D69 connects the stairwell vent path to the FHB Access Area +21’ Elev.
    - Door D37 establishes the ultimate path to atmosphere on the FHB +21’ Elev.

The hoses and manifolds are stored in the FHB. The spray monitors/nozzles are pre-staged and permanently mounted inside the FHB at poolside. The portions of the FHB used for storage and pre-staging are classified as seismically qualified and due to the FHB location within the NPIS, all stored and pre-staged materials are fully protected from all applicable external events.

2.4.2 Phase 2 Strategy Modes 1-4

Once the SFP has begun to boil, the inventory within the pool will begin to steam off. The SFP boil-off rate was calculated to be a maximum of 37.74 gpm for a normal spent fuel heat load (Reference 3.36). Based on the maximum boil-off rate, make-up would be required by 95.5 hours based on the time to reach Level 3 per NEI 12-02. Level 3 per NEI 12-02 is the level where fuel remains covered and actions to implement make-up water addition should no longer be deferred. As the time at which make-up is required or will commence is greater than the time by which off-site equipment is available, SFP make-up can be accomplished utilizing Phase 2 or Phase 3 equipment. The capability to provide SFP make-up and/or spray during Phase 2 is accomplished using the CCW make-up (CCW MU) pumps.

Make-up can be provided to the SFP via the permanently installed piping from the CCW MU pumps to the SFP. If the permanently installed piping is unavailable, make-up from the CCW MU pumps is provided using hoses routed directly to the SFP from the bonnet connection on valves CMU-511A or CMU-511B. If SFP spray is required, the identical flow strategy is utilized except for using the hoses routed directly to spray monitors installed on the north side of the SFP. All equipment is either stored or pre-staged within the confines of the seismically qualified RAB or FHB structures within the NPIS and is fully protected from all applicable external events. As an additional capability, the FWTPs have been sized to be able to provide direct hose and spray make-up to the pool.

Component Cooling Water Make-up Pump/SFP Make-up Piping

Make-up capability is provided by using a CCW MU pump, repowered from the FLEX diesel generator. The CCW MU pumps are seismically qualified pumps capable of 600 gpm flow at 150 ft. TDH (Reference 3.68). Discharge piping from the CCW MU pumps to the SFP is seismically qualified. All components are located within the NPIS and confined within seismically qualified structures. All components are fully protected from all applicable external events.

The CCW MU pumps are designed to take suction from the CSP. As the CSP will be depleted by the time SFP make-up is required. A FLEX tie-in has been installed on CCW MU pump suction piping to allow the pump to take a suction from either the FLEX connection on the RWSP (primary) or from the WCT basins (alternate) via an additional FLEX ACCW gravity drain connection at WCT ‘A’ Basin (Figure 2).

As the CCW MU pumps are capable of supplying 600 gpm, they are more than adequate to provide the required SFP make-up rate of approximately 38 gpm. Operators will monitor the SFP level via the SFP level instrumentation, installed in response to NRC Order EA-12-051, and start and stop the pump accordingly.

NEI 12-06 guidance requires a portable injection source to provide SFP make-up for spent fuel cooling following a BDBEE. The WF3 FLEX strategy credits the installed CCW MU pumps in lieu of a portable injection source to provide the SFP make-up. This alternate approach is discussed in Section 2.15.3.

<u>Make-up via Hoses direct to the SFP</u>

NEI 12-06 guidance specifies that a plant shall be capable of making up to the SFP via hose, directed into the SFP. This hose is routed into the SFP area during Phase 1 as described previously. During Phase 2, the pump providing the make-up is the CCW MU pump on the repowered train.

The CCW MU pumps are capable of providing a greater flow rate than the approximately 38 gpm make-up rate required to match SFP boil-off (Reference 3.58).

As an additional contingency, the FWTPs have been sized to accommodate direct to SFP make-up (Reference 3.25).

<u>Spray via Pre-Staged Nozzle</u>

Two spray monitors are permanently pre-staged on pedestals in the FHB at spent fuel pool deck elevation. While NEI 12-06 assumes that the SFP liner and penetrations are intact, this spray capability is required to provide additional diversity and flexibility to the strategy.

The SFP spray monitor nozzle will discharge with a spray pattern to provide spent fuel cooling. NEI 12-06 requires a minimum of 200 gpm to the pool or 250 gpm if overspray occurs. Since operator access to the SFP is precluded at the time the spray is placed into service and occurrence of overspray cannot be assured or controlled, the FLEX strategy assumes 250 gpm spray is required. The SFP spray monitors that are located on pedestals 5’ above floor elevation are such that the spray pattern is towards the center of the pool over the SFP foreign material exclusion barriers. The pedestals are designed and constructed to be seismically qualified. Water is provided via FLEX hose previously staged during Phase 1. The hose is stored on the FHB +46’ Elev. in a FLEX JOBOX. In order to deploy the spray capability, additional hose is connected to the previously staged portion at the SFP stairwell and either connected to the CCW MU pump or run to the FWTP or NSRC LP/HF pump manifold. The CCW MU pumps, the FWTP or the NSRC LP/HF pump are each capable of providing 250 gpm for SFP spray, thus meeting the requirement of the NEI 12-06 guidance. As previously noted, all pre-staged equipment is located within the confines of the NPIS inside seismically qualified structures and is fully protected from all applicable external events.

2.4.3 Phase 3 Strategy Modes 1-4

The Phase 3 strategy is a continuation of the strategy described above for the Phase 2 capability. Additionally, the strategy is augmented in Phase 3 as described below.

In the event the primary CCW MU pump becomes unavailable, the preferred strategy for SFP make-up is to use the opposite train CCW MU pump powered from the NSRC 4160V generator.

Additional capability to provide SFP make-up can be accomplished utilizing NSRC equipment (e.g. LP/HF pump, submersible pump, NSRC 4160V generator and water treatment skid). Due to WF3’s unique design and classification as a wet site, and as additional contingency capability, WF3 has included FWTPs to supplement any pumping equipment provided by the NSRC needed for SFP make-up.

Also, during Phase 3, the NSRC provides a LP/HF pump that can be deployed and provide backup capability to the CCW MU pumps. The NSRC LP/HF pump is capable of providing a significantly greater flow rate than the make-up rate required to match SFP boil-off (approximately 38 gpm). As the make-up rate is significantly higher than the boil-off rate of the SFP, level monitoring will be required and the pump manifold will need to be throttled to prevent over-flow of the SFP. The NSRC LP/HF pump and valves for the associated manifold are all operated at the location of the equipment.

2.4.4 Structures, Systems, and Components

2.4.4.1 Component Cooling Water Make-up

The CCW MU pumps provide the motive force for supplying SFP make-up by hard piping. The CCW MU system is a seismically qualified source of make-up to the SFP. The CCW MU meets the requirements in NEI 12-06 for protection from all applicable external events. The CCW/ACCW piping was evaluated for tornado missile protection and determined to be reasonably protected from applicable missiles by virtue of their location, construction characteristics and surrounding structures that intervene with a missile's flight path (Reference 3.58). The use of the CCW MU system is considered an alternative to the NEI 12-06 guidance (see Section 2.15.3).

2.4.4.2 Wet Cooling Tower Basins/Auxiliary Component Cooling Water Suction Piping

The ACCW piping allows for utilizing the inventory of the WCT basins for SFP make-up. Section 2.3.4.9 provides a description of this suction line.

2.4.4.3 Class 1E Electrical Distribution System

The Class 1E switchgear is utilized to repower a CCW MU pump via the FLEX diesel generator. DC power is utilized for control power and instrumentation. Section 2.3.4.6 provides a description of the Class 1E distribution system.

2.4.4.4 Refueling Water Storage Pool

The RWSP may be utilized for make-up to the SFP if available. Section 2.3.4.8 provides a description of this component.

2.4.4.5 Condensate Storage Pool

The CSP water inventory, if available, may be utilized for make-up to the SFP. Section 2.3.4.7 provides a description of this component.

2.4.5 FLEX Modifications

2.4.5.1 Component Cooling Water Make-up Pump Connection

A tie-in connection was installed on the CCW MU pump suction piping to allow for the pump to take suction from either the tie-in connection on the RWSP (Section 2.3.5.5) or the WCT basins via the ACCW gravity drain connection to WCT A Basin (Section 2.3.5.2) (Figure 2). The tie-in connection is located upstream of CCW MU B, and it is located adjacent to the TDEFW pump. This tie-in is seismically qualified and is located within the RAB, therefore, the connection is protected from all applicable external events.

2.4.5.2 Spray Monitor Permanent Staging

Two spray monitors with nozzles are installed in the FHB. The locations are within 20 ft. radius of the SFP to provide spray capability to the SFP. These spray monitors are installed on pedestals comprised of structural steel members and are mounted onto the pedestals in their supplied mounting brackets. The non-safety related spray monitors are seismically anchored within the FHB +46 Elev. next to the SFP.

2.4.6 Key SFP Parameters

The key parameter for the SFP make-up strategy is the SFP water level. The SFP water level is monitored locally by the instrumentation that was installed in response to Order EA-12-051, Reliable Spent Fuel Pool Level Instrumentation (Reference 3.5).

2.4.7 Thermal-Hydraulic Analyses

An analysis (Reference 3.36) was performed to determine the time to boil and the boil off rate for the SFP with normal spent fuel load and a full core off-load. The cask storage pit is included and considered in this analysis given that the gate between the SFP and cask storage pit is removed once spent fuel assemblies are stored in the cask storage pit.

The results of this calculation determined that the time to boil for the SFP, based on an initial pool water temperature of 120°F is 12.86 hours for a normal spent fuel load and 3.75 hours for a full core off-load. The boil-off rate is 37.74 gpm for a normal spent fuel load and 130 gpm for a full core off-load. The time to reach Level 3 of the SFP is 95.5 hours for a normal core off-load, and 27.8 hours for a full core off-load. Level 3 is defined as the level that when reached, make-up should no longer be deferred. Per NEI 12-02 (Reference 3.6), Level 3 begins at the top of the spent fuel racks (+/- 1 foot).

The CCW MU pumps are credited within the plant design basis for providing safety-related make-up to the SFP. As the pumps, flow path, and water sources are robust for all extreme external hazards, the CCW MU pumps are available following a BDBEE. Based on the boil-off rates provided above, the CCW MU pumps are adequate to provide the SFP make-up required to support the FLEX strategy.

Based on the results of the analysis, the on-site FWTPs exceed the full core off-load make-up rate provided above (Section 2.3.10.2).

2.4.8 FLEX Pump and Water Supplies

2.4.8.1 FLEX Water Transfer Pump (FWTP)

See Section 2.3.10.2.

2.4.8.2 Refueling Water Storage Pool and Wet Cooling Tower Basins

The RWSP or WCT basins are the credited make-up sources of water to the SFP via existing CCW MU piping and a CCW MU pump. If the CSP water inventory is available, it can be used as a backup capability to the RWSP or WCT.

2.4.8.3 Mississippi River

Water from the Mississippi River is utilized during Phase 3 to provide SFP make-up utilizing an NSRC-supplied water treatment unit.

2.4.9 Electrical Analysis

The SFP make-up capability is provided by using a CCW MU pump repowered from the FLEX diesel generator via MCC 311A (B). MCC 311A (B) is a safety-related Class 1E medium voltage AC distribution switchgear. The SFP level is monitored by instrumentation installed by Order EA-12-051. The SFPI instrumentation connects to a source of power independent of the normal AC/DC power system. The instruments have built-in batteries that will enable them to function for up to seven days following a loss of power.

2.5 Containment Integrity

With an ELAP initiated in Modes 1-4, containment cooling is lost, containment temperature and pressure will slowly increase. Containment pressure and temperature response was analyzed (Reference 3.44) through 120 hours following an ELAP. The results of this analysis determined that containment design limits are not challenged during this period of time which is adequate time for Phase 3 implementation. In order to ensure the availability of instrumentation, cooling is established approximately 120 hours into the event as discussed below (Section 2.5.3). Containment spray is not required to respond to an ELAP given the gradual progression of the containment heat-up and pressurization.

2.5.1 Phase 1 Modes 1 - 4

Containment integrity is not challenged during Phase 1. Key FLEX instrumentation located within containment and credited for use in response to an ELAP event remains functional throughout the duration of the event. No FLEX portable equipment is required as a mitigating strategy to preserve containment integrity.

2.5.2 Phase 2 Modes 1 - 4

Containment integrity is not challenged during Phase 2. No FLEX portable equipment is required as a mitigating strategy to preserve containment integrity.

2.5.3 Phase 3 Modes 1 - 4

Phase 3 entails utilizing the NSRC 4160V generator to repower a containment fan cooler (CFC), a CCW pump, and the missile protected dry cooling tower DCT fans via the Class 1E switchgear. A single CFC is capable of maintaining containment within design temperature limits for the expected FLEX heat loads (Reference 3.68). Each fan is operated remotely from the main control room. The heat removed by the CFC is transferred to the UHS. In the event that the robust portion of the UHS is not available (i.e., loss of all CCW pumps and/or loss of all DCT fans), alternate tie-in points on the CCW system are available to be used in conjunction with an NSRC low pressure/medium flow (LP/MF) pump providing once-through-cooling to the CFC.

2.5.4 Structures, Systems, Components

2.5.4.1 Reactor Containment Building

The reactor containment building comprises a free standing steel containment vessel, a containment internal structure and a reinforced concrete shield building. The primary containment is a free standing steel pressure vessel which is surrounded by a reinforced concrete shield building. The shield building is a seismically qualified structure. The containment vessel is a cylindrical steel pressure vessel with hemispherical dome and ellipsoidal bottom completely enclosed by the reinforced concrete shield building.

2.5.4.2 Containment Fan Coolers

A containment fan cooler is utilized during Phase 3 to reduce containment temperature. The Phase 3 equipment includes a pump capable of being tied into the CCW system to allow for cooling flow to the CFC. A single CFC is capable of maintaining containment within design temperature limits.

2.5.4.3 Component Cooling Water

The CCW system is a closed cooling water system serving all reactor auxiliaries requiring cooling water. Heat is removed and dispersed to the atmosphere by the DCTs and by the CCW heat exchangers. The CCW cools the containment fan coolers to ultimately reject the heat to atmosphere.

2.5.4.4 Class 1E Electrical Distribution

Description is provided in Section 2.3.4.6. The Class 1E switchgear will be utilized to repower the CFC. Containment instrumentation is maintained for the duration of the event.

These systems are located within the NPIS, therefore, they are protected from all external events, except for some portions of the DCT coils that are exposed to wind-generated missiles. The DCT is located inside the NPIS with only 60% of the DCT coils being missile protected. As stated in Section 2.5.3, if the DCTs are not available, alternate tie-in points on the CCW system are available to be used in conjunction with the NSRC equipment.

2.5.5 Key Containment Parameters

Instrumentation providing the following key parameters is credited for all phases of the containment integrity strategy:

- Containment pressure

Containment pressure is monitored and procedures are in place (Reference 3.71) to initiate containment cooling once containment pressure reaches 25 psia. The containment analysis results (Reference 3.44) determined that this pressure is reached at approximately 96 hours after the event. The results of the analysis also determined that the corresponding containment temperature at 96 hours is approximately 220°F. The design containment temperature is 264°F. Since containment cooling is initiated at a containment temperature below the design containment temperature, containment integrity is not challenged.

2.5.6 Thermal-Hydraulic Analyses

A containment evaluation determined that no mitigating actions are required to maintain containment integrity during Phases 1 and 2 for an ELAP that occurs with S/Gs available. The containment evaluation also determined that if an ELAP occurs when the plant is shutdown (Modes 5 or 6) it may challenge containment design limits unless a vent path is established (Section 2.17). For Modes 5 and 6, a strategy is provided requiring containment venting via an existing containment penetration or other pathway within 6 hours of the ELAP to ensure that containment will not pressurize sufficiently to challenge containment pressure or temperature design limits under minimum RCS inventory conditions.

2.5.7 NSRC LP/MF Pump and Water Supplies

The NSRC is providing a LP/MF pump (nominal 2,500 gpm) and an NSRC-suction lift booster pump which can be used to provide once-through-cooling to the CFC. The water supply is the Mississippi River.

2.5.8 Electrical Analysis

The Phase 3 coping strategy described for Modes 1-4 with steam generators available can restore power to the CCW pump and DCT fans (Section 2.5.3). The 4160V generator being supplied from the NSRC will provide adequate power to perform the noted strategies. In addition, an evaluation determined that the containment electrical equipment being credited for use in response to a BDBEE will operate in an ELAP and will remain functional during the ELAP duration (Reference 3.68).

2.6 Characterization of External Hazards

2.6.1 Seismic

The NEI guidance states that all sites will address BDB seismic considerations in the implementation of FLEX strategies. Final Safety Analysis Report (FSAR) Section 2.5.4.9 identifies the safe shutdown earthquake (SSE) to be a hypothetical earthquake with an epicentral intensity of VI MM occurring adjacent to the site, which corresponds to a horizontal surface acceleration of 0.06g. The plant was conservatively designed for 0.1g maximum horizontal ground acceleration. The peak vertical acceleration for the postulated SSE is 2/3 peak horizontal acceleration or 0.067g. The operating basis earthquake (OBE) for the site is postulated to have a peak horizontal acceleration of 0.05g and a peak vertical acceleration of 0.033g. These peak accelerations are one half of the corresponding peak SSE accelerations.

NEI 12-06 indicates that the particular challenges that must be addressed due to seismic hazards include impediments to equipment movement, access to connection points and water supplies.

NEI 12-06 states that consideration should be given to the impacts from large internal flooding sources that are not seismically robust and do not require AC power. Examples for these sources are gravity drainage from a lake or cooling basins for non-safety-related cooling water systems. Due to the WF3 FLEX strategy's reliance upon mounted equipment within the RAB, potential sources of flooding were reviewed for internal flooding impacts to the strategy. Water sources identified that could cause internal flooding within the RAB are listed and assessed for robustness in Reference 3.63.

2.6.2 External Flooding

FLEX equipment must be deployable and functioning in the presence of an external flood. FSAR section 2.4.3 identifies the probable maximum flood (PMF) level to be Elev. +27.0 ft. mean sea level (MSL). This value was determined to provide acceptable conservatism for the levee failure analyses. FSAR section 2.4.1.1 states that all safety-related components are housed in the nuclear plant island structure (NPIS) which is flood-protected up to Elev. +30.0 ft. MSL. The

NPIS is a reinforced concrete box structure with solid exterior walls. All exterior doors and penetrations below Elev. +30.0 ft. MSL which lead to areas containing safety—related equipment are watertight. This design also protects the plant from the probable maximum precipitation (PMP) water level. From FSAR Section 2.4.2.3.1, the 10 square mile PMP depths for 6, 12 and 24 hours are 30.7, 34.6 and 39.4 inches respectively (approximately a maximum of 22 ft. MSL). According to FSAR section 2.4.3.5, the water levels in the Mississippi River at WF3 were estimated for the following three cases: 1) a project design flood level of +24 ft. MSL, 2) a moderate Mississippi River flood coincident with the probable maximum hurricane, yielding a maximum water level of +23.7 ft. MSL and 3) PMF, for which the maximum water level considered possible is Elev. +27 ft. MSL.

Characteristics of WF3's flooding hazard are discussed in the paragraphs above. The limiting flood case has been determined to be the PMF with a flood level of +27 ft. MSL. This limiting flood source does not need to be characterized in terms of warning time as all FLEX strategies are above the PMF level or are contained within accessible, flood-protected structures.

2.6.3 Severe Storms with High Wind

WF3 is located in the 240 to 250 mph hurricane wind contour per NEI 12-06 (Reference 3.3, Figure 7-1). The design basis tornado (DBT) for WF3 greatly exceeds this wind speed, therefore while hurricane winds are also considered for FLEX, DBT winds and associated missiles are limiting. As a hurricane site, separation criteria cannot be utilized to provide an acceptable strategy for severe storms with high winds.

The local meteorological assessment included in WF3's final safety analysis report (FSAR section 2.3.1.2.4) details the site's DBT as a tornado funnel with a peripheral tangential velocity of 300 mph and a translational velocity of 60 mph with an external pressure drop of three psi in three seconds.

All structures and equipment necessary to initiate and maintain a safe plant shutdown have been designed to withstand short-term loadings resulting from the DBT. Protection is provided by design margins and the judicious use of missile barriers such that the probability does not exceed acceptable values.

The WF3 FLEX strategy credits some exposed portions of the EFW piping, main steam piping and ACCW piping that were previously approved and determined not to require physical protection as the probability of occurrence of a tornado generated missile strike was sufficiently small. An additional evaluation for FLEX (Reference 3.58) also determined that the portions of exposed piping are considered reasonably protected from wind-generated missiles per Order EA-12-049 and will remain functional following a severe storm with high winds.

2.6.4 Ice, Snow and Extreme Cold

Monthly and annual values of daily mean temperature and average and extreme daily maximum and minimum temperatures are shown in Section 2.3.2.1.2 of the WF3 FSAR, based on data records for New Orleans. From this data, the monthly averages indicate that January is the coldest month. The lowest average monthly temperature for the area over a 30 year period (from 1931-1960) is 53.8°F in January (Reference 3.19, Table 2.3-29). Therefore, based on the data provided above and in Section 8.2.1 of Reference 3.3, extreme low temperature hazards are screened out for Waterford. Reference 3.3, Figure 8-1, provides a representation of the maximum three day snowfall records across the U.S. This figures shows that WF3 is not susceptible to a large amount of snow that could be a problem for deployment of the FLEX equipment.

Per NEI 12-06 (Reference 3.3, Figure 8-2), WF3 falls into ice severity Level 3 - Low to medium damage to power lines and/or existence of considerable amounts of ice. There is no significant hazard from snow or extreme cold for WF3. However, debris and ice removal equipment is stored in the ‘N+1’ building.

2.6.5 High Temperatures

Per NEI 12-06 (Reference 3.3), all sites will address extreme high temperatures up to 110-120°F. Per FSAR section 2.3.2.1.2, on the average there are seven days a year in the New Orleans area when the temperature rises to 95°F or higher with 102°F being the highest recorded temperature. WF3 has based its high temperature BDBEE value on the maximum expected temperatures for this site, equal to or greater than the highest record temperature. FLEX equipment is designed for high temperature operation and the storage/maintenance solution ensures operability when deployed. This includes ensuring adequate ventilation or supplementary cooling, if required.

2.7 Planned Protection of FLEX Equipment

In order to assure reliability and availability of the FLEX equipment required by the FLEX strategy, WF3 has sufficient equipment to address all functions on-site, plus one additional spare, i.e., an “N+1” capability. It is also acceptable per NEI 12-06 guidance to have multiple strategies to accomplish a function with the associated equipment for each strategy not requiring “N+1” capability. Per NEI 12-06, the “N+1” capability applies to the FLEX equipment that directly supports maintenance of the FLEX safety functions. Other FLEX support equipment only requires an “N” capability.

Per NEI 12-06, at least one set of each FLEX equipment is to be protected from all extreme external hazards applicable to the site. For example, the “N” pump could be protected against seismic and external flooding hazards, while the “N+1” pump is protected against severe storms with high winds. The object is to ensure the minimum set of FLEX equipment is always available following an extreme external hazard.

For WF3, the minimum equipment required to support the FLEX safety functions (“N” set) is stored within the NPIS, a seismically qualified structure robust for severe storms with high winds (including tornado wind loads and missiles), external flooding up to +30’ MSL, ice, and extreme high temperatures (Reference 3.68). The majority of the spare equipment is stored within the “N+1” storage building, a commercially procured storage facility designed to meet ASCE 7-10, located south of the protected area, near the independent spent fuel storage installation (ISFSI). Deployment of the “N+1” equipment is not dependent on off-site power. The building equipment doors are manually operated roll-up doors. The “N+1” storage building ventilation consists of natural circulation through louvers. NEI 12-06 Section 5.3.1 states that large portable FLEX equipment should be secured as appropriate and that it should be evaluated and protected from seismic interactions as to ensure that unsecured components do not damage the equipment. A seismic movement calculation (Reference 3.45) for the “N+1” FLEX equipment housed in the FLEX “N+1” storage building provides the separation distance of the equipment within the building to ensure that they will not interact with each other during a seismic event. In the event that outdoor temperature is forecasted to fall below 32°F, measures are taken to protect the equipment located in the “N+1” storage building against cold weather (Reference 3.70). Along with provision of temporary heating for the “N+1” storage building interior, the measures also include provision of power to the “N+1” FLEX diesel generator block heater.

Note that the treatment of the “N” and the “N+1” equipment is considered an alternate approach to NEI 12-06 to meet the NRC Order and it is discussed in Section 2.15.1.

Spare hoses and cables are stored with the “N” set of cables and hoses within the NPIS and fully protected from all applicable external hazards. The spare length of hoses and cables consists of the greater of:

- 10% of the total cable or hose length
- The longest single segment of cables or hoses

Storing less than a full “N+1” set of cables and hoses is considered an alternate approach to NEI 12-06, Rev. 0 to meet the NRC Order (See Section 2.15.4).

The following FLEX equipment is stored within the Nuclear Plant Island Structure (NPIS):

- FLEX diesel generator - The FLEX diesel generator is stored within an enclosure built on the RAB +41’ Elev. roof. The diesel generator enclosure houses the diesel generator and an initial fuel supply. Cables required to place the diesel generator into service are stored within the RAB +21’ Elev. on cable reels.

- FCCP - The FCCP is pre-staged within the RAB on the -35’ Elev. by the TDEFW pump. Required hoses and electrical cables are stored on the same elevation in JOBOXs.

- FWTP - The FWTP is stored within the RAB +21’ Elev. wing area. Required hoses are stored on the same elevation in JOBOXs. The FWTP can be deployed to the +21’ Elev. Q-deck during Phase 3 as a backup if external flooding exists.

- FLEX diesel fuel transfer pump - The FDFTP is stored on the RAB +46’ Elev. (Reference 3.47) near the essential chillers. Required hoses are stored on the same elevation in JOBOXs. The pump is deployed and controlled locally at the RAB +46’ Elev. outside of the feed tanks rooms to provide diesel fuel from the feed tanks to the various diesel-powered FLEX equipment.

- FLEX cables and hoses (including the “N+1” compliment) - FLEX cables and hoses are stored on racks within the NPIS inside the seismically qualified RAB as identified for each of the new FLEX components, along with a spare length.

- FLEX main control room fan - A portable fan and extension cord are provided for ventilating the main control room. The fan, along a spare, are stored within the main control room envelope, in the computer room.

- FLEX internal flooding sump pump - A portable diaphragm air operated sump pump is provided on the RAB -35' Elev for coping with internal flooding. The pump, associated hoses, and necessary fittings are stored in JOBOXs on the RAB +21' Elev. and RAB -35' Elev.

- SBO air compressor – The compressed air to run the FLEX internal flooding sump pump comes from the SBO air compressor, permanently staged on the RAB +21' Elev. by the emergency diesel generators which will be moved to the Q-deck. The air compressor provides adequate air flow and pressure to drive the pump and is diesel-driven.

- Phase 3 FLEX equipment – Adapters for hooking the NSRC Phase 3 pumps up to the existing FLEX tie-ins are stored within the NPIS. Additionally, tools and connection equipment for connecting the Phase 3 NSRC 4160V generator to the site switchgear are also stored within the NPIS.

The following FLEX equipment is stored within the N+1 storage building:

- "N+1" FLEX diesel generator - A spare FLEX diesel generator is stored in the "N+1" storage building. The "N+1" diesel generator provides the capability to restore the "N" function by relocating the "N+1" diesel generator to the RAB.

- "N+1" FCCP - A spare FCCP is stored in the "N+1" storage building. Should the FCCP within the RAB become unavailable, the "N+1" FCCP could be relocated into the plant.

- "N+1" FWTP - This FWTP provides additional backup capability to the FLEX strategy in the event that water is needed from either the Mississippi River or another on-site surviving water source prior to the arrival of the NSRC water transfer pump. The hoses to deploy the "N+1" FWTP are stored in the "N+1" storage building.

- Towing / debris / ice removal equipment - The "N+1" storage building contains towing and debris/ice removal equipment to allow for deployment of “N+1” and Phase 3 equipment should the extreme external hazard cause debris within travel deployment paths. Consistent with the alternate approach described below, towing equipment is part of the mitigating actions to “N” equipment unavailability. The towing equipment may also be utilized to transport a FWTP to an optional deployment location in a non-flood event.

- Bulk fuel storage tank – provides capability to transport up to 500 gallons of diesel fuel for augmentation to refuel portable FLEX equipment and FLEX support equipment.

- Portable diesel light towers– portable diesel generator lighting stations towers. These towers can be deployed as needed to support night time operations.

- Miscellaneous personnel safety equipment including high voltage power line energization detection equipment.

Deployments of the FLEX and debris removal equipment from the“N+1” storage building are not dependent on off-site power. All actions are accomplished manually.

In the event that outdoor temperature is forecasted to fall below 32°F, measures are taken to protect the equipment located in the “N+1” storage building against cold weather (Reference 3.70). Along with provision of temporary heating for the “N+1” storage building interior, the measures also include provision of power to the “N+1” FLEX diesel generator block heater.

To provide assurance that the FLEX strategy is successful if implemented, the unavailability controls below are included for all of the pre-staged FLEX equipment.

The controls consider:

- Within 24 hours, take action to implement compensatory measures within 72 hours to restore the “N” function capability. For example, the “N+1” equipment may be staged to restore the “N” equipment or the “N+1” equipment could be relocated to provide additional protection beyond that afforded by the “N+1” storage building.

- If the “N” set of FLEX equipment continues to remain unavailable after a longer time frame (e.g., 45 days as described in NEI 12-06 Section 11.5), the “N” set would be physically replaced with the “N+1” set or other compensatory action taken to restore the “N” function/FLEX capability with off-site equipment. The unavailable equipment would then be restored or replaced to provide an “N+1” complement, to be stored back within the “N+1” storage building within 90 days from the onset of unavailability.

- Given notice of an impending extreme external hazard (e.g., a hurricane warning or prolonged Mississippi River levels slowly rising to potential flood level), pre-planned actions are taken to relocate specific “N+1” FLEX equipment such that it is provided additional protection from the hazard.

2.8 Planned Deployment of Flex Equipment

2.8.1 Haul Paths

Because the “N” equipment is permanently pre-staged inside the NPIS there is no credible debris/access hazard to contend with.

A review of available geotechnical and liquefaction assessments performed in the UFSAR (Section 2.5.4.8 of Reference 3.19) and for the ISFSI pad indicated that the liquefaction potential of the encountered subsurface soils is low. Therefore, it is likely that the liquefaction potential is low for the soils below the “N+1” storage building site, the designated travel path and the staging area B. If equipment from the “N+1” storage building is needed, plant personnel performing “N+1” equipment deployment will have to perform an assessment of the haul path and begin debris removal to the required deployment area. The haul path from the “N+1” storage building is shown as the dashed line on Figure 1. Assistance from Security is required to gain access through the de-energized security gates and barriers. The haul path assessment will also ascertain if power lines are down. If lines are down, low-voltage lines and high-voltage lines like the 230kV lines that cross the haul path near the “N+1” storage building will be verified de-energized. De-energization can be verified by:

- Using a Delsar AC Hotstick, Salisbury High Voltage Detector Kit, or similar, and/or
- Bringing in trained high voltage transmission personnel and equipment to establish safe passage across or through these power lines.

Phase 3 of the FLEX strategies involves the receipt of equipment from NSRC and various commodities such as fuel and supplies. Transportation of these deliveries can be through airlift or via ground transportation.

2.8.2 Accessibility

For WF3, the minimum equipment required to support the FLEX safety functions (“N” set) is stored within the NPIS, therefore accessibility to the primary FLEX equipment is not a concern. The majority of the spare equipment is stored within the “N+1” storage building, a commercially procured storage facility designed to meet ASCE 7-10. Deployment of the “N+1” equipment is not dependent on off-site power. The building equipment doors are manually operated roll-up doors. The haul path from the “N+1” storage building was assessed for soil liquefaction (Section 2.8.1) and evaluated for potential debris (Reference 3.68). Based on these assessments no significant concerns exist for the deployment and availability of the “N+1” FLEX equipment.

2.9 Deployment of Strategies

2.9.1 EFW Make-up Strategy (Core Cooling)

Water inventory is available following all BDBEEs in the following sources for use during Phase 1 and beyond.

- CSP
- RWSP
- WCT Basins
- BAMT

Water inventory in the circulating water intake piping is available for use by the FLEX strategies following non-flood, non-seismic BDBEEs. All these water sources are discussed in Section 2.3.10.5.

The Phase 2 water inventory management strategy evaluates the robust water sources that are available based on each event. The water inventory strategy shows that the credited available water sources will not deplete until well beyond the first 72 hours of the event. As off-site resources are fully available at 72 hours, off-site equipment and augmented staffing are credited for water source inventory replenishment activities. The strategy for all flood events is the same: The inventory of the CSP and WCT are utilized and once they are depleted, the borated water within the RWSP is utilized to extend coping beyond 72 hours. For non-flood events, the strategy is broken down further into seismic vs. non-seismic events. For non-flood, non-seismic events, the plant will cope for greater than 72 hours by gravity draining the water inventory within the circulating water intake piping. For non-flood, seismic events, similar to the flood scenario, the available inventory from the RWSP is utilized.

Due to WF3's unique design and classification as a wet site, WF3 has included FWTPs to provide backup water replenishment capability to the equipment provided by the NSRC should it be needed. Either of the NSRC LP/HF pumps, or FWTPs can be used to replenish on-site water sources with an indefinite supply of water from the Mississippi River or surrounding flood water. This equipment is discussed further in Section 2.3.10.2.

For flood events and seismic events, coping is extended beyond 72 hours by utilizing borated water within the RWSP for core cooling via the FCCP or TDEFW pump when the WCT basin inventory is exhausted. This strategy relies on hose connections between the new RWSP drain line connection and the new suction line tie-ins for the CCW MU pumps, TDEFW pump, and/or FCCP. The use of borated water within the steam generators has been evaluated acceptable with no detrimental impact to heat transfer (Reference 3.20). The use of borated water for core cooling via the steam generators extends coping to greater than 72 hours, after which borated water is replenished utilizing the Phase 3 strategy relying on a combination of NSRC equipment (mobile boration unit, water treatment skid, etc.).

For non-flood, non-seismic events, WF3 can cope for greater than 72 hours without requiring replenishment utilizing the inventory of the CSP, WCT basins, and CWI piping. Replenishment via the off-site NSRC equipment or FWTP would be necessary after 72 hours. Core cooling is maintained by supplying the S/Gs by way of the TDEFW pump or the FCCP, both of which can take suction from the WCT basins.

2.9.2 RCS Make-up Strategy (Inventory Control)

Coping to maintain RCS inventory control for Phase 1 is met by minimizing RCS leakage (via isolation of the RCP seal controlled bleed-off, plant cooldown and depressurization) and passive borated water injection from the SITs.

The Phase 2 FLEX strategy provides borated make-up from the RWSP or BAMTs to the RCS using a repowered charging pump. Inventory in the RWSP will provide coping capability for greater than 72 hours. This make-up is necessary to account for normal RCS leakage and the assumed RCP seal leakage and to maintain natural circulation once the SITs have been isolated. The charging pump selected is repowered by the FLEX diesel generator using the existing plant Class 1E switchgear. As the charging pumps are already designed for make-up to the RCS, no additional FLEX connections or hoses are required to support this strategy except the electrical connections to obtain power from the FLEX diesel generator.

Phase 3 coping strategy is a continuance of the Phase 2 strategy with backup provided by either one of the two remaining installed charging pumps, or utilizing an NSRC HP pump. The NSRC HP pump can provide additional back-up capability to the charging pumps and will utilize the new FLEX tie-in suction and discharge connection points located on the RWSP and HPSI discharge piping respectively. Replenishment of borated water to the RWSP in Phase 3 relies on NSRC equipment (LP/HF, mobile boration unit, water treatment skid, etc.).

2.9.3 Electrical Strategy

For Phase 1, the station batteries are relied upon to provide power to instrumentation necessary to monitor the plant conditions. Control power will also be provided to remotely control ADVs, the TDEFW pump, and EFW control valves for the first 4 hours (Reference 3.68). As part of the SBO response, the SBO procedure directs an initial load shed to extend battery life to 4 hours. In order to extend battery duration (12.5 hours, References 3.14 and 3.15) to after the FLEX diesel generator is placed into service, a deeper load shed strategy is performed on one of the batteries. The preferred train is ‘B’, however; an ‘A’ train extended load shed is provided as an alternate.

Phase 2 of the FLEX electrical strategy begins once the FLEX diesel generator has been placed into service. This action is time critical and must be completed within 12 hours of the start of the event. The FLEX diesel generator is pre-staged in a new enclosure situated on the RAB +41’ Elev. roof. The FLEX diesel generator is capable of supplying power to either battery charger that powers the DC electrical train selected for extended load shed. Once the battery charger is repowered from the FLEX diesel generator, battery power remains available indefinitely.

The Phase 3 strategy is to extend the Phase 2 strategy supplemented with NSRC equipment, including an NSRC 4160V generator capable of repowering additional site loads.

The DC electrical power FLEX strategy performed for events occurring while the plant is initially in Modes 1 through 4, and 5 with the S/Gs available is bounding for Modes 5 and 6 with S/Gs unavailable. The AC electrical power FLEX strategy timeline may be accelerated in Modes 5 and 6 with the S/Gs unavailable, depending on the outage risk assessment. If the plant risk is high with a short time to boil, the FLEX cables and refueling equipment hoses could be pre-routed to reduce the time required to place the FLEX diesel generator into service.

2.9.4 Spent Fuel Pool Make-up Strategy

Phase 1 of the normal operating condition for SFP cooling is to rely on the initial liquid inventory of the SFP. Phase 2 begins once the SFP make-up is required at a time no later than when Level 3 is reached (Section 2.4.2). The primary make-up path provides water from either the RWSP or the WCT basins to the SFP via existing CCW MU piping and a CCW MU pump. A secondary make-up path provides water directly into the SFP via hoses connected with an adapter on the discharge of a CCW MU pump. Additionally, spray capability is provided by nozzles connected by hoses to the same manifold.

2.9.5 Fueling of Equipment

The total Phase 2 FLEX equipment fuel consumption rate for the WF3 FLEX strategy is 0.69 gpm (Reference 3.48). The FDFTP is more than capable of providing 0.69 gpm of the assumed consumption rate for the Phase 2 strategies. The consumption rate includes the following equipment:

- FLEX diesel generator
- FWTP
- FDFTP
- Portable diesel air compressor
- Miscellaneous loads such as lighting, tow vehicles, etc.

The diesel fuel oil storage tanks (EGF-MTNK-0001A(B)) contain a minimum of 39,300 gallons of diesel fuel each (Reference 3.68). The diesel fuel oil feed tanks (EGF-MTNK-0002A(B)) contain a minimum of 339 gallons each (Reference 3.68). Therefore, the site has a minimum inventory of diesel fuel oil on site to maintain the above FLEX consumption rate for approximately 47.5 days from either train of the diesel generator fuel oil storage and transfer system. NSRC equipment brought in during Phase 3 will increase the fuel consumption rate. Therefore, if necessary, a diesel fuel truck service can be established by 72 hours following the start of the BDBEE.

The “N” FLEX diesel generator is equipped with a 400 gallon tank to allow for initial operation prior to implementing the diesel fuel replenishment strategy. The tank’s volume will be maintained at a minimum of 330 gallons for approximately 12 hours of operation. With the FLEX diesel generator being placed into service by 12 hours following the start of the BDBEE, the fuel replenishment strategy would need to be implemented prior to 24 hours.

The diesel fuel strategy consists of repowering an existing diesel fuel oil transfer pump (EGF-MPMP-0001A or EGF-MPMP-0001B) and level instrumentation associated with the feed tank, EGF-ILS-6907A(B) and EGF-ILS-6908A(B). This will transfer fuel from the diesel fuel oil storage tanks to the diesel fuel oil feed tanks. The diesel fuel oil transfer is controlled from the associated emergency diesel generator (EDG) control panel. This equipment is repowered by the FLEX diesel generator and allows the feed tank level instruments to automatically control the transfer pump.

Vent valve EGF-121A(B) on the diesel fuel oil feed tank to the EDG is used as the supply connection for the FDFTP which is staged just outside of the feed tank rooms. The discharge of the FDFTP is routed to a manifold that will have discharge connections to the FLEX diesel generator, the FWTP, if deployed, located at the Q-deck (RAB +21’ Elev. west side), the SBO diesel-driven air compressor, and a short discharge hose to allow refueling of the FDFTP. The FDFTP is controlled locally on the RAB +46’ Elev. outside of the feed tank rooms. Once nozzles are in place and ready for fueling, the pump is started to supply fuel. The nozzles prevent spillage and overfilling. As the FLEX diesel transfer pump is stored within the RAB and inside the NPIS, it is fully protected from all applicable external events.

All credited diesel powered FLEX equipment is capable of being refueled while operating.

2.10 Off-site Resources

2.10.1 National SAFER Response Center

The industry has established two regional NSRCs to support utilities during BDB events. Entergy has established contracts with the Pooled Equipment Inventory Company (PEICo) to participate in the process for support of the NSRCs as required. Each NSRC will hold five (5) sets of equipment, four (4) of which is able to be fully deployed when requested, the fifth set will have equipment in a maintenance cycle. In addition, BDB equipment hose and cable end fittings are standardized with the equipment supplied from the NSRC.

For non-persistent flooding events, the on-site equipment staging location (“staging area B”) for Phase 3 NSRC equipment is in the plant parking lot as depicted on Figure 1.

For persistent flooding events, NSRC equipment will be transported by helicopter from the off-site staging location to the plant site. Equipment will be landed on the RAB roof +69’ Elev. (Figure 6).

2.10.2 Equipment List

The equipment stored and maintained at the NSRC for transportation to the local assembly area to support the response to a BDBEE at WF3 is listed in Table 12. Table 12 identifies the equipment that is specifically credited in the FLEX strategies for WF3.

2.11 Habitability and Operations

2.11.1 Equipment Operating Conditions

Following an ELAP, ventilation providing cooling to occupied areas and areas containing FLEX strategy equipment is lost. Per the guidance given in NEI 12-06, FLEX strategies must be capable of execution under the adverse conditions (unavailability of installed plant lighting, ventilation, etc.) expected following a BDB External Event (BDBEE) resulting in an ELAP/LUHS. Loss of ventilation analyses were performed to quantify the maximum steady state temperatures expected in specific areas related to FLEX implementation to ensure the environmental conditions remain acceptable for personnel habitability and within equipment design limits.

The main control room (MCR) will heat up following an ELAP. As an SBO has already been analyzed, existing emergency operating procedures direct operator actions to minimize the heat-up during the first 4 hours of the station blackout. The station blackout EOP (Reference 3.52) directs operators to open Doors D84, D293, D292, D259, D291, and D77 if power is not expected to be returned within 30 minutes. Additionally, the SBO EOP procedure directs opening six ceiling access panels and opening process analog control (PAC) cabinet doors.

For an ELAP, the analysis performed (Reference 3.53) determined additional actions are required to maintain the MCR habitable for the duration of the event. Doors D70, D72, D73, D75, D91, D185, D261 and D262 are also required to be opened in 4 hours to establish passive ventilation. In addition, a 15,000 CFM portable ventilation fan is required by 13 hours to maintain the MCR temperature at or below 110°F to ensure habitability. The FLEX MCR portable fan (and its backup "N+1" fan) are stored within the RAB in an area adjacent to the MCR and are deployed to door D259 and utilize the ventilation path established above. The fan requires 115V AC power. Convenience receptacles are available that are powered by the FLEX diesel generator.

The room heat-up analysis for the switchgear rooms determined that forced ventilation is not required to maintain equipment below the limiting component maximum ambient design temperature. This is based on that actions are required at 2 hours from the start of the ELAP to open doors D7, D9, D18, D21, D36 and D51.

Due to the FLEX actions required in the switchgear rooms during the first 12 hours following the event, habitability temperature was determined over this initial timeframe. At 12 hours, switchgear 'B' reaches 109°F and switchgear 'A' reaches 110°F. These temperatures are acceptable for operator actions. Once the switchgear is repowered (following FLEX diesel generator deployment), the rooms will begin to heat-up further (but not in excess of equipment's design ambient temperatures). However, continuous occupancy is not expected and therefore forced ventilation is not required. Re-entry to the area remains possible considering limited stay times at the elevated temperature conditions.

The battery rooms require ventilation to prevent the accumulation of hydrogen gas while the batteries are being charged during Phases 2 and 3. Ventilation is provided via repowering the existing battery room exhaust fans (SVS-MFAN-0006A(B) for train A batteries or

SVS-MFAN-0005A(B) for Train B batteries) from the FLEX diesel generator. By repowering only the exhaust fan, a slight negative pressure is drawn on the room, purging whatever hydrogen is generated via the normal discharge to atmosphere (Reference 3.68).

The 3A-S and 3B-S battery rooms are adjacent to the respective switchgear rooms. The switchgear room heat-up evaluations discussed above are applied to the battery rooms which conclude no room cooling is required. The 3AB-S battery room is not credited beyond its initial 4 hours per existing SBO analysis and therefore room cooling or hydrogen removal is not required for that room.

The FCCP, charging pumps, CCW MU pump and TDEFW pump are utilized at various times during the FLEX strategy. All of these pumps are located on the -35' Elev. of the RAB. An area heat-up calculation (Reference 3.55) was prepared to determine the temperature conditions of the common area shared by the operating FLEX equipment during an ELAP response. The calculation determined that forced ventilation would not be required for well beyond 72 hours. If the Train A charging pump is utilized for RCS injection during Phase 2, Door 252 will need to be propped open to provide passive ventilation to the room.

Due to the FLEX actions required in the area surrounding the TDEFW pump, the RAB -35' Elev. was evaluated for operator accessibility. The calculation indicates the maximum temperature over the first 72 hours is 103°F around the TDEFW pump and 104°F in the hallway outside the charging pump rooms (Reference 3.55).

The -35' Elev. wing area contains the rigid suction hoses necessary to establish a gravity drain path from WCT basin A to the TDEFW pump (or FCCP). No operating equipment is present in this area, therefore the heat load is minimal and a detailed heat-up analysis was not performed. The room remains accessible to allow for the connection of the hoses.

The diesel fuel oil feed tanks are located on the RAB +46' Elev. within enclosures accessed via doorways to the roof. Actions are required within the rooms to begin diesel fuel oil replenishment approximately 24 hours after the start of the event (See Section 2.9.5). No operating equipment is present in this area during staging and deployment activities, therefore, the heat load is minimal and a detailed heat-up analysis was not performed. The room remains accessible for the connection of hoses. As the hoses are routed through the applicable doorway, the room will approach atmospheric conditions.

The new FLEX diesel generator enclosure on the RAB +41’ Elev. has been evaluated for room heat-up considerations (Reference 3.56). Passive ventilation is provided in the new enclosure to ensure the FLEX diesel generator will remain functional for the duration of the BDBEE response. The FLEX diesel generator enclosure is protected from external hazards.

The strategy to prevent excessive steam accumulation in the FHB consists of propping open the SFP doors to establish a vent path. Propping open these doors provides a ventilation pathway to maintain room habitability by venting steam created by pool boil-off in addition to a pathway for laying hoses. Door D187 provides the initial path from the SFP area to the stairwell. Door D69 connects the stairwell vent path to the FHB Access Area +21’ Elev. Door D37 establishes the ultimate path to atmosphere on the FHB +21’ Elev.

2.12 Personnel Habitability

Personnel habitability was evaluated in Section 2.11 above and determined to be acceptable.

2.13 Lighting

Lighting panels for high priority areas is repowered by the Phase 2 FLEX diesel generator. Diesel powered lighting towers are stored in the “N+1” storage building and can be deployed if required. Portable flashlights, that are normal equipment supplied to station personnel and operators, can be required for work in some areas of the plant (limited to indoor areas where lighting was not determined to be vital). In addition, high powered light emitting diode (LED) flashlights are being stored in JOBOXs.

2.14 Communications

Certain manual actions are required following a BDBEE for emergency planning (EP) communications.

An uninterruptable power supply (UPS) and battery pack is permanently installed in the technical support center (TSC) (located within the control room envelope) to provide continuous 120 VAC power to operations and maintenance radio desksets for up to 24 hours. After 24 hours, the UPS can be repowered by the FLEX diesel.

UPSs and battery packs are permanently installed in RAB +7 Elev. area to maintain emergency response radio and satellite phone communications for up to 24 hours. After 24 hours, portable power cords are temporarily installed from receptacles that are powered by distribution panels that are re-energized by the FLEX generator. The portable cords are routed from these receptacles to the RAB +7' elevation work area that contain the UPSs and radio and satellite phone battery charging units. This communication equipment is unplugged from their normal locations and plugged into the portable cords until normal AC power is restored.

Portable self-contained satellite phone "pelican cases" are deployed following a BDBEE and is staged in the RAB to allow emergency response personnel use of the satellite phones from within each facility within the RAB.

In the event that the main radio antenna is not available following a BDBEE, a temporary radio antenna is deployed to restore external radio communications. The antenna, cable, and antenna tripod are stored in a FLEX JOBOX located in the RAB. All equipment needed for execution of these strategies is stored or located within the confines of the RAB inside the NPIS and is fully protected and accessible during all applicable external events.

Finally, certain doors are required to be open following a BDBEE for heat and hydrogen dissipation, replacement radio antenna cable routing, telephone cable routing, and portable power cord routing. Table 5 below outlines the doors required to be opened as well as the purpose for opening the doors.

Table 5 EP Communication Doors Required to be Opened

Location	Door Number	Purpose
-4' Elevation (Stairwell)	D136	• Portable power cord routing (A-Train)
+7' Elevation (Communication Equipment Room)	D123	• Replacement radio antenna cable routing
+7' Elevation (Stairwell)	D107	• Portable power cord routing (A-Train and B-Train)
+7' Elevation (Stairwell and Vestibule)	D125 & D101	• Replacement radio antenna cable routing • Hydrogen dissipation
+21' Elevation	D20	• Portable power cord routing (A-Train and

Location	Door Number	Purpose
(Stairwell)		B-Train)
+46' Elevation (Control Room Envelope)	D73	• Telephone cable routing • Hydrogen dissipation
+46' Elevation (Stairwell and Vestibule)	D70 & D71	• Telephone cable routing • Hydrogen dissipation
+46' Elevation (TSC)	D93	• Telephone cable routing • Hydrogen dissipation
+69' Elevation (To RAB rooftop)	D185	• Telephone cable routing • Hydrogen dissipation

2.15 Alternate Approaches to Meet the NRC Order

The WF3 FLEX strategy has been developed following the guidance of NEI 12-06 supplemented with NEI FAQs and additional guidance from the PWR Owner's Group. The NEI 12-06 guidance provides an acceptable means to implement the NRC Order for FLEX. Alternative approaches have been established by the industry and individual licensees that provide acceptable alternatives to the guidance of NEI 12-06. NEI 12-06, Section 13, states that licensees should describe the extent to which NEI 12-06 is being followed, including a description of any alternatives to the guidance. The alternative approaches utilized by the WF3 FLEX strategy are described below.

2.15.1 Method of Storage and Protection of FLEX Equipment

Due to WF3's classification as a "wet site", the FLEX strategy is designed to fully protect at least one set of FLEX equipment from all applicable external events by permanently pre-staging the FLEX equipment within the protected areas of the NPIS. NEI 12-06 states that in some cases, FLEX equipment may need to be stored in its deployed position. The "N" set of FLEX equipment is stored in the NPIS to ensure it is protected from all extreme external hazards. The pre-staged FLEX equipment includes:

- FCCP;
- FWTP (backup to NSRC pump);

- FLEX diesel generator;
- FDFTP,
- Interconnecting cables, hoses, adaptors and manifolds,
- Spare compliment of cables and hoses, and
- Internal flooding FLEX portable sump pump and compressor

WF3 is implementing the unavailability controls described in NEI 12-06, Section 11.5, which call for initiation of actions by 24 hours and compensatory measures within 72 hours. To assist with unanticipated unavailability of the “N” set, evaluations have been performed and pre-planned strategies have been developed to provide reasonable protection of specific “N+1” equipment (FCCP, FLEX diesel generator and FDFTP) for the predictable external events with pre-warning (i.e., Mississippi River flood and hurricanes) and instances where the “N” set is unavailable for conditions other than conduct of routine maintenance and testing during normal operations.

The “triggers” for relocation of the N+1 equipment for predictable external events with pre-warning are as follows:

- If the Mississippi River level fronting the site rises to +25 feet, the N+1 FCCP, FLEX diesel generator, and FDFTP should be considered for relocation to the RAB.
    - o If the Mississippi River level is projected to rise to +27 feet within the next 12 hours, the N+1 FCCP should be relocated to the RAB -35’ elevation.
    - If a greater than or equal to Category 4 hurricane warning is issued for St. Charles Parish, the N+1 FCCP, FLEX diesel generator, and FDFTP should be considered for relocation to the RAB.
        - The FCCP should be further moved to the RAB -35’ Elev. prior to 12 hours before hurricane landfall.

2.15.2 <u>Use of Installed Charging Pumps for RCS Inventory Control with Steam Generators Available</u>

The WF3 FLEX strategy for RCS inventory control relies upon repowering an installed charging pump. Either train of electrical power is capable of supplying power to two of the three installed charging pumps utilizing the ‘A/B’ bus. The charging pumps will draw suction from the RWSP or BAMT and supply make-up to the RCS via the charging header or an alternate injection path through HPSI, depending on the pump selected.

A damage/integrity assessment check of the charging pumps is performed prior to selecting the deep load shed power train to ensure that no concerns exist with the charging pump being re-powered. Charging pump A has additional diversity for the RCS injection flow path, relating to the configuration of isolation valves and the cross-tie location on the charging pump discharge header. Should the assessment detect an issue that requires use of the alternate injection path, the train A electrical strategy and charging pump is utilized.

This strategy is considered acceptable per NEI FAQ 2013-06 (Reference 3.59). The charging pumps are seismically qualified, Safety Class 2 pumps. The pumps are located in the RAB -35’ Elev. within three separated pump cubicles. As the RAB is protected against high winds, tornado missiles, and external flooding, the charging pumps and associated piping are therefore robust for all hazards. Internal flooding has been evaluated and no sources of non-seismic piping have been identified that could impact pump operation.

The charging pumps are designed to supply 44 gpm at a discharge pressure of 2350 psig (Reference 3.68). This is more than sufficient to provide the make-up rate of 25 gpm to maintain natural circulation within the RCS and maintain adequate shutdown margin (Reference 3.16). Therefore, the charging pumps are capable to meet the FLEX RCS inventory control function.

The charging pumps are equipped with a packing cooling-lubricating system. The function of the packing cooling-lubricating system is to supply cooling and lubricating water in between the primary and secondary packing to prevent deterioration of the packing. Deterioration of packing without cooling and lubrication is a gradual process and therefore Combustion Engineering considered the system as non-essential and not safety-related (Reference 3.68). The pumps are capable of operating with leaking seals. The pumps have been subsequently upgraded since the original installation, when original vendor testing demonstrated over 100 hours of pump performance without the packing cooling-lubricating system (Reference 3.60). As the packing cooling-lubricating system is non-essential, its operation is not required for a BDBEE.

2.15.3 Use of Installed CCW MU Pumps for SFP Make-Up

NEI 12-06 guidance requires a portable injection source to provide make-up for spent fuel cooling following a BDBEE. The WF3 FLEX strategy credits the installed CCW MU pumps in lieu of a portable injection source to provide the SFP make-up.

The CCW MU pumps are seismically qualified, Safety Class 3 centrifugal pumps capable of 600 gpm flow at 150 ft. TDH (Reference 3.68). Discharge piping from the CCW MU pumps to the SFP is seismically qualified. The pumps are cooled by flushing water from the pump discharge, via connections integral with the pump (Reference 3.41). The CCW MU pumps, associated piping, and associated valves are housed entirely within protected, robust structures of the NPIS. The flow path to the SFP terminates directly into the SFP and requires no valve manipulations within the SFP area.

The CCW MU pumps are powered from Class 1E buses 3A311-S and 3B311-S (References 3.42 and 3.43). The load for a CCW MU pump is considered in the FLEX diesel generator sizing. The pumps can be operated by hand switch from the control room. Control power is available following restoration of shed loads.

The CCW MU pumps are credited within the plant design basis for providing safety-related make-up to the SFP. As the pumps, flow path, and water sources are robust for all extreme external hazards, the CCW MU pumps will be available following a BDBEE. As the maximum make-up rate required is 125.2 gpm (for a full core off-load), the CCW MU pumps are adequate to provide the SFP make-up required to support the FLEX strategy (Reference 3.36).

Based on this discussion, the use of CCW MU pumps for SFP make-up is considered an acceptable alternate approach to meet the NRC Order.

2.15.4 Minimum Spare Inventory of Hoses and Cables

NEI 12-06 guidance calls for a spare set of equipment that is required to maintain the FLEX safety functions to be stored on-site. Subsets of this spare equipment are hoses and cables required to implement the FLEX strategies. Hoses and cables are passive components that are unlikely to be damaged by an extreme external hazard. The “N” set of hoses and cables are protected from all extreme external hazards. As an alternate approach to meet the NEI 12-06, additional lengths of hoses and cables are stored with the “N” set of equipment rather than storing a complete second set in the “N+1” storage building. This spare capability supports the FLEX strategy requirements beyond the minimum necessary to support the “N” equipment on-site, thus meeting the definition of “N+1 capability” in NEI 12-06. Furthermore, this alternate approach for meeting the requirements for an “N+1” capability has been endorsed by the NRC (Reference 3.46).

The additional length of hoses and cables to be stored with the “N” set of equipment is the longer of 10% of the total hose/cable run or the longest segment of hose/cable. The 10% criteria extends separately to each size or type of hoses and cables. The hoses and cables utilized by the WF3 FLEX strategy are not one continuous hose or cable but rather are composed of smaller sections joined together to form a sufficient length.

Hoses and cables are passive devices unlikely to fail provided they are appropriately inspected and maintained. The hoses and cables for WF3 are stored in robust storage locations within the NPIS, accessible following an extreme external hazard, and are maintained in accordance with industry recommendations. The storage of additional spare cables and hoses for WF3 along with the “N” set provides additional assurance that the FLEX strategy can be implemented for all events even if a segment of the hoses or cables were to be damaged during the strategy implementation. This method is considered an alternate approach as the NEI guidance does not specifically define “N” as the entire length of cables and hoses.

2.16 Non-Robust Water Sources

2.16.1 Secondary Water Sources

Section 2.3.10.5 provides a list of credited water sources that may be used to provide cooling water to the S/Gs. There are other available water sources that are not credited due to their non-robust design but can be used, if available, to provide additional capability in support of the strategy. These sources of water are the condensate storage tank (CST), the primary water storage tank (PWST) and the demineralized water storage tank (DWST). Table 6 provides these other non-robust water sources and their available volumes.

Table 6 – Non-Robust Water Sources

Water Source	Tank Maximum	Minimum Level
CST	256,667 gallons	174,287 gallons
PWST	256,667 gallons	226,710 gallons
DWST	528,767 gallons	348,839 gallons

2.17 Shutdown and Refueling Analysis

WF3 will comply with the Nuclear Energy Institute position paper entitled "Shutdown/Refueling Modes" addressing mitigating strategies in shutdown and refueling modes. This position paper is dated September 18, 2013 (Reference 3.9) and has been endorsed by the NRC staff (Reference 3.10).

The FLEX strategy for core cooling with S/Gs unavailable is described below.

Phase 1 with the steam generators not available consists only of boiling the existing water inventory within the RCS/reactor cavity. Pressure in containment is maintained below the design limit via placing a vent in service.

The Phase 2 strategy utilizes the FCCP for RCS make-up by taking suction from the RWSP FLEX tie-in and providing discharge to the FLEX tie-ins located downstream of the HPSI ‘A’ or ‘AB’ pumps. The FLEX diesel generator is utilized to provide power to the FCCP via the Class 1E switchgear. If the plant configuration and time since shutdown results in a time to uncover the core (Reference 3.49) less than the time required to place the FLEX diesel generator into service during an outage, pre-staging of the FLEX diesel generator cables will be considered.

The make-up rate required to account for boil off of RCS inventory and prevent precipitation of boric acid was determined to be a maximum of 132 gpm (Reference 3.16). The FCCP is capable of providing more flow than the minimum required. The 132 gpm value is determined utilizing the decay heat of the reactor 48 hours following shutdown for the outage, plus 6% additional flow for boric acid precipitation flushing.

Borated water sources will be utilized until sufficient shutdown margin is maintained to prevent reactor criticality from occurring. Non-borated water sources may be utilized to match boil-off once shutdown margin is verified and consideration of dilution is accounted for (NEI FAQ 2013-10, Reference 3.51).

Phase 3 entails supplementing the FCCP with NSRC equipment if required. Boric acid precipitation flushing is required at hour 125 (or 254 during Mode 6) during this Phase (Reference 3.16). To provide flushing flow, the flow rate will be monitored using the FCCP flow instrumentation, and the flow control valve will be adjusted to allow 6% greater flow than required flow at the time flushing is required.

Alternatively, if desired, the SDC system can be restored via the NSRC 4160V generator.

The FLEX strategy for SFP cooling during a full core off-load consists of the same strategies as described for Modes 1-4 (Section 2.4). The actions and transition times are sooner due to the higher decay heat load in the pool. For a full core off-load, the time to boil is approximately 3 hours and 45 minutes, and the time to no longer defer make-up is approximately 28 hours (Reference 3.36).

With the core entirely off-loaded to the SFP, initial water sources for FLEX may not be available due to differences in configuration during the defueled state as opposed to Modes 1-4 when fuel is located inside the reactor vessel. To assure “defense in depth”, adequate water inventory will be identified as part of the outage risk management process. Depending on the outage plant configuration a pump other than the CCW make-up pump may be pre-staged to provide SFP make-up for this strategy. The FWTPs are each capable of providing sufficient flow to meet the 250 gpm spray capability (Reference 3.25), which exceeds the full core off-load make-up rate of approximately 130 gpm (Reference 3.36).

With an ELAP initiated in Modes 5-6 containment integrity could be challenged if not vented within approximately 6 hours (Reference 3.44). The Mode 5-6 analysis assumes that the plant has been shut down for 48 hours, RCS at a bulk temperature of 200°F, and at reduced inventory (mid-loop) with the pressurizer manway removed for venting. The containment analysis also assumes borated make-up is provided to the RCS within one hour. As the RCS heats up and begins to boil, decay heat removal occurs by steam transfer into containment. Without any mitigating actions in this scenario, containment design limits are exceeded approximately 13 hours after the ELAP.

Additional analysis performed demonstrated that establishing a vent path equivalent to a 5.5” ID pipe within 6 hours ensures the design limits for containment temperature and pressure are not exceeded. The existing integrated leakage rate test (ILRT) containment penetration (Penetration 63) is one acceptable vent path (Reference 3.44) as the piping penetration exceeds the 5.5” in diameter. Other acceptable containment vent paths may also be utilized if the cross-sectional area is equivalent to that of a 5.5” ID circular vent path.

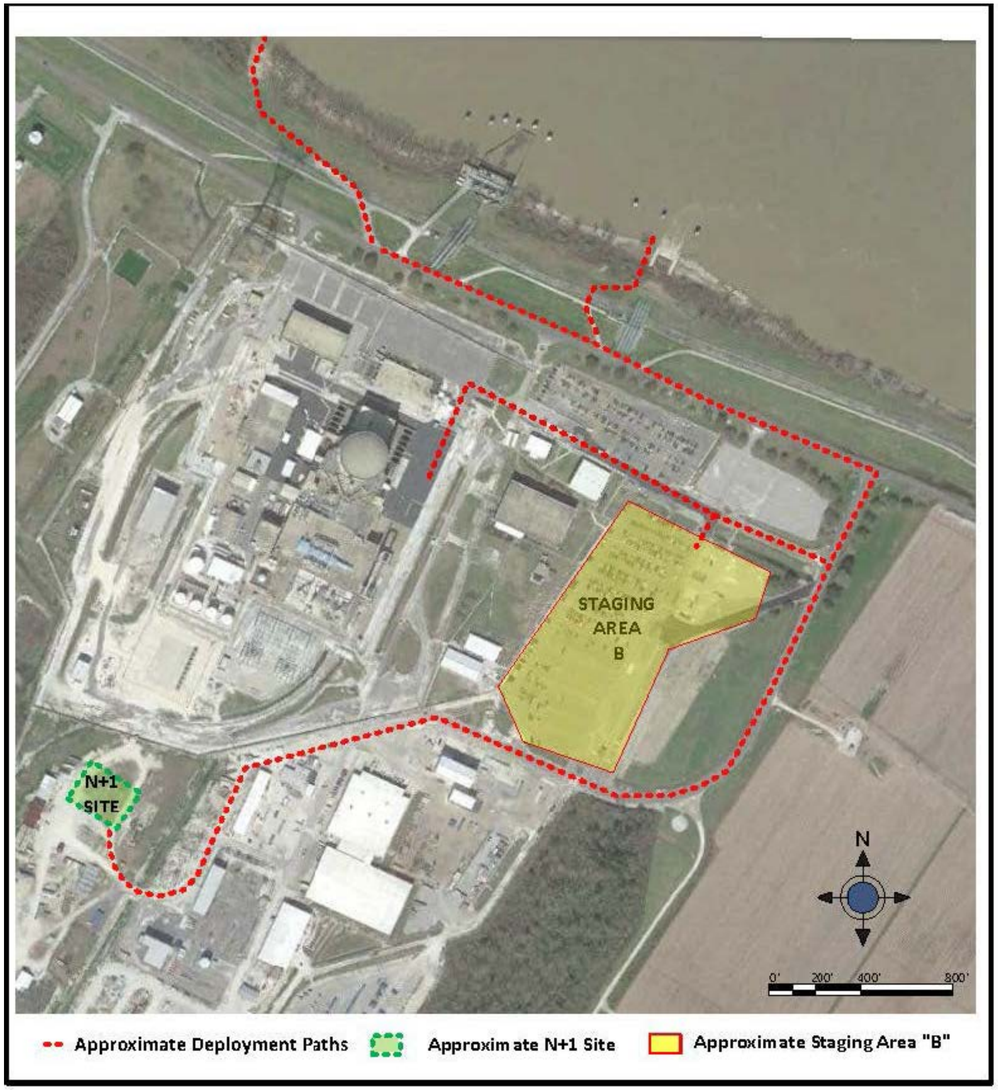


Figure 1: NSRC Staging Area and On-Site Haul Paths

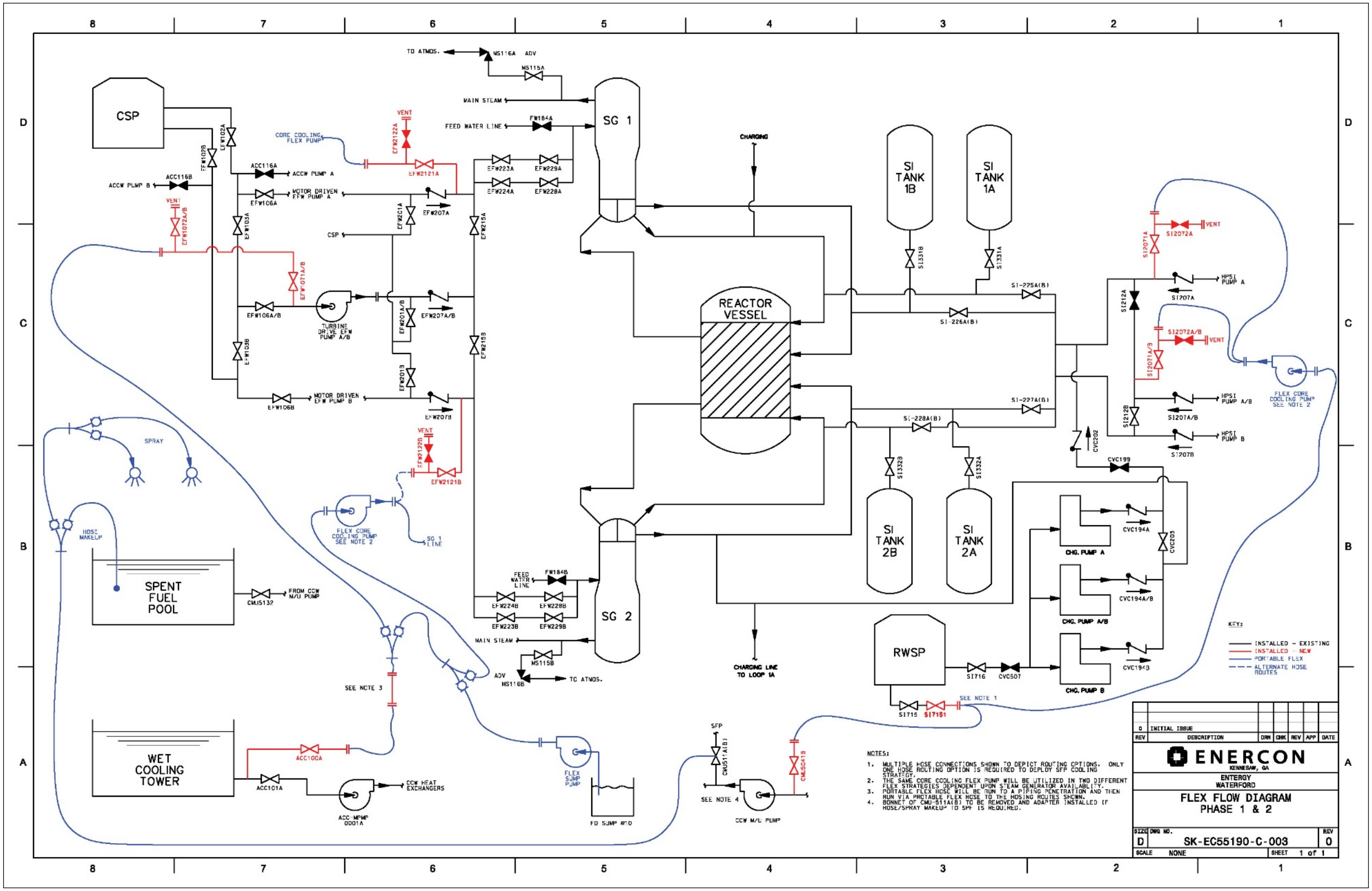


Figure 2: FLEX Flow Diagram Phase 1 and 2

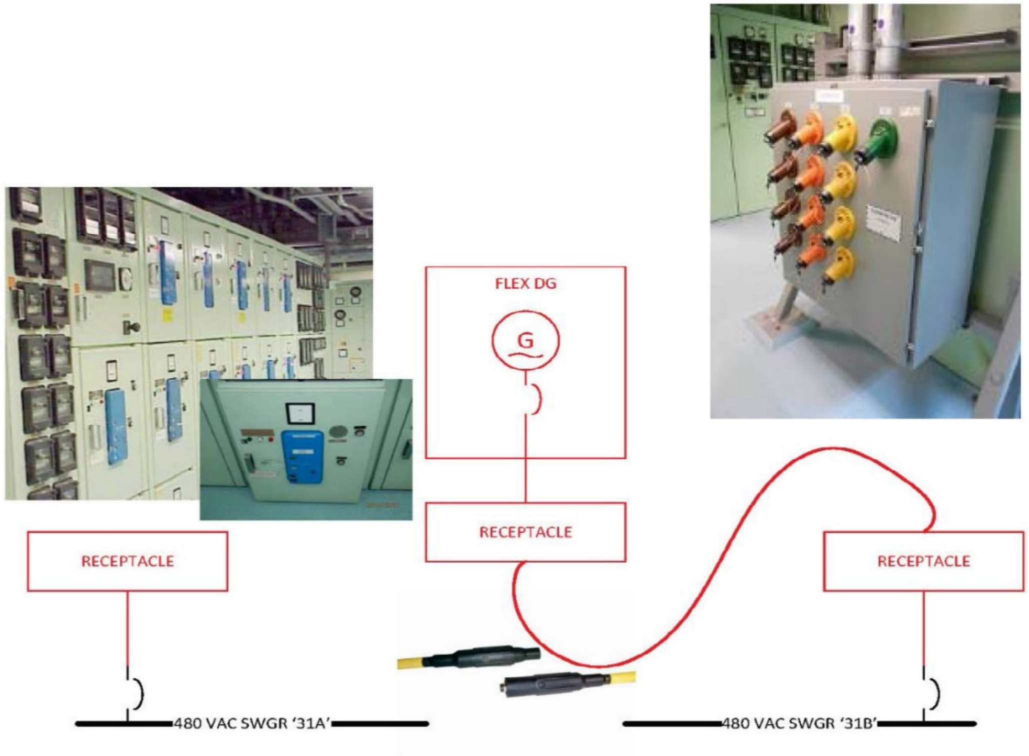


Figure 3: Electrical Connections for FLEX Diesel Generator

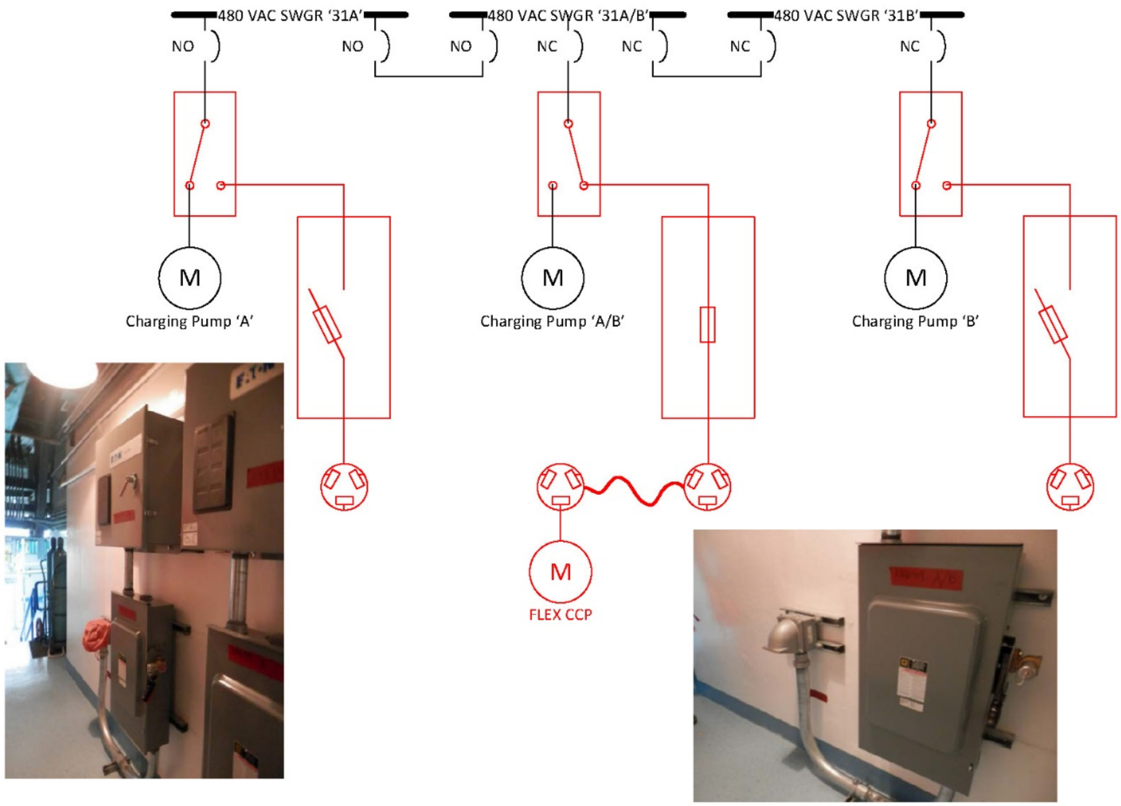


Figure 4: Electrical Connection for FLEX Core Cooling Pump

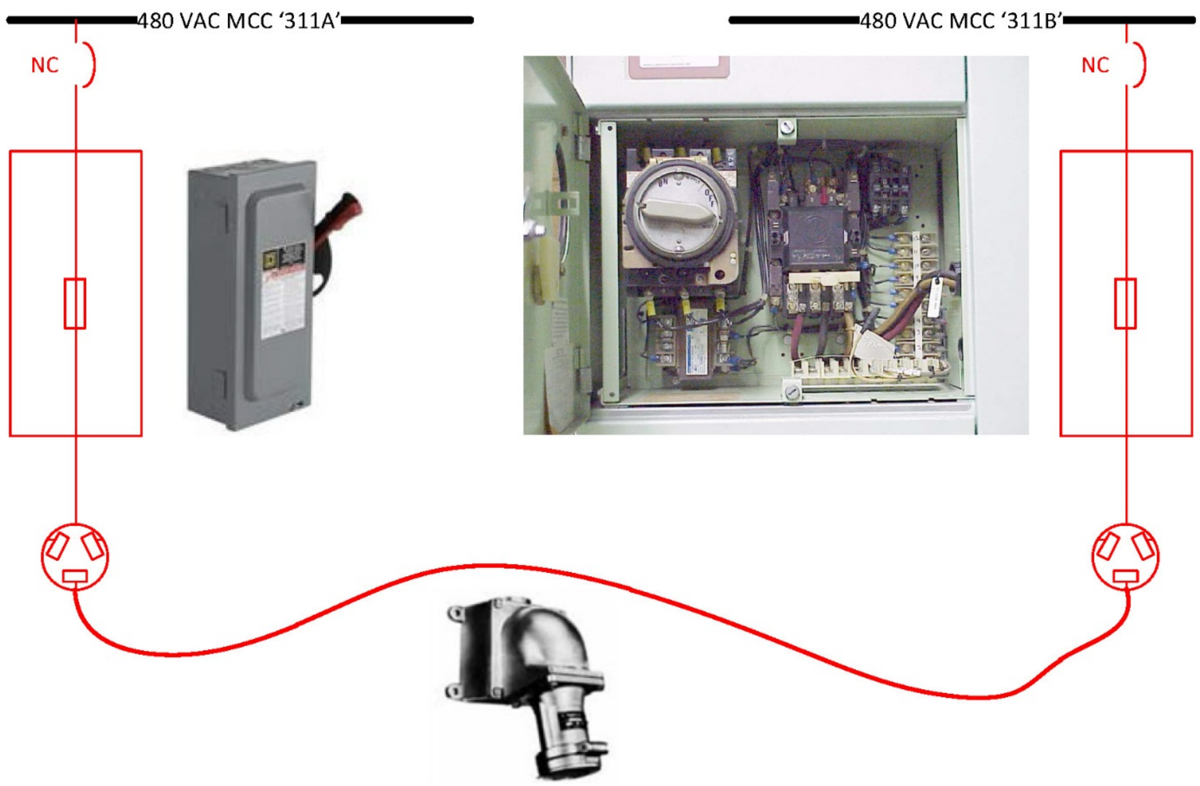
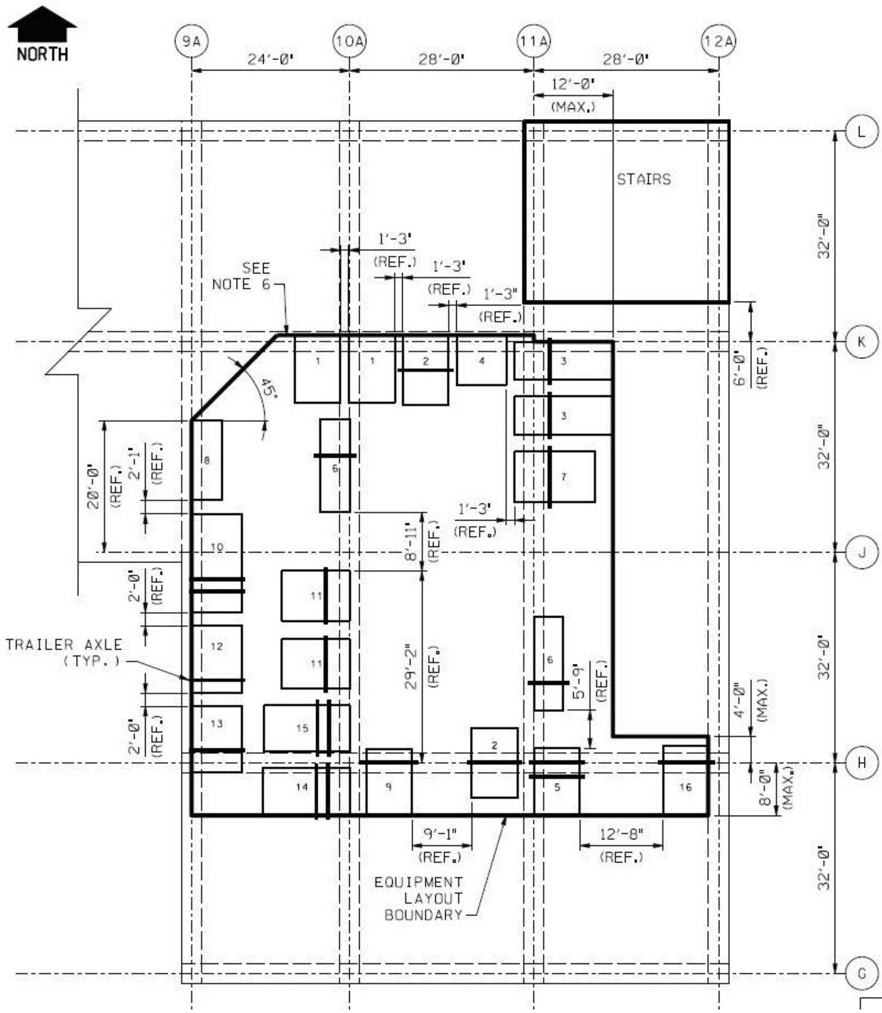


Figure 5: MCC Cross-Tie to Isolate the SITs



EQUIP. ID NO.	EQUIPMENT	QTY.	UNIT WT. (LBS.) (SEE NOTE 7)	LENGTH (IN.)	WIDTH (IN.)
1	HOSE MODULE-LARGE	2	7500	123	84
2	POWER CABLE TRAILER-BLUE	2	8020	128	83
3	MV TURBINE GENERATOR	2	9208	178	70
4	MV TURBINE GENERATOR FUEL TANK	1	12349	91	91
5	LP/HF PUMP AND TRAILER	1	12830	123	84
6	LIGHT TOWER	2	1912	170	54
7	4160V DISTRIBUTION CENTER	1	8000	147	93
8	PORTABLE AIR COMPRESSOR AND HOSES	1	4803	145	56
9	SG/RPV PUMP AND TRAILER	1	9997	122	84
10	WATER PURIFICATION-GENERATOR AND TRAILER	1	11100	180	92
11	WATER PURIFICATION-RO SKID-1 AND TRAILER	2	13680	123	91
12	WATER PURIFICATION-DISC FILTRATION AND TRAILER	1	9801	123	91
13	WATER PURIFICATION-HYDRO CYCLONE AND TRAILER	1	9242	121	91
14	MOBILE BORATION TANK	1	13920	158	87
15	MOBILE BORATION GENERATOR	1	7136	156	84
16	SUBMERSIBLE PUMP	1	8517	127	82

NOTES:

1. FOR THE EQUIPMENT ON A TRAILER, THE LARGER DIMENSION OF EQUIPMENT AND TRAILER IS SHOWN.
2. EQUIPMENT ID NO. 1 MAY BE REPLACED BY A MAXIMUM OF TWO (2) FUEL BLADDERS WITH A 500 GALLON CAPACITY (MAXIMUM TOTAL WEIGHT OF 3730 LBS).
3. THE MINIMUM CLEAR SPACING BETWEEN TWO PIECES OF EQUIPMENT SHOULD BE 2'-6" UNLESS NOTED OTHERWISE.
4. MAXIMUM HEIGHT OF EQUIPMENT IS 97'.
5. SEE DRAWING SK-EC55190-C-002 FOR DETAILED HELICOPTER LANDING AREA PLAN.
6. ALL EQUIPMENT IS TO BE LOCATED SOUTH OF PIPE 7SA8-147. REFERENCE DRAWING G 204 AND ESSE-SA-90.
7. ALL UNIT WEIGHTS ARE OPERATIONAL WEIGHTS WHICH INCLUDE EQUIPMENT DRY WEIGHT AND LIQUID CONTENT WEIGHT AS APPLICABLE.

REFERENCES:

G 204
ESSE-SA-90

ENTERGY WATERFORD

RAB ROOF EQUIPMENT LAYOUT PLAN

Figure 6: Alternate Staging Area B

2.18 Sequence of Events

The sequence of events tables (Tables 7, 8 and 9) presented within this section summarize the event timelines for the response to an ELAP with the plant originally in Modes 1 through 4, in Mode 5 with S/Gs available, in Modes 5 and 6 with S/Gs not available, and under plant conditions where a full core off-load has occurred. Validation of each of the FLEX time constraint actions has been completed in accordance with the FLEX Validation Process document issued by NEI and includes consideration of available staffing.

Modes 1 through 4, and 5 with Steam Generators Available

The Modes 1 through 4, and 5 with S/Gs available sequence of events assumes timing based on a reactor operating at 100% for 100 days (for decay heat consideration) and a limiting spent fuel load based on the shortest outage time period. Recovery actions are not included in this sequence of events.

Table 7: Modes 1-4, and 5 with S/G Available Timeline

Action Item	Time Constraint (hrs)	Action	Remarks / Applicability
	0	Event Starts	Plant @ 100% power
1	0.5	Complete Station Blackout Coping Actions*	SBO actions are proceduralized in emergency operating procedures (EOPs)
2	0.5	Isolate Controlled Bleed-off	Controlled bleed-off isolated per SBO procedures. This is a containment isolation action that limits controlled bleed-off to a maximum of 15 gpm/RCP seal.
3	1	Declare ELAP*	The ELAP declaration is a time critical step that allows operators to take actions outside of their licensing basis.
4	1.5	Integrity Assessment of Train B charging pump	Due to train asymmetries, an integrity assessment of the Train B charging pump

Action Item	Time Constraint (hrs)	Action	Remarks / Applicability
		room	room is performed to inform the selection of electrical train prior to performing the extended load shed
5	2	Complete Deep Load Shed*	One train of station batteries undergoes deep load shed to extend battery life to 12.5 hours. The train not selected continues to be available until minimum voltage is reached at approximately 4 hours.
5a	2	If Train A is to be repowered (undergoes extended load shed in Action Item 4): Perform local manual operation of the Train A Atmospheric Dump Valve (ADV), MS-116A, prior to de-energizing Static Uninterruptable Power Supply (SUPS) SMC.	Remote control power for MS-116A is lost during the Train A Extended Load Shed. Local manual control is required prior to shedding SUPS SMC. If a Train B extended load shed is utilized, control power is retained and the limiting condition for remote operation is the safety-related accumulator which is sized for 10 hours of operation.
6	2	Complete operator actions to establish passive ventilation in the Switchgear Rooms*	Doors D7, D9, D18, D21, D36, and D51 need to be opened by 2 hours to ensure the Switchgear Rooms remain accessible and to ensure no impact to thermally sensitive equipment.
7	2	Commence initial plant cooldown/depressurization	Plant will cooldown from approximately 543°F to approximately 456°F at 50°F/hr for approximately 2 hours.
	4**	Complete initial plant cooldown	

Action Item	Time Constraint (hrs)	Action	Remarks / Applicability
			Cooldown/depressurization is based on S/G pressure instrumentation to a target band of 450-470 psia. Cooldown is to protect RCP seals.
8	4	Commence local manual control of the TDEFW pump	The control system is operable until the AB station battery reaches its minimum voltage.
9	4	Complete operator actions to establish passive ventilation in the Main Control Room*	Doors D70, D72, D73, D75, D91, D186, D261, and D262 need to be opened by 4 hours to ensure the Main Control Room remains below 110°F until the FLEX diesel generator is placed into service, after which forced ventilation utilizing a portable fan is placed into service.
10	4	Perform local manual operation of the atmospheric dump valves (ADVs) Perform local manual operation of the EFW Flow Control/Isolation valves	Because control power is lost on the opposite train valves once batteries reach minimum voltage at approximately 4 hours, local manual control of the ADVs and EFW flow control/isolation valves is taken. Accumulators allow for remote operation prior to 4 hours.
11	6	Complete damage assessment*	A damage assessment is conducted to evaluate surviving non-robust water sources and plant equipment that could be utilized to extend on-site coping capability. Additionally, internal

Action Item	Time Constraint (hrs)	Action	Remarks / Applicability
			flooding is assessed and operator actions taken accordingly to isolate or mitigate leaking.
12	8	Suction for TDEFW pump transferred from CSP to WCT basins	TDEFW pump suction is transferred from the CSP to the WCT basins once the available inventory of the CSP is depleted. Transfer of suction utilizes new FLEX tie-in connections on the ACCW system in the -35’ Elev. Wing Area.
13	12	Establish SFP Vent Path	SFP vent path is established by propping open SFP building doors to provide a path from the Fuel Handling Building (FHB) +46’ Elev. to the environment via the FHB +21’ Elev. Timing is based on the time to boil of 12 hours, 45 minutes under limiting normal operating conditions (partial core off-load, 25 days following previous cycle shutdown).
14	12	Complete deployment of SFP make-up hoses and spray nozzles to SFP area	Deployment of hoses and nozzles are required to provide the option for direct make-up into the SFP as well as SFP spray functionality. These hose runs are completed prior to time to boil of 12 hours, 45 minutes under normal operating conditions. SFP make-up is not required until hour 95 for the limiting condition.

Action Item	Time Constraint (hrs)	Action	Remarks / Applicability
15	12	Place FLEX diesel generator into service	Timing is completed before RCS make-up and SIT isolation is required. Placed into service prior to battery life depletes for instrumentation in 12.5 hours.
16	12.5	Isolate the safety injection tanks and commence additional cooldown/depressurization to 400°F RCS cold leg / S/G pressure approximately 250-260 psia	Timing allows for 30 minutes to close SIT isolation valves on both trains. Additional cooldown from approximately 456°F to 400°F at 50°F/hr reduces RCS leakage and S/G pressure to allow for commencement of FCCP injection to the S/Gs.
17	12.5	Place charging pump in service for RCS inventory control and boration	RCS make-up is available via the charging pumps following connection to FLEX electrical panels once FLEX diesel generator is deployed. Make-up is required by 17 hours to ensure natural circulation is maintained. The pumps are available by hour 12.5 to maintain RCS inventory during the additional cooldown to 400°F and after the SITs have been isolated.
18	13	Place portable control room fan into service*	Once the FLEX diesel generator is placed into service, a portable fan is placed in door D259 to supply ventilation to the Main Control Room. Additionally, the hallway to the Technical Support Center will include a barrier

Action Item	Time Constraint (hrs)	Action	Remarks / Applicability
			to establish air flow through the Main Control Room once the fan is energized.
19	14.5	Complete additional plant cooldown/depressurization stabilizing at 400°F RCS cold leg / S/G pressure approximately 250-260 psia	The cooldown will take approximately one hour to complete. Once RCS is stabilized at cold leg temperature of 400°F (S/G pressure between 250 and 260 psia) and SITs isolated, the FCCP can be placed into service if needed.
20	14.5	FCCP ready to be placed into service	TDEFW pump performance may continue; however, the FCCP cables and hoses should be staged when resources permit, completing prior to the completion of the additional plant cooldown. The pump can be placed into service when needed once the FLEX diesel generator is placed into service and the RCS is cooled to a cold leg temperature of 400°F.
21	24	Debris removal / towing equipment	Debris removal in order to clear the NSRC staging area for Phase 3 equipment and the capability to tow the FWTP is required to get the pump out to the Mississippi River in a non-flood, seismic event. In a flooding event, no debris removal equipment is required as suction is taken directly off of the flood water.

Action Item	Time Constraint (hrs)	Action	Remarks / Applicability
			This action completes by 24 hours to support receipt of NSRC equipment as early as 24 hours following the event initiation.
22	24	Complete deployment of FLEX fuel oil replenishment equipment and commence fuel oil replenishment strategy	FLEX equipment requiring diesel fuel will need to be replenished beginning at approximately 24 hours The FDFTP is employed to provide diesel fuel from either of the emergency diesel feed tanks to both the FLEX diesel generator within a new enclosure on the RAB +41' Elev. roof, and in response to a flood event, the FLEX equipment on the +21' Elev. Q-deck. The FDFTP is stored within the RAB.
22a	24	Completes action required to maintain communications equipment beyond 24 hours	The EP Communications strategy requires opening the following doors in and around the control room to allow for heat dissipation and cable routing: D70, D71, D73, D78, and D93. *Note: Doors D70 and D73 will have already been opened in support of room heat-up for the main control room (Action Item 9).* Additional doors throughout the RAB are opened as well (D20, D101, D107, D123, D125, D136 and D185).
23a	38	Align gravity drain from RWSP to TDEFW pump	Once the WCT basins are depleted, make-up will

Action Item	Time Constraint (hrs)	Action	Remarks / Applicability
		or FCCP (flood or seismic events)	continue to be provided via TDEFW pump or FCCP, taking suction off of the RWSP.
23b	38	Align gravity drain from CWI piping to WCT basin (Non-seismic/non-flood events)	Once the original inventory of the WCT basins is depleted, make-up is provided via gravity drain from the CWI piping.
24	72	Stage FWTP (if NSRC equipment not available)	FWTP to be staged depending on the initiating event. Backup water transfer can be utilized to replenish depleted inventories if desired.
24a	72	Verify make-up to the SFP. Stage alternate SFP make-up/spray hose if SFP from primary path does not result in increasing SFP levels	Ensures SFP make-up is available prior to SFP level reaching Level 3 or 1 foot above the top of the spent fuel rack (which is reached at approximately 95.5 hours).
25a	72 (Flood or seismic events)	Align NSRC water treatment system	A water treatment system delivered by the NSRC is utilized to clean the make-up water coming from the water transfer pump. In a flood or seismic event, the NSRC water treatment system is needed by 72 hours to support the NSRC mobile boration system which will take suction from the water treatment system to mix a boric acid solution to replenish the RWSP. In non-flood, non-seismic events, borated make-up is
25b	72 (Flood or seismic events)	Place NSRC mobile boration system into service	

Action Item	Time Constraint (hrs)	Action	Remarks / Applicability
			not required until well beyond 72 hours, and therefore this equipment is not time-critical.
26a	72	Align FLEX or NSRC water transfer equipment (Flood or seismic events)	Once the WCT basins and RWSP are depleted, an indefinite source of coolant is established using on-site FLEX or NSRC equipment and the Mississippi River.
26b	72	Align FLEX or NSRC water transfer equipment (Non-flood / non-seismic events)	Once the WCT basins are depleted including the additional water gravity drained from the CWI piping, an indefinite source of coolant is established using on-site FLEX or NSRC equipment and the Mississippi River.
27	72	Align NSRC 4160V generator	The 4160V generator is supplied by the NSRC and utilized to implement the Phase 3 strategy for WF3. As the Phase 2 strategy for electrical power can be extended indefinitely, this action is not time sensitive.
28	72	Establish fuel truck service	Diesel fuel replenishment is required once the on-site fuel sources are depleted. The site has a substantial amount of available fuel and therefore this action is not expected to be time sensitive.
29	95	Commence SFP make-up	Once the SFP has started to boil (approximately 12 hours, 45 minutes), an approximate 82 hours, 40

Action Item	Time Constraint (hrs)	Action	Remarks / Applicability
			minutes of boil-off inventory is available over Level 3 in the SFP (1 foot above the top of the spent fuel rack). Primary make-up strategy is to repower the Component Cooling Water (CCW) Make-up (MU) pump and provide make-up from the WCT or RWSP to the SFP via existing piping and new FLEX connections.

*These FLEX strategy items are applicable to all Modes/plant conditions sequence of events.

**Note that the completion time of the cooldown is approximate per Reference 3.16. The actual completion time is dependent on the cooldown rate achieved which is maintained less than 50°F/hr and therefore may extend the initial cooldown completion time up to 4.5 hours.

Modes 5 and 6 with Steam Generators not Available

In Modes 5 and 6 with the steam generators not available, a detailed timeline is not required as the plant will go through many short term configurations for which a single timeline would not apply. The following actions are time sensitive actions required based on analyses performed. The actions in Table 8 are those that are specific to Modes 5 and 6 with the steam generators not available. Actions associated with all ELAP responses (e.g., load shedding activities) from Table 7 are not repeated in this timeline.

Table 8: Modes 5 and 6 Timeline

Action Item	Time Constraint (hrs)	Action	Remarks / Applicability
	0	Event Starts	Plant @ 0% power, S/Gs not available, RCS vent established
1	Dependent on outage risk	Commence RCS make-up	RCS time to boil and uncover is heavily dependent on the time since reactor shutdown and the

Action Item	Time Constraint (hrs)	Action	Remarks / Applicability
	assessment.		water level within the RCS / reactor cavity. Once the RCS begins to boil, make-up needs to be provided as soon as possible to ensure adequate cooling and to keep the core covered.
2	Dependent on outage risk assessment.	Place FLEX diesel generator into service and commence RCS injection via FCCP	RCS injection is required to provide coolant to the RCS to match boil-off. The FCCP can be aligned to provide injection to the RCS via HPSI piping. The FCCP is an electrically driven pump that cannot be deployed until after the FLEX diesel generator is operational. If the plant configuration and time since shutdown results in a time to core uncovery less than the time required to place the FLEX diesel generator into service during an outage, pre-staging of FLEX equipment must be considered.
3	6	Establish containment vent	A containment vent is established to prevent containment over-pressurization. A vent greater than 5.5 inches inner-diameter is necessary to relieve containment pressure prior to containment pressure reaching 30 psia (approximately 6 hours).
4	125 (254 in Mode 6)	Provide flushing flow to prevent boric acid precipitation	Flushing flow is required to preclude precipitation of boric acid in the vessel. When flushing flow is required, the flow rate will need to be increased 6%.

Full Core Off-load

For a full core off-load, the following timeline applies. The principle differences between this strategy and the Modes 1 through 4 strategy are:

- SFP actions occur sooner and are prioritized
- No actions are required for the primary or secondary loops of the RCS
- Water transfer is not required until significantly later due to the abundance of water available for SFP make-up.
- Considering the short time-frame available to stage equipment prior to boiling within the pool, pre-staging of coiled hosing may be considered prior to off-loading the core.

Table 9: Full Core Off-load Timeline

Action Item	Time Constraint (hrs)	Action	Remarks / Applicability
	0	Event Starts	Plant @ 0% power, reactor defueled
1	0	Perform Station Blackout Coping Actions	SBO actions are proceduralized in EOPs
2	1	Declare ELAP	The ELAP declaration is a time critical step that allows operators to take actions outside of their licensing basis.
3	2	Perform Deep Load Shed	One train of station batteries will undergo deep load shed to extend battery life to 12.5 hours. The train not selected will continue to be available until minimum voltage is reached at approximately 4 hours.
4	3.75	Establish SFP Vent Path	SFP vent path is established by propping open SFP building doors. Timing is based on the time to boil under limiting full

Action Item	Time Constraint (hrs)	Action	Remarks / Applicability
			core off-load conditions (full core off-load, 3 days following previous cycle shutdown).
5	3.75	Deploy SFP make-up hoses to SFP area	Deployment of hoses and nozzles are required to provide the option for direct make-up into the SFP as well as SFP spray functionality. If not pre-staged, these hoses are routed prior to time to boil under full core off-load conditions (3 hours, 45 minutes). SFP make-up is not required until hour 27.
6	6	Complete damage assessment	A damage assessment will be conducted to evaluate surviving non-robust water sources and plant equipment that could be utilized to extend on-site coping capability. Additionally, internal flooding is assessed and operator actions taken accordingly to isolate or mitigate leaking.
7	12	Connect and Start FLEX diesel generator	Timing is completed before station batteries reach minimum voltage. Deep load shed extends battery life for instrumentation to 12.5 hours.
8	24	Debris removal / towing equipment	Debris removal to clear the NSRC staging area for Phase 3 equipment and the capability to tow the FWTP is required to get the pump out to the Mississippi River in a non-flood event. In a flooding event, no debris removal equipment is required as suction is taken directly off of the flood water.

Action Item	Time Constraint (hrs)	Action	Remarks / Applicability
			This action completes by 24 hours to support receipt of NSRC equipment as early as 24 hours following the event initiation.
9	24	Complete deployment of FLEX fuel oil replenishment equipment and commence fuel oil replenishment strategy	FLEX equipment requiring diesel fuel will need to be replenished beginning at approximately 24 hours. The FDFTP is employed to provide diesel fuel from either of the emergency diesel feed tanks to both the FLEX diesel generator within a new enclosure on the RAB +41’ el roof, and in response to a flood event, the FLEX equipment on the +21’ Elev. Q-deck. The FDFTP is stored within the RAB.
10	27	Commence SFP make-up	Once the SFP has started to boil (approximately 3 hours, 45 minutes), an additional 24 hours of boil-off inventory is available above Level 3 in the SFP (1 foot over the top of the spent fuel rack). Primary make-up strategy is to repower the CCW MU pump and provide make-up from the CSP and/or RWSP to the SFP via existing piping.
11	72	Deploy FLEX or NSRC water transfer pump to provide make-up to the SFP directly or to the ongoing Phase 2 SFP make-up pump (CCW MU pump)	In the event of an ELAP during a full core off-load, only make-up water is required for the SFP. The NPIS houses enough borated and non-borated water to make-up for over 120 hours, in addition to the amount of time until make-up is required (27 hours)

Action Item	Time Constraint (hrs)	Action	Remarks / Applicability
12	72	Align NSRC 4160V generator	The 4160V generator is supplied by the NSRC and utilized to implement the Phase 3 strategy for WF3. As the Phase 2 strategy for electrical power can be extended indefinitely, this action is not time sensitive.
13	72	Establish fuel truck service	Diesel fuel replenishment is required once the on-site fuel sources are depleted. The site has a substantial amount of available fuel and therefore this action is not expected to be time sensitive.

2.19 Programmatic Elements

2.19.1 Overall Program Document

The WF3 Program Document, EN-OP-201-08, provides a description of the FLEX Program for WF3. The key program elements provided in the Program Document include:

- Description of the FLEX strategies and basis
- Provisions for documentation of the historical record of previous strategies and the basis for changes
- The basis for the ongoing maintenance and testing programs chosen for the FLEX equipment
- Designation of the minimum set of parameters necessary to support strategy implementation

In addition, the program description includes a list of the FLEX basis documents that is kept up to date for facility and procedure changes.

Existing design control procedures have been revised to ensure that changes to the plant design, physical plant layout, roads, buildings, and miscellaneous structures will not adversely impact the approved FLEX strategies.

Future changes to the FLEX strategies may be made without prior NRC approval provided 1) the revised FLEX strategies meet the requirements of NEI 12-06, and 2) an engineering basis is documented that ensures that the change in FLEX strategies continues to ensure the key safety functions (core and SFP cooling, containment integrity) are met.

2.19.2 Procedural Guidance

The inability to predict actual plant conditions that require the use of FLEX equipment makes it impossible to provide specific procedural guidance. As such, the FSGs will provide guidance that can be employed for a variety of conditions. Clear criteria for entry into FSGs will ensure that FLEX strategies are used only as directed for ELAP conditions, and are not used inappropriately in lieu of existing procedures. When FLEX equipment is needed to supplement EOPs or Off-Normal Operating Procedures (OOPs) strategies, the EOP or OOP, Severe Accident Mitigation Guidelines (SAMGs), or Extreme Damage

Mitigation Guidelines (EDMGs) will direct the entry into and exit from the appropriate FSG procedure.

FSGs will provide available, pre-planned FLEX strategies for accomplishing specific tasks in the EOPs or OOPs. FSGs will be used to supplement (not replace) the existing procedure structure that establishes command and control for the event.

Procedural interfaces have been incorporated into Procedure OP-902-005, Station Blackout Recovery (Reference 3.52), to the extent necessary to include appropriate reference to FSGs and provide command and control for the ELAP.

FSGs are reviewed and validated by the involved groups to the extent necessary to ensure the strategy is feasible. Validation may be accomplished via walk-throughs or drills of the guidelines.

2.19.3 Staffing

Using the methodology of NEI 12-01 (Reference 3.8), an assessment of the capability of the WF3 on-shift staff and augmented emergency response organization (ERO) to respond to a BDBEE was performed (Reference 3.62).

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

- an extended loss of AC power (ELAP)
- an extended loss of access to ultimate heat sink (UHS)
- 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.

Due to the unique challenges of Waterford for a flooding extreme external hazard, the personnel arriving post event are not assumed to be available to support FLEX tasks until 12 hours post event.

A team of subject matter experts from Operations, Operations Training, Radiation Protection, Chemistry, Security, Emergency Planning and FLEX Project Team personnel performed a staffing assessment. The participants reviewed the assumptions and applied existing procedural guidance, including applicable draft and approved FSGs for coping with a BDBEE using minimum on-shift staff. 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 the estimated time to prepare for and perform the task.

The Phase 2 staffing assessment (References 3.62 and 3.67) concluded that the current minimum on-shift staff as defined in the WF3 Emergency Plan is sufficient to support the implementation of the mitigating strategies (FLEX strategies), as well as the required emergency plan actions, with no unacceptable collateral tasks assigned to the on-shift personnel during the first 12 hours. The assessment also concluded that the on-shift staff, with assistance from augmented staff, is capable of implementing the FLEX strategies necessary after the 12 hour period within the constraints. It was concluded that the emergency response function would not be degraded or lost.

This assessment also concluded that sufficient personnel resources exist in the current WF3 augmented ERO to fill positions for the expanded emergency response functions. Thus, the ERO resources and capabilities necessary to implement Transition Phase coping strategies performed after the end of the "no site access" 12-hour time exist in the current program.

2.19.4 <u>Training</u>

Based on the guidance in NEI 12-06, WF3's Nuclear Training Program has been revised to assure personnel proficiency in the mitigation of BDB external events is adequate and maintained. These programs and controls were developed and have been implemented in accordance with the systematic approach to training (SAT) process.

Initial training was provided and periodic training is provided to site emergency response leaders on BDB emergency response strategies and implementing guidelines. Personnel assigned to direct the execution of mitigation strategies for BDB external events have received the necessary training to ensure familiarity with the associated tasks, considering available job aids, instructions, and mitigating strategy time constraints.

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

2.19.5 Equipment List

The major equipment stored and maintained within the NPIS and WF3 FLEX storage building necessary for the implementation of the FLEX strategies in response to a BDBEE are listed in Tables 10 and 11. Tables 10 and 11 identify the quantity, applicable strategy, and capacity/rating for the major FLEX equipment components, as well as, various clarifying notes.

2.19.6 Equipment Maintenance and Testing

Maintenance and testing of FLEX equipment is governed by the Entergy Preventive Maintenance (PM) Program as described in EN-DC-324. The Entergy PM Program is consistent with INPO AP-913 and utilizes the EPRI Preventive Maintenance Basis Database as an input in development of fleet specific Entergy PM Basis Templates. Based on this, the Entergy fleet PM program for FLEX equipment follows the guidance NEI 12-06, Section 11.5.

The Entergy PM Basis Templates include activities such as:

- Periodic static inspections
- Operational inspections
- Fluid analysis
- Periodic functional verifications
- Periodic performance validation tests

The Entergy PM Basis Templates provide assurance that stored or pre-staged FLEX equipment is being properly maintained and tested. In those cases where EPRI templates were not available for the specific component types, preventative maintenance (PM) actions were developed based on manufacturer provided information/ recommendations.

Additionally, the station performs periodic facility readiness checks for equipment that is outside the jurisdiction of the normal PM program and considered a functional aspect of the specific facility (EP communications equipment such as radios, batteries, battery chargers, satellite phones, etc.). These facility functional readiness checks provide assurance that the EP communications equipment outside the jurisdiction of the PM Program is being properly maintained and tested.

The unavailability of equipment and applicable connections that directly perform a FLEX mitigation strategy for core, containment, and SFP is managed such that risk to mitigating strategy capability is minimized. Maintenance/risk guidance conforms to the guidance of NEI 12-06 as follows:

Portable FLEX equipment may be unavailable for 45 days provided that the site FLEX capability (N) is available.

If portable equipment becomes unavailable such that the site FLEX capability (N) is not maintained, initiate actions within 24 hours to restore the site FLEX capability (N) and implement compensatory measures (e.g., repair equipment, use of alternate suitable equipment or supplemental personnel) within 72 hours.

Table 10: FLEX Equipment Stored in the NPIS

Use and (potential / flexibility) diverse uses						**Performance Criteria**
FLEX Equipment	**Core**	**Containment**	**SFP**	**Instrumentation**	**Accessibility**	
FLEX Core Cooling Pump (1)	X					250 gpm at 700' TDH
FLEX Water Transfer Pump (1)	X		X			400 gpm at 180' TDH (flood conditions) 400 gpm at 333' TDH (non-flood conditions)
FLEX Diesel Fuel Transfer Pump (1)	X		X			15 gpm at 47' TDH
FLEX Diesel Generator (1)	X	X	X	X		400 kW, 3-phase system
Cables and Hoses	X		X			
Internal Flooding Sump Pump (1)					X	64 gpm at 35' TDH
SBO Air Compressor					X	27 scfm at 100 psig

Use and (potential / flexibility) diverse uses						Performance Criteria
FLEX Equipment	**Core**	**Containment**	**SFP**	**Instrumentation**	**Accessibility**	
(1)						
Main Control Room Fan	X	X	X	X		15850 cfm
(2) Phase 3 FLEX Equipment	X	X	X	X		

Table 11: FLEX Equipment Stored in the "N+1" Storage Building

Use and (potential / flexibility) diverse uses						**Performance Criteria**
Portable Equipment	**Core**	**Containment**	**SFP**	**Instrumentation**	**Accessibility**	
FLEX Core Cooling Pump (1)	X					250 gpm at 700' TDH
FLEX Water Transfer Pump (1)	X		X			400 gpm at 180' TDH (flood conditions) 400 gpm at 333' TDH (non-flood conditions)
FLEX Diesel Generator (1)	X	X	X	X		400 kW, 3-phase system
Portable Light Towers (4)					X	4000 W output
Portable Fuel Trailer (1)	X	X	X		X	500 gallon with a 12V pump with battery
Class 3 Light Duty Pickup Truck (1)					X	Class 3, 4 wheel drive with diesel engine
Front-End Loader (1)					X	20 ton metric capacity

Table 12: NSRC Equipment

	Use and (potential / flexibility) diverse uses					Performance Criteria
Portable Equipment	**Core**	**Containment**	**SFP**	**Instrumentation**	**Accessibility**	
NSRC S/G Pump	X					500 gpm @ 515 psia
NSRC Low Pressure/High Flow Pump	X		X			5000 gpm @ 150 psig
NSRC Low Pressure/Medium Flow Pump		X				2500 gpm @ 300 psi
NSRC High Pressure Pump	X					60 gpm @ 2015 psia
NSRC Generator (4160V)	X	X	X	X		4160V, 2000 kW
NSRC Generator (480V)	X	X	X	X		480V, 1000kW
Mobile Boration Unit	X		X			1000 gallon tank
Mobile Water Purification System	X		X			500 gpm

3. References

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3.3 Nuclear Energy Institute (NEI) 12-06, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide, Revision 0, dated August 2012 (ADAMS Accession No. ML12221A205)

3.4 NRC Interim Staff Guidance JLD-ISG-2012-01, "Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events", Revision 0, dated August 29, 2012 (ADAMS Accession No. ML 12229A174).

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3.13 NRC Letter, Boron Mixing Endorsement Letter in Regards to Mitigation Strategies Order EA-12-049, dated January 8, 2014 (ADAMS Accession No. ML13276A183)

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3.15 ECE14-004, Battery 3A-S “A” Train Calculation for FLEX Event, Revision 1

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3.19 Waterford 3 Final Safety Analysis Report (FSAR), Rev. 307

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