PSEG Nuclear LLC
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PSEG
Nuclear LLC

Order EA-12-049

LR-N16-0120

SEP 28 2016

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

Salem Generating Station Units 1 and 2
Renewed Facility Operating License Nos. DPR-70 and DPR-75
NRC Docket Nos. 50-272 and 50-311

Subject: Salem Generating Station Unit 1 Compliance with March 12, 2012 NRC Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049) and Final Integrated Plan for Units 1 and 2

References:

1. NRC Order Number EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012

2. PSEG Letter LR-N16-0070, "Salem Generating Station Unit 2 Compliance with March 12, 2012, NRC Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)," April 23, 2016

3. NRC Letter, "Salem Nuclear Generating Station, Unit Nos. 1 and 2 – 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 (TAC Nos. MF0868, MF0869, MF0913, and MF0914)," dated October 10, 2014

On March 12, 2012, in response to events at the Fukushima Dai-ichi nuclear plant, the Nuclear Regulatory Commission (NRC) issued Order EA-12-049 (Reference 1) to all power reactor licensees, including PSEG Nuclear LLC (PSEG). NRC Order EA-12-049 was immediately effective and directed PSEG 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. In accordance with the reporting requirement of Condition IV.C.3 of the Order, this letter affirms that Salem Generating Station (SGS) Unit 1 has achieved full compliance with NRC Order EA-12-049, Attachment 2, "Requirements for Mitigation Strategies for Beyond-Design-Basis Events at Operating Reactor Sites and Construction Permit Holders." PSEG previously affirmed SGS Unit 2 compliance with NRC Order EA-12-049 via Reference 2.

Attachment 1 provides a summary of SGS Unit 1 compliance with the NRC Order EA-12-049 requirements. Attachment 2 provides the responses to items in the NRC mitigation strategies and spent fuel pool level instrumentation audit report (Reference 3) for SGS Units 1 and 2. Also, with both units in compliance with NRC Order EA-12-049, PSEG document EM-SA-100-1000, Attachment 1, "Final Integrated Plan - Beyond-Design-Basis FLEX Mitigating Strategies, Salem Generating Station Units 1 and 2," is enclosed.

There are no regulatory commitments contained in this letter. If you have any questions or require additional information, please do not hesitate to contact Mr. Brian Thomas at 856-339-2022.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on 9/28/16
(Date)

Sincerely,

Eric Carr
Acting Site Vice President
Salem Generating Station

Attachment 1: Salem Generating Station Unit 1 Compliance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events"

Attachment 2: Salem Generating Station Units 1 and 2 Response to NRC FLEX Audit Items

Enclosure: EM-SA-100-1000 Attachment 1, "Final Integrated Plan – Beyond-Design-Basis FLEX Mitigating Strategies, Salem Generating Station Units 1 and 2"

cc: Mr. Daniel Dorman, Administrator, Region I, NRC
Ms. Carleen J. Parker, Project Manager, NRC/NRR/DORL
Mr. John Boska, Senior Project Manager, NRC/NRR/JLD
Mr. Patrick Finney, NRC Senior Resident Inspector, Salem
Mr. Patrick Mulligan, Chief, NJBNE
Mr. Thomas Cachaza, Salem Commitment Tracking Coordinator
Mr. Lee Marabella, PSEG Commitment Coordinator – Corporate

Attachment 1

Salem Generating Station Unit 1 Compliance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events"

Salem Generating Station Unit 1 Compliance with NRC Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events"

References for this attachment are identified in Section 5.

1 INTRODUCTION

PSEG Nuclear LLC (PSEG) developed an Overall Integrated Plan (OIP) (Reference 1) for the Salem Generating Station (SGS) Units 1 and 2, documenting the diverse and flexible coping strategies (FLEX) in response to NRC Order EA-12-049 (Reference 2). In References 3 through 8, PSEG provided six-month status reports associated with implementation of the requirements of NRC Order EA-12-049. PSEG used the guidance of Revision 0 of NEI 12-06 (Reference 9) to develop the SGS FLEX strategies.

The original compliance milestone for SGS Unit 1 implementation of NRC Order EA-12-049 was prior to startup from the 23rd refueling outage (S1R23) in the fall 2014. In response to PSEG's request (Reference 10), the NRC staff approved schedule relaxation (Reference 11) to allow SGS Unit 1 to fully implement the FLEX strategies prior to startup from the 24th refueling outage (S1R24), which included implementation of design changes to reduce reactor coolant pump (RCP) seal leakage. Consistent with the NRC schedule relaxation in Reference 11, SGS Unit 1 achieved full compliance with NRC Order EA-12-049 on July 27, 2016, prior to initial entry into Mode 2 (Startup) from S1R24 on July 28, 2016. The current FLEX strategies for SGS Units 1 and 2 are described in the enclosed Final Integrated Plan (FIP).

2 NRC FLEX AUDIT ITEM RESOLUTION

SGS Units 1 and 2 responses to items identified in the NRC's interim staff evaluation (ISE) (Reference 13) and NRC audit report (Reference 14) are provided in Attachment 2.

3 MILESTONE SCHEDULE STATUS

All SGS Units 1 and 2 FLEX milestones are complete as shown in the final milestone status table below.

Milestone	Original Target Completion Date	Activity Status	Revised Target Completion Date
Submit Overall Integrated Plan	Feb 2013	Complete	
Six-Month Status Update	Aug 2013	Complete	
	Feb 2014	Complete	
	Aug 2014	Complete	
	Feb 2015	Complete	
	Aug 2015	Complete	
	Feb 2016	Complete	
Develop Strategies	May 2013	Complete	
Modifications			
Develop Modifications – Unit 1	Dec 2013	Complete	Jul 2015
Implement Modifications – Unit 1	Oct 2014	Complete	Jul 2016
Develop Modifications – Unit 2	Dec 2013	Complete	Jun 2015
Implement Modifications – Unit 2	Oct 2015	Complete	Feb 2016
Flex Support Guidelines (FSGs)			
Develop FSGs – Unit 1	Dec 2013	Complete	Mar 2015
Approve FSGs – Unit 1	May 2016	Complete	May 2016
Validation Walk-throughs or Demonstrations of FLEX Strategies and Procedures – Unit 1	Nov 2014	Complete	May 2016
Develop FSGs – Unit 2	Dec 2013	Complete	Mar 2015
Approve FSGs – Unit 2	Nov 2015	Complete	Feb 2016
Validation Walk-throughs or Demonstrations of FLEX Strategies and Procedures – Unit 2	Nov 2015	Complete	Feb 2016

Milestone	Original Target Completion Date	Activity Status	Revised Target Completion Date
Perform Staffing Analysis	Dec 2013	Complete	Jun 2014
Develop Training Plan	Jun 2014	Complete	
Implement Training			
Unit 1 Training	Dec 2014	Complete	May 2016
Unit 2 Training	Dec 2014	Complete	Nov 2015
Develop Strategies/Contract with National SAFER Response Centers (formerly known as Regional Response Centers)	Oct 2013	Complete	Oct 2014
Procure Equipment			
Unit 1 Procurement	Dec 2013	Complete	Jun 2015
Unit 2 Procurement	Dec 2013	Complete	Nov 2015
Create Maintenance Procedures	May 2014	Complete	Feb 2016
Emergency Preparedness (EP) Communications Improvements	Jun 2014	Complete	Nov 2014
Unit 1 Implementation Outage	Oct 2014	Complete	Jul 2016
Unit 1 Report to NRC When Full Compliance is Achieved	Feb 2015	Complete with this Report	Sep 2016
Unit 2 Implementation Outage	Oct 2015	Complete	Nov 2015
Unit 2 Report to NRC When Full Compliance is Achieved	Feb 2016	Complete	Apr 2016

4 NRC ORDER EA-12-049 COMPLIANCE ELEMENTS SUMMARY

SGS Unit 1 compliance with NRC Order EA-12-049 (Reference 2) was achieved using the guidance in NEI 12-06, Revision 0 (Reference 9) which has been endorsed by the NRC (Reference 12), with clarifications on determining baseline coping capability and equipment quality. The significant compliance elements have been addressed for SGS Unit 1, as described below.

Strategies - Complete

SGS Unit 1 mitigation strategies are in compliance with NRC Order EA-12-049 and are documented in the enclosed Final Integrated Plan (FIP).

Modifications - Complete

The plant modifications required to support the FLEX strategies for SGS Unit 1 were implemented in accordance with the station design control process such that the associated systems and components are fully capable of supporting the FLEX strategies.

Equipment – Procurement, Maintenance, and Testing – Complete

The equipment required to implement the FLEX strategies for SGS Unit 1 was procured, received, initially tested and/or performance verified. The availability of FLEX equipment and connection points is administratively controlled by OP-SA-108-115-1001, “Operability Assessment and Equipment Control Program.” Periodic maintenance and testing is being addressed via the PSEG Preventive Maintenance process.

Protected Storage – Complete

The storage facilities required for implementation of the SGS Unit 1 mitigation strategies have been placed within the Owner Controlled Area using the PSEG design change process. The storage configuration addresses all of the hazards identified in NEI 12-06 such that the minimum set of equipment (“N” set) will survive any of the external events associated with the applicable NEI 12-06 hazards.

Procedures – Complete

FLEX Support Guidelines (FSGs) for SGS Unit 1 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 PSEG procedure control process.

Training – Complete

Training for SGS Unit 1 has been completed in accordance with an accepted training process, as recommended in NEI 12-06, Section 11.6.

Staffing – Complete

PSEG completed the SGS staffing assessment (Reference 15) in response to the NRC staff 10 CFR 50.54(f) information request dated March 12, 2012 (Reference 16). Administratively controlled minimum shift staffing levels are sufficient to implement multi-unit mitigation strategies. The NRC staff concluded that the staffing assessment adequately addresses the SGS response strategies (Reference 17).

National SAFER Response Center – Complete

PSEG 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 PSEG with Phase 3 equipment stored in the National SAFER Response Centers in accordance with PSEG Vendor Technical Document (VTD) 903060, Volume 1, “Salem Generating Station SAFER Response Plan.”

Validation - Complete

PSEG performed validation in accordance with industry-developed guidance (Reference 18) to assure required tasks, manual actions, and decisions for the SGS Unit 1 FLEX strategies are feasible and may be executed within the time constraints identified in the enclosed FIP.

FLEX Program Document - Established

The SGS FLEX overall program document has been developed in accordance with the requirements of NEI 12-06, and has been approved in accordance with PSEG’s document control process.

5 REFERENCES

1. PSEG letter LR-N13-0034, "PSEG Nuclear LLC's Overall Integrated Plan for the Salem Generating Station in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)," dated February 28, 2013
2. NRC Order Number EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events," dated March 12, 2012
3. PSEG Letter LR-N13-0175, "PSEG Nuclear LLC's First Six-Month Status Report for the Salem Generating Station in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)," dated August 25, 2013
4. PSEG Letter LR-N14-0027, "PSEG Nuclear LLC's Second Six-Month Status Report for the Salem Generating Station in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)," dated February 25, 2014
5. PSEG Letter LR-N14-0187, "PSEG Nuclear LLC's Third Six-Month Status Report for the Salem Generating Station in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)," dated August 26, 2014
6. PSEG Letter LR-N15-0023, "PSEG Nuclear LLC's Fourth Six-Month Status Report for the Salem Generating Station in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)," dated February 18, 2015
7. PSEG Letter LR-N15-0168, "PSEG Nuclear LLC's Fifth Six-Month Status Report for the Salem Generating Station in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)," dated August 26, 2015
8. PSEG Letter LR-N16-0043, "PSEG Nuclear LLC's Sixth Six-Month Status Report for the Salem Generating Station in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)," dated February 29, 2016
9. Nuclear Energy Institute (NEI) Report NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0, dated August 2012

10. PSEG Letter LR-N14-0173, “PSEG Nuclear LLC's Request for Relaxation from NRC Order EA-12-049, ‘Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events’ - Salem Generating Station Unit 1,” dated July 31, 2014

11. NRC Letter, “Salem Nuclear Generating Station, Unit No. 1 - Relaxation of the Schedule Requirements for Order EA-12-049 ‘Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events,’" dated September 15, 2014

12. 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

13. NRC letter, “Salem Nuclear Generating Station, Unit Nos. 1 and 2 – Interim Staff Evaluation and Audit Report Relating to Overall Integrated Plan in Response to Order EA-12-049 (Mitigation Strategies) (TAC Nos. MF0868 and MF0869),” dated January 24, 2014

14. NRC Letter, “Salem Nuclear Generating Station, Unit Nos. 1 and 2 - 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 (TAC Nos. MF0868, MF0869, MF0913, and MF0914),” dated October 10, 2014

15. PSEG letter LR-N14-0141, “Salem Generating Station’s Response to March 12, 2012, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, Enclosure 5, Recommendation 9.3, Emergency Preparedness – Staffing, Requested Information Items 1, 2, and 6 - Phase 2 Staffing Assessment,” dated June 16, 2014

16. US Nuclear Regulatory Commission (NRC) letter, "Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident," dated March 12, 2012

17. NRC letter, “Response Regarding Licensee Phase 2 Staffing Submittals Associated with Near-Term Task Force Recommendation 9.3 Related to the Fukushima Dai-ichi Nuclear Power Plant Accident (TAC Nos. MF4310, MF4311, MF4312, MF4313, MF4321, MF4322, MF4323, MF4324, MF4325, MF4326, and MF4327)," dated September 29, 2014

18. NEI letter APC-14-17, “Validation Document for FLEX Strategies,” dated July 18, 2014

Attachment 2

Salem Generating Station Units 1 and 2 Response to NRC FLEX Audit Items

SGS Units 1 and 2 Response to NRC FLEX Audit Items

References for this attachment are identified in Section 3.

1 INTRODUCTION

The NRC staff's initial review and audit of the SGS mitigation strategies is documented in the Interim Staff Evaluation (ISE) dated January 24, 2014 (Reference 1). The ISE identified NRC Generic Concerns, Open Items (OIs), and Confirmatory Items (CIs) for PSEG to address as part of implementation of the requirements of NRC Order EA-12-049 (Reference 2). The NRC staff conducted an on-site audit of the SGS mitigation strategies in August 2014. The audit included a review of the Generic Concerns, OIs, and CIs, and also resulted in additional Audit Questions (AQs) and Safety Evaluation (SE) items. The NRC audit report dated October 10, 2014 (Reference 3) includes a listing of open audit items. Section 2, below, provides responses to the NRC Generic Concerns, open CI, OI, AQ, and SE items, and includes responses to the closed items from the ISE for completeness.

2 SGS UNITS 1 AND 2 RESPONSE TO NRC FLEX AUDIT ITEMS

2.1. Generic Concern – Battery Life

Item Description

SGS is currently working on extending the battery duty cycle, and is following the industry position on battery life as outlined in the Nuclear Energy Institute (NEI) white paper dated August 27, 2013 (Reference 4) and endorsed by NRC via letter to NEI dated September 16, 2013 (Reference 5).

SGS Units 1 and 2 Response

Battery coping calculations ES-3.005, "28 VDC Beyond Design Base Event Battery Sizing Calculation," and ES-4.008, "125 VDC Salem BDBEE Battery Sizing Calculation," have been satisfactorily completed using the NRC-endorsed white paper. The calculations show that the deep load shedding strategy will provide at least six hours of battery life without charging. PSEG provided these calculations to the NRC staff as part of the audit process.

2.2. Generic Concern – MAAP

Item Description

SGS is using the Modular Accident Analysis Program (MAAP) to complete the development of FLEX timelines and strategies, consistent with the NRC endorsement letter to NEI dated October 3, 2013 (Reference 7).

SGS Units 1 and 2 Response

PSEG performed MAAP analyses of the containment response to an Extended Loss of AC Power (ELAP) event for SGS, consistent with the NRC endorsement letter to NEI (Reference 7). The results of the MAAP analyses were provided to the NRC staff as part of the audit process, in response to CI 3.2.3.A and CI 3.2.3.B (Items 2.26 and 2.27, below).

2.3. Generic Concern and SE #10 – Shutdown / Refueling Modes

Item Description

SGS will enhance shutdown risk processes and procedures using the supplemental guidance provided in the NEI position paper entitled “Shutdown / Refueling Modes,” dated September 18, 2013 (Reference 8) and endorsed by the NRC via letter to NEI dated September 30, 2013 (Reference 9). NRC audit item SE #10 is for PSEG to provide the revised shutdown risk processes and procedures.

SGS Units 1 and 2 Response

PSEG revised SGS procedures to enhance shutdown risk processes and procedures consistent with the NRC-endorsed guidance (References 8 and 9). The following procedures and guidance documents have been revised and provided to the NRC staff as part of the audit process:

- OP-SA-108-115-1001, “Operability Assessment and Equipment Control Program”

- OU-AA-103, “Shutdown Safety Management Program”
- OU-SA-105, “Shutdown Safety Management Program - Salem Annex”

- S1/S2.OP-AB.RHR-0001, “Loss of RHR”
- S1/S2.OP-AB.RHR-0002, “Loss of RHR at Reduced Inventory”
- S1/S2.OP-AB.LOOP-0001, “Loss of Off-Site Power”
- S1/S2.OP-AB.FUEL-0002, “Loss of Refueling Cavity or Spent Fuel Pool Level”
- S1/S2.OP-AB.SF-0001, “Loss of Spent Fuel Cooling”

2.4. Generic Concern and SE #11 – Preventive Maintenance (PM)

Item Description

As part of the development of FLEX maintenance and testing programs, SGS will use the EPRI Technical Report entitled “Nuclear Maintenance Applications Center: Preventative Maintenance Basis for FLEX Equipment,” transmitted to NRC via NEI letter dated October 3, 2013 (Reference 10) and endorsed by NRC letter dated

October 7, 2013 (Reference 11). NRC audit report item SE #11 is for PSEG to provide the FLEX maintenance and testing program.

<u>SGS Units 1 and 2 Response</u>

PSEG identified the FLEX equipment PM activities using the NRC-endorsed EPRI guidance, EPRI or PSEG templates appropriate for the equipment, and vendor recommendations. These activities are tracked and implemented using PSEG's PM process and are retrievable via the SAP work management system.

2.5. Generic Concern and OI 3.2.1.8.A – Core Sub-criticality

<u>Item Description</u>

Core Sub-Criticality - The Pressurized Water Reactor Owners Group (PWROG) submitted to NRC a position paper, dated August 15, 2013, via Reference 12, which provides test data regarding boric acid mixing under single-phase natural circulation conditions and outlined applicability conditions intended to ensure that boric acid addition and mixing would occur under conditions similar to those for which boric acid mixing data is available. The licensee should address the clarifications in the NRC endorsement letter dated January 8, 2014 (Reference 13). The NRC audit report (Reference 3) requests completion of the Emergency Operating Procedure (EOP) setpoint calculations and a determination of how much RCP seal leakage must be considered in the ELAP analyses.

<u>SGS Units 1 and 2 Response</u>

PSEG responded to this item via SAP Order Operation 80108711-0080 as part of the audit process. Transmittal of Design Information (TODI) NFS 14-106 provided the EOP setpoint V.08 value of 12 hours, which is the latest time after reactor trip / start of ELAP for initiation of borated makeup to ensure core subcriticality. This setpoint was determined using the NRC-endorsed PWROG position paper on boron mixing (References 12 and 13). The setpoint calculation assumed conservative End of Life (EOL) core conditions, an initial cooldown to 420 degrees F, and the conservative assumption of no RCP seal leakage. The V.08 setpoint also accounts for a one-hour boron mixing time. The setpoint of 12 hours occurs prior to the onset of reflux cooling.

In order to address core subcriticality during an ELAP with RCP seal leakage, PSEG performed Technical Evaluation 80111831-0210, and provided it to the NRC staff as part of the audit process, in response to AQ-34 (Item 2.46, below). The evaluation uses SGS-specific RCP seal leakage rates calculated by Westinghouse, accounting for the installation of flow restricting orifices in the RCP seal leakoff lines during the fall 2015 (Unit 2) and spring 2016 (Unit 1) refueling outages. Technical Evaluation 80111831-0210 concludes that the boric acid storage tanks and one FLEX boron mixing tank are capable of providing sufficient boron to establish the required boron concentration at 10.3 hours following the ELAP. The FLEX boron mixing tank can produce sufficient boron to make up for leakage indefinitely.

2.6. OI 3.2.4.7.A - Water Sources

Item Description

The licensee appears to use a probability approach to reach a conclusion that at least one of the three tanks depended on for SG makeup will survive an ELAP event. NEI 12-06 (Reference 6) guidance does not give probability as an option. The licensee should determine if a water supply would be available after a tornado event by analyzing the tornado characteristics for the site compared to the separation characteristics of the tanks. This is an alternate approach from the strategies identified in NEI 12-06. The NRC audit report (Reference 3) states that if the separation approach is used, the Hope Creek fire water cross connect valve needs to be protected to survive a tornado, and requests that the actions to switch to an alternate water supply be shown to be completed prior to Reactor Coolant System (RCS) heatup due to steam generator dryout.

SGS Units 1 and 2 Response

PSEG Vendor Technical Document VTD 903078 Revision 2, “FLEX Water Storage Tornado Wind Hazard Evaluation,” provides a basis for adequate separation of the SGS Auxiliary Feedwater (AFW) Storage Tanks and the Hope Creek Generating Station (HCGS) Fire Water Tanks, based on a conservative plant-specific tornado evaluation. VTD 903078 concludes that the probability of a tornado damaging multiple AFW water sources is on the same order as the 10^{-6} occurrences per year conservative estimate acceptance limit used for man-made hazard accidents resulting in radiological release (i.e., 2.038×10^{-6} occurrences per year to damage both the AFW Storage Tanks and the HCGS Fire Water Tanks).

Because SGS is using the separation option to demonstrate adequacy of water sources, resolution of this item also required the replacement of the HCGS fire protection cross tie valve post indicator (valve operator) with a curb box design to improve missile protection. The cross-tie pipe has an underground isolation valve at the interface to each station's system. The SGS valve (1FP-30) is located under a curb box and operated with a valve key. The HCGS valve (0-KC-V-115) had an above ground post indicator as the valve operator. In order to decrease tornado vulnerability of the HCGS valve, the post indicator was replaced with a curb box design similar to the SGS valve, as part of Design Change Package (DCP) 80111494, “Salem FLEX Generator Deployment (Canyon).”

Time validation of the ability to establish the HCGS fire protection water supply to the SGS turbine-driven AFW pumps prior to RCS heatup due to SG dryout is included in

VTD 903021, "Response to Beyond Design Basis External Events FLEX Validation Document Based on NEI 12-06 Methodology Salem Generating Station."

VTD 903078 and VTD 903021 have been provided to the NRC staff as part of the audit process.

2.7. CI 3.1.1.1.A - Protection of FLEX Equipment Including FLEX Diesel Generators (DGs)

Item Description

The licensee needs to finalize its evaluation of the use of the SGS auxiliary building and the use of the Hope Creek Generating Station, Unit 2 reactor building for permanent FLEX equipment storage.

SGS Units 1 and 2 Response

This item has been closed as part of the audit process. PSEG finalized the FLEX storage locations, including the use of alternatives to NEI 12-06 (Reference 6), as summarized in the most recent six-month status report (Reference 14).

2.8. CI 3.1.1.2.A - Deployment of FLEX Equipment

Item Description

The licensee should complete a review of deployment routes between the proposed equipment storage locations and the areas the equipment will be moved to and evaluate the potential for soil liquefaction.

SGS Units 1 and 2 Response

This item was addressed in the February 2014, six-month status report (Reference 15) and closed during the on-site NRC audit. The response is repeated below for convenience.

Liquefaction of the uppermost and recent geologic age site layered sediments, beyond the areas of safety related structures, could possibly occur during the seismic event; but it is expected that the material's behavior as a liquid would cease following the earthquake and would revert to a stiffness and strength needed to accommodate equipment movement onsite. In the event pathways or roadways are damaged, alternate travel routes around the potentially undermined surfaces would be implemented. In addition, Phase 3 equipment can be transported to the site via helicopter.

2.9. CI 3.1.1.2.B - Deployment of FLEX Equipment

Item Description

The licensee does not state that the Nuclear Service Water Connections will be protected from seismic events. Confirm that this is ensured.

SGS Units 1 and 2 Response

Discharge hoses will be routed from the diesel engine-driven FLEX Service Water (SW) pump discharge to a primary connection on the SW test header or to an alternate connection within the missile-protected Service Water Intake Structure (SWIS) in SW Bays 2 and 3, that can supply the SW nuclear headers. The SW connections are seismically robust.

2.10. CI 3.1.1.3.B - Procedural Interfaces - Seismic Hazard

Item Description

The licensee's integrated plan did not provide any information on: 1) non-robust internal flooding sources that do not require AC power; 2) the use of AC power to mitigate ground water in critical locations.

SGS Units 1 and 2 Response

To address the potential for seismically induced internal flooding hazards, PSEG reviewed large internal flooding sources that are not seismically robust and do not require AC power, e.g., gravity drainage from lakes or cooling basins for non-safety-related cooling water systems (NEI 12-06, Section 5.3.3). There are no internal flooding sources of this type that are within the SGS flood protected boundary. FLEX equipment storage locations outside of flood-protected structures were evaluated for the potential impact of failure of large, non-seismic tanks. The largest non-seismic tanks are the two demineralized water storage tanks (DWSTs), each with a 500,000 gallon capacity. The DWSTs are greater than 400 feet away from the closest outdoor FLEX equipment storage area. Significant open areas exist between the storage sites and non-seismic tanks. Due to the distances and intervening structures, it is unlikely that significant flooding and equipment damage will occur to equipment at the storage locations.

The SGS FLEX strategy does not rely on AC power for ground water mitigation within the plant flood protected areas. For a hurricane event, dewatering pumps to remove accumulated rainwater from the Canyon Area (outdoor area between the SGS Unit 2 Fuel Handling Building and Auxiliary Building) will be powered by the FLEX DG or station power (if available).

2.11. CI 3.1.1.4.A - Considerations in Using Offsite Resources - Seismic Hazard - Flooding Hazard - High Winds Hazard - Snow, Ice and Extreme Cold Hazard

Item Description

Equipment staging areas for deployment of offsite equipment from SAFER will be finalized in a future 6 month update.

SGS Units 1 and 2 Response

PSEG finalized the equipment staging areas as described in Vendor Technical Document (VTD) 903060 Volume 1, "SAFER Response Plan for Salem Generating Station," and EM-SA-100-1000, "Response to Beyond Design Basis External Events Program Document Salem Generating Station." These documents have been provided to the NRC staff as part of the audit process.

Onsite Staging Area "B" at the northeast corner of the site is a minimum of 350' x 250', which is large enough to accommodate the on-site staging area required by SAFER for SGS and HCGS. The area would be utilized at approximately 20 to 24 hours after the initiating event and notification to the offsite organization (SAFER). By this time, additional personnel utilizing the debris removal equipment would be capable of restoring the on-site staging and deployment areas and routes to a usable status. This would include, if required, grading the soil after a seismic event, removal of snow and ice, and removal of debris after a flooding or high wind event. SAFER equipment is designed to be able to operate under extreme cold conditions.

2.12. CI 3.1.2.2.A - Deployment of FLEX Equipment - Flooding Hazard

Item Description

Finalization of proposed changes to the deployment of FLEX equipment during a hurricane induced flooding condition will be provided in a future 6 month update.

SGS Units 1 and 2 Response

This item was closed to SE #6 (Item 2.42, below) as part of the audit process.

2.13. CI 3.1.4.2.A - Deployment of FLEX Equipment - Flooding Hazard

Item Description

The licensee should address the formation of frazil ice and means to cope with it.

SGS Units 1 and 2 Response

This item was closed as part of the audit process. Suction hoses will be placed in the river and water will be drawn through strainers to limit pump damage and blockage from debris and frazil ice.

2.14. CI 3.1.4.2.B – Deployment of FLEX Equipment – Snow, Ice and Extreme Cold Hazards

Item Description

The licensee should address manual operations required by plant personnel during periods of snow, ice, and extreme cold hazards.

SGS Units 1 and 2 Response

This item was closed as part of the audit process. PSEG integrated the FLEX capabilities into existing site cold weather procedures and established periodic FLEX equipment status checks that include diesel keep warm systems and verification that access to equipment is not impaired by snow or ice. The following procedures were revised to support outdoor FLEX equipment operational functionality and deployment during periods of cold weather including snow and ice:

- OP-AA-108-111-1001, “Severe Weather and Natural Disaster Guidelines”
- SC.OP-PT.ZZ-0002, “Station Preparations for Seasonal Conditions”
- SC.OP-PM.FLX-0001, “FLEX Standby Equipment Status Checks”
- MA-AA-716-002-1002, “Facilities Maintenance Guidelines”

2.15. CI 3.1.5.2.A - Deployment of FLEX Equipment - High Temperature Hazard

Item Description

The licensee should confirm that there is no need for backup ventilation with respect to protection of FLEX equipment during high temperature hazards and what the impacts of high temperature hazards would be on the deployment of the FLEX equipment in such conditions.

SGS Units 1 and 2 Response

This item was closed during the audit process based on walkdowns and the use of air-cooled FLEX equipment. CI 3.2.4.2.C (Item 2.30, below) provides additional information regarding GOTHIC analyses of temperatures in plant areas during an ELAP.

2.16. CI 3.1.5.3.A – Procedural Interfaces – High temperature Hazard

Item Description

The licensee should specify the peak temperature for which FLEX equipment would be expected to operate.

SGS Units 1 and 2 Response

This item was closed during the audit process based on equipment being procured to operate in expected temperatures. CI 3.2.4.2.C (Item 2.30, below) provides additional information regarding GOTHIC analyses of temperatures in plant areas during an ELAP.

2.17. CI 3.2.1.A - RCS Cooling and Heat Removal, and RCS Inventory Control Strategies

Item Description

The licensee should specify which analysis performed in WCAP-17601-P (Reference 16) is applicable to SGS and justify the use of that analysis by identifying and evaluating the important parameters and assumptions demonstrating that they are representative of SGS and appropriate for simulating the ELAP transient.

The NRC audit report (Reference 3) identifies the licensee input needed regarding applicability of WCAP-17601-P to SGS:

> “Demonstrate how the Salem RCP seal leakage rate will meet the rate assumed in Section 5.2 (of WCAP-17601-P). Also, update the ELAP

parameters comparison to show the Salem SG PORVs steam flow rate in percent of full power steam flow."

SGS Units 1 and 2 Response

PSEG provided a revised ELAP parameters comparison table as part of the audit process. Revision 2 of the table reflects the plant-specific calculation of RCP seal leakage which is currently used as the basis for the SGS FLEX strategy in lieu of the WCAP-17601-P values. The plant-specific RCP seal leakage flow rates at 2250 psia (14.5 gpm per pump) and 1500 psia (15.2 gpm per pump) are lower than the WCAP-17601-P peak flow rate of 21 gpm per pump that was used in the initial development of the SGS FLEX strategy.

Revision 2 of the ELAP parameters comparison table also provides SGS Steam Generator Power-operated Relief Valve (SG PORV) (MS10 valve) steam flow rate in percent of full power steam flow, i.e., four SG PORVs with a combined capacity of 10% of full power steam flow.

2.18. CI 3.2.1.1.A and SE #5 - Computer Code Used for ELAP Analysis

Item Description

Reliance on the NOTRUMP code for the ELAP analysis of Westinghouse plants is limited to the flow conditions prior to reflux condensation initiation. Verify that the code is not used beyond these flow conditions. This includes specifying an acceptable definition for the onset of reflux condensation cooling. NRC audit item SE #5 pertains to resolution of differences between NOTRUMP and NRC simulations of an ELAP using the TRACE code.

SGS Units 1 and 2 Response

PSEG provided a response to the NRC's position on the use of NOTRUMP (Reference 17) as part of the audit process. The use of NOTRUMP as it applies to the SGS FLEX strategy is limited to the flow conditions prior to initiation of reflux cooling. The onset of reflux cooling is considered to occur when the one-hour centered moving average of the steam generator U-bend flow quality has increased to a value of 0.1 in any one loop. This definition of reflux cooling is consistent with the NRC staff's letter to the PWROG (Reference 17) regarding the use of NOTRUMP and the PWROG-14027-P (Reference 18) scaling methodology to evaluate ELAP events. Reflux cooling precedes core uncovery during an ELAP scenario and prevention of reflux cooling is a conservative means of demonstrating adequate core cooling via the FLEX strategies, e.g., as shown in WCAP-17601-P (Reference 16).

2.19. CI 3.2.1.1.B and SE #9 - Computer Code Used for ELAP Analysis

Item Description

The licensee utilized the existing analyses in WCAP-17601-P (Reference 16) to develop its sequence of events and time constraints. The licensee will validate the response times at a future time. NRC audit item SE #9 is for PSEG to provide validation and verification procedures which also address human factors concerns.

SGS Units 1 and 2 Response

PSEG revised the timelines using plant-specific evaluations that include resolution of RCP seal leakage issues, and performed timeline validation documented in Vendor Technical Document VTD 903021, "Response to Beyond Design Basis External Events FLEX Validation Document Based on NEI 12-06 Methodology Salem Generating Station." VTD 903021 uses NEI guidance (Reference 19) with consideration of human factors and has been provided to the NRC staff as part of the audit process.

2.20. CI 3.2.1.2.A and SE #2 - Reactor Coolant Pump Seal Leakage Rates

Item Description

Confirm that the RCP seal initial maximum leakage rate used in the analysis is greater than or equal to the upper bound expectation for the ELAP event (21 gpm/seal) discussed in the PWROG white paper addressing the RCP seal leakage for Westinghouse plants. NRC audit item SE #2 pertains to higher than expected leakage rates identified by Westinghouse.

SGS Units 1 and 2 Response

PSEG installed ¼-inch diameter flow restricting orifices in the SGS Units 1 and 2 RCP seal leakoff lines, via Design Change Package (DCP) 80112920 and 80112919, respectively. The generic leakage rate of 21 gpm per pump originally used to develop the SGS FLEX strategy has been superseded by a Westinghouse calculation of plant-specific leakage based on the installation of the orifices. PSEG provided a response to this item as part of the audit process. A margin assessment to address leakage rate uncertainty based on plant specific attributes of the SGS FLEX strategies is summarized below.

RCS Cooldown - The SGS FLEX timeline assumes the initial RCS cooldown is initiated within two hours of an ELAP, consistent with generic Westinghouse assumptions. VTD 903021, "Response to Beyond Design Basis External Events FLEX Validation Document Based on NEI 12-06 Methodology Salem Generating Station," shows a margin of 30 minutes based on time validation.

RCS Makeup Time - PSEG Technical Evaluation 80111831-0220 uses the methodology of PWROG-14027-P (Reference 18) to determine a plant-specific time to reflux cooling of approximately 17.4 hours. The time to reach reflux cooling conditions provides significant margin with respect to the SGS FLEX timeline value of eight hours to begin RCS injection. In addition, actual times for RCS makeup would depend on the scenario that results in the ELAP, with eight hours considered to be a maximum value. SGS can allocate resources in response to low level as indicated by Reactor Vessel Level Instrumentation (RVLIS) or Pressurizer level. FLEX Support Guideline S1/S2.OP-FS.FLX-0001 “Long Term RCS Inventory Control” (FSG-1) has a caution statement to reallocate resources to implement the FSG-1 RCS makeup strategy immediately if RVLIS level is <74%.

Boration Sources and Makeup Capacity - The boric acid storage tanks (BASTs) and FLEX boric acid mixing tank are capable of producing sufficient boron to establish the required shutdown margin before the EOP setpoint V.08 maximum time of 12 hours to initiate boration following reactor trip, and maintain subcriticality indefinitely. FLEX Charging Pump capacity of 56 gpm at high pressures is greater than the 40 gpm capacity recommended for a four-loop Westinghouse plant by WCAP-17601-P.

PSEG reduced SGS RCP seal leakage during an ELAP via installation of flow restricting orifices. The resulting plant-specific calculated flow rates at 2250 psia (14.5 gpm per pump) and the peak value at 1500 psia (15.2 gpm per pump) are lower than the generic WCAP-17601-P peak flow rate of 21 gpm per pump. The plant-specific leakage rates and FLEX capabilities provide margin to accommodate uncertainty in calculated leakage rates.

2.21. CI 3.2.1.2.B - Reactor Coolant Pump Seal Leakage Rates

Item Description

In some plant designs, such as those with 1200 to 1300 psia SG design pressures and no accumulator backing of the main steam system power-operated relief valve actuators, the cold legs could experience temperatures as high as 580^{o}F before cooldown commences. This is beyond the 550^{o}F qualification temperature of the O-rings used in the RCP seals. For those Westinghouse designs, a discussion of the information (including the applicable analysis and relevant seal leakage testing data) should be provided to justify that (1) the integrity of the associated O-rings will be maintained at the temperature conditions experienced during the ELAP event, and (2) the seal leakage rate of 21 gpm/seal used in the ELAP is adequate and acceptable.

SGS Units 1 and 2 Response

PSEG provided a response to the NRC staff as part of the audit process, based on design changes to install four high pressure nitrogen bottles per SG PORV (MS10 valve) via DCPs 80110341 and 80110419 for Units 1 and 2 respectively. The backup nitrogen bottles permit automatic or manual operation of each valve from the main control room. This will support the FLEX strategy of performing a symmetrical RCS cooldown beginning at 2 hours following the ELAP (T+2 hours) and completing the initial cooldown at T+4 hours. With the enhanced capability to control SG pressure (and therefore RCS temperature) using the nitrogen-backed SG PORVs, the RCP seal package components would be expected to perform as designed during the ELAP event.

2.22. CI 3.2.1.5.A - Monitoring Instrumentation and Controls

Item Description

The review identified a concern with the level of accuracy of the FLEX instrumentation to ensure that electrical equipment remains protected (from an electrical standpoint, e.g., power fluctuations) and with the ability of this instrumentation to provide operators with accurate information ensure the maintenance of core cooling, containment, and spent fuel cooling. The licensee should confirm the accuracy of portable equipment instrumentation as it relates to equipment protection and operator information for maintenance of FLEX strategies.

SGS Units 1 and 2 Response

This item was closed during the audit process based on use of instrumentation as described in S1/S2.OP-FS.FLX-0007(Q), “Loss of Vital Instrumentation or Control Power” (FSG-7).

2.23. CI 3.2.1.6.A - Sequence of Events

Item Description

During the NRC audit process the licensee summarizes the changes in its mitigation strategies for Phase 1 and Phase 2. The evaluation for implementing these changes will be communicated in a future 6 month update. The NRC audit report (Reference 3) subsequently stated that the NRC staff reviewed the changes and have no concerns, and requested that the changes be issued on the docket in an update to the Overall Integrated Plan.

SGS Units 1 and 2 Response

The current SGS FLEX strategies are docketed via the enclosed Final Integrated Plan (FIP). Table 3 of the FIP provides the sequence of events timeline.

2.24. CI 3.2.1.9.A - Use of Portable Pumps

Item Description

The Integrated Plan provides a table depicting the FLEX equipment to be deployed and states that the quantity does not reflect the NEI 12-06 spare capability (N+1) guidance. The licensee should specify how many pieces of equipment will be available for an ELAP/Loss of Ultimate Heat Sink (UHS), and this should meet N+1 requirements unless an alternative approach is proposed.

SGS Units 1 and 2 Response

This item was closed during the NRC audit process. Table 1 of the enclosed FIP identifies major Phase 2 FLEX equipment, including equipment shared with Hope Creek Generating Station (HCGS). Section 2.18.6 of the FIP addresses N+1 requirements including use of the NRC-endorsed alternative to NEI 12-06 Revision 0 for hoses and cables.

2.25. CI 3.2.2.A - Spent Fuel Pool Cooling Strategies

Item Description

In the audit and review, the licensee provided additional information regarding the SFP makeup during an ELAP event. It stated that a new 4" FLEX hose is being evaluated as replacement for SFP makeup. This connection would be upstream of 1(2)SF9 and would allow water from SW, AFW, and the FLEX boron mixing tank pump discharges to be aligned for SFP makeup. The proposed connection point is in the Auxiliary Building in the SFP pump area. Additionally, a spray pipe system is being re-evaluated. The licensee should provide details of the final configuration, including flow rates, and this information should be included in a six-month update.

SGS Units 1 and 2 Response

This item was closed during the NRC audit process. The SFP make-up configuration is described in Section 2.4 of the enclosed FIP.

2.26. CI 3.2.3.A – Containment Cooling

Item Description

The licensee committed to perform further containment analysis to demonstrate that containment integrity can be maintained up until a point in time when containment cooling can be restored during Phase 3.

SGS Units 1 and 2 Response

PSEG provided Technical Evaluations of the SGS MAAP containment analyses to the NRC staff as part of the audit process, as follows:

Technical Evaluation 80111831-0030 evaluated containment response to an ELAP during Modes 5 and 6 (Cold Shutdown and Refueling). The Mode 5 and 6 MAAP analysis indicates that containment pressure can be maintained below the design pressure of 47 psig and well below the test pressure of 54 psig using the installed containment vent paths through the personnel airlocks.

Technical Evaluation 80111831-0040 evaluated containment response to an ELAP in Modes 1 through 4 (Power Operation to Hot Shutdown) and concluded that containment pressure can be maintained substantially below the design pressure using only FLEX RCS cooldown via the steam generators. Technical Evaluation 80111831-0041 confirmed that the conclusion of 80111831-0040 remains valid with consideration of plant-specific RCP seal leakage.

2.27. CI 3.2.3.B - Containment Functions Strategies

Item Description

In the audit and review, the licensee stated that SGS plans to use the MAAP analysis to complete the FLEX strategies and timelines. Review these analyses when available.

SGS Units 1 and 2 Response

PSEG provided the Technical Evaluations of the MAAP analyses results as part of the audit process, as summarized above in response to CI 3.2.3.A – Containment Cooling (Item 2.26).

2.28. CI 3.2.4.2.A - Ventilation - Equipment Cooling

Item Description

The licensee has provided insufficient details of the ventilation provided in the battery room to support a conclusion that there is reasonable assurance that the effects of elevated or lowered temperatures in the battery room, especially if the ELAP is due to a high or low temperature hazard, have been considered. Confirm the adequacy of the ventilation provided in the battery room to protect the batteries from the effects of elevated or lowered temperatures.

SGS Units 1 and 2 Response

This item was closed as part of the NRC audit process based on Technical Evaluation 80111831-0020 (high temperature) and 80111831-0080 (low temperature).

2.29. CI 3.2.4.2.B - Ventilation - Equipment Cooling

Item Description

The licensee provided a discussion on how hydrogen concentration in the battery rooms will be mitigated when the batteries are being recharged during Phases 2 and 3. The licensee will provide strategies to repower installed battery room exhaust fans or portable fans for ventilation.

SGS Units 1 and 2 Response

This item was closed during the on-site NRC audit based on the preliminary Phase 2 FLEX strategy to re-energize the battery room exhaust fans prior to placing the batteries on charge. Attachment 1 of S1/S2.OP-FS.FLX-0005, “Initial Assessment and FLEX Equipment Staging” (FSG-5), includes the actions to use FLEX power to re-energize the battery chargers and the battery room exhaust fans. FSG-5 directs the operator to start the exhaust fans after energizing the battery chargers (i.e., the fans are started via the procedure steps immediately following re-energizing the battery chargers).

2.30. CI 3.2.4.2.C - Ventilation - Equipment Cooling

Item Description

The licensee stated that GOTHIC modeling and room heat-up calculations are being developed for plant strategic areas including the TDAFW rooms. The results of the modeling and analyses will be communicated in a future 6 month update.

SGS Units 1 and 2 Response

PSEG completed Technical Evaluation 80111831-0020, "UPDATED - Unit 1 and 2 Evaluation of Salem GOTHIC Results," to document the results of GOTHIC analyses of temperatures during an ELAP, and provided the evaluation to the NRC staff as part of the audit process. The results of the GOTHIC analyses summarized in Technical Evaluation 80111831-0020 show that with the actions listed below, the SGS FLEX strategy can be implemented without impact to equipment or personnel.

1. Opening the TDAFP room door within 30 minutes of an ELAP, and installing a portable fan in the doorway at approximately 10 hours.

2. Restoration of the #11/21 Switchgear and Penetration Area Ventilation, at approximately 24 hours following an ELAP.

3. Restoration of the #12 Control Area Ventilation fan, at approximately 24 hours following an ELAP. NOTE - #22 Control Area Fan is not required since the Control Room Envelope is a common area.

Technical Evaluation 80111831-0020 also assumes a Fuel Handling Building exhaust fan is re-energized to provide a vent path from the SFP area. This is performed using S1/S2.OP-FS.FLX-0005, "Initial Assessment and FLEX Equipment Staging."

2.31. CI 3.2.4.4.A – Communications

Item Description

Confirm that upgrades to the site's communications systems have been completed.

SGS Units 1 and 2 Response

This item was closed as part of the NRC audit process, based on review of Design Change Package (DCP) 80110936, "Salem Communications Upgrade," and related equipment enhancements.

2.32. CI 3.2.4.6.A - Personnel Habitability - Elevated Temperature

Item Description

Confirm the maximum environmental room temperatures at ELAP coping periods greater than the 4-hours assumed in NUMARC 87-00, and confirm that measures are in place to ensure personnel habitability, as needed.

SGS Units 1 and 2 Response

This item is addressed by Technical Evaluation 80111831-0020, “UPDATED - Unit 1 and 2 Evaluation of Salem GOTHIC Results,” which was provided to the NRC staff as part of the audit process. The results of Technical Evaluation 80111831-0020 are described in response to CI 3.2.4.2.C - Ventilation - Equipment Cooling (Item 2.30, above).

2.33. CI 3.2.4.6.B - Personnel Habitability

Item Description

The licensee stated that formal analyses would be performed to support the initial actions taken to provide cooling for the MCR until Phase 2 actions can be implemented. The results of the modeling and analyses will be communicated in a future 6 month update.

SGS Units 1 and 2 Response

This item is addressed by Technical Evaluation 80111831-0020, “UPDATED - Unit 1 and 2 Evaluation of Salem GOTHIC Results,” which was provided to the NRC staff as part of the audit process. The results of Technical Evaluation 80111831-0020 are described in response to CI 3.2.4.2.C - Ventilation - Equipment Cooling (Item 2.30, above).

2.34. CI 3.2.4.8.A - Electrical Power Sources/Isolations and Interactions

Item Description

The licensee stated that diesel generator sizing calculations are in progress. The results will be communicated in a future six-month update.

SGS Units 1 and 2 Response

PSEG Calculation ES-15.019, “FLEX Electrical System Analysis – Salem 1 and 2,” has been provided to the NRC staff as part of the audit process (text only) and demonstrates that the Phase 2 480 VAC and Phase 3 4160 VAC FLEX Diesel Generators (DGs) are appropriately sized to support the FLEX strategies.

2.35. CI 3.2.4.8.B - Electrical Power Sources/Isolations and Interactions

Item Description

The licensee discussed use of electrical equipment such as 480 VAC DG Power Distribution, 480 VAC "A" Vital Bus, 230 VAC DG Power Distribution, associated cablings and connectors. Confirm that electrical isolation will be maintained such that (a) Class 1E equipment is protected from faults in portable/FLEX electrical equipment and (b) multiple sources do not attempt to power electrical buses.

SGS Units 1 and 2 Response

PSEG Calculation ES-15.019, “FLEX Electrical System Analysis – Salem 1 and 2,” has been provided to the NRC staff as part of the audit process (text only) and addresses protective device selection and coordination.

2.36. CI 3.2.4.8.C – Minimum DC Bus Voltage

Item Description

Confirm the analyses address the minimum voltage that must be maintained on the dc buses and its basis.

SGS Units 1 and 2 Response

Battery coping calculations ES-3.005, “28 VDC Beyond Design Base Event Battery Sizing Calculation” and ES-4.008, “125 VDC Salem BDBEE Battery Sizing Calculation” address the battery voltages to support the FLEX strategies and have been provided to the NRC staff as part of the audit process.

2.37. CI 3.2.4.9.A - Portable Equipment Fuel

Item Description

Confirm that sufficient fuel is available considering the fuel consumption rate for each FLEX piece of equipment.

SGS Units 1 and 2 Response

This item was closed as part of the audit process. Technical Evaluation 80111831-0060, “Evaluation of FLEX Portable Equipment Fuel Usage Against NEI 12-06 Requirements,” has been provided to the NRC staff and concludes that installed sources of fuel can supply FLEX equipment for approximately five days after an ELAP, after which offsite resources are assumed available to resupply the diesel fuel oil.

2.38. CI 3.2.4.10.A - Load Reduction to Conserve DC Power

Item Description

The licensee should describe the results of the final battery load shed analyses, including which functions are lost, plant components that will change state, and the effects of components changing state.

SGS Units 1 and 2 Response

This item is addressed by Technical Evaluations 80111831-0050, “Salem Unit 1 ELAP DC Coping Analysis” and 80111831-0051, “Salem Unit 2 ELAP DC Coping Analysis,” which have been provided to the NRC staff as part of the audit process. The Technical Evaluations reviewed loads de-energized during the deep load shed to preserve 28 V and 125 V battery life. The evaluation concluded that the load shed would not cause conditions that would prevent implementation of the FLEX Phase 1 or Phase 2 strategies, and that equipment required to implement the Phase 1 or Phase 2 strategies would be available when required.

2.39. CI 3.3.2.A - Configuration Control

Item Description

The licensee should provide the single line diagrams of the proposed electrical systems. As part of this item the NRC audit report (Reference 3) requested PSEG to address potential personnel hazards regarding the orientation of disconnecting blades in the FLEX power receptacles.

SGS Units 1 and 2 Response

PSEG provided the single line diagrams as part of the audit process, and they are included in the enclosed FIP. PSEG provided the following information in response to the personnel safety aspect of this item:

“The disconnects equipped with receptacles for attaching portable cables are all orientated such that the potential power feed side is wired to the non-blade side of the receptacle. Below is a description of the orientation used.

- If the FLEX bus is the power source, the power cable to the disconnect is wired to the stationary side (non-blade side).
- If the plant bus is energized (normal configuration, no ELAP), the plant equipment is wired to the stationary side (non-blade side) of the disconnect.

The portable cable connections between disconnects are normally wired to the blade side of the disconnect. Portable cables will be installed prior to closing any disconnects (procedurally controlled)."

2.40. CI 3.4.A - Offsite Resources

Item Description

The licensee's Integrated Plan addressed the use of off-site resources to obtain equipment and commodities to sustain and backup the site's coping strategies (NEI 12-06, Section 12.2, Guideline 1). The licensee should provide information on how the plan addresses implementation guidelines 2 through 10.

SGS Unit 2 Response

PSEG provided Vendor Technical Document (VTD) 903060 Volume 1, "SAFER Response Plan for Salem Generating Station," to the NRC staff as part of the audit process. The NRC issued their staff assessment of the National SAFER Response Centers in a letter to NEI dated September 26, 2014 (Reference 20), which concluded that SAFER has taken the appropriate actions to support site responses to a beyond-design-basis external event, and "licensees can reference the SAFER program and implement their SAFER Response Plans to meet the Phase 3 requirements of Order EA-12-049."

2.41. SE #1 - RCS Venting

Item Description

NRC staff needs to complete its review of FSG-8.

SGS Units 1 and 2 Response

PSEG provided draft FLEX Support Guidelines (FSGs) during the on-site audit and has since provided approved FSG's on the e-portal. PSEG assumes that this item is pending NRC approval unless additional PSEG action is requested.

2.42. SE #6 - Permanent Staging of the FLEX Generators in the SGS Unit 2 Canyon (an Alternate to NEI 12-06)

Item Description

Provide an evaluation of the susceptibility to damage for the FLEX generators. Demonstrate that the construction of the canyon wall is viable.

SGS Units 1 and 2 Response

The SGS FLEX strategy uses three 480 V FLEX Diesel Generators (DGs) to provide Phase 2 power for both SGS units, and includes pre-staging of two DGs in the outdoor storage area between the SGS Unit 2 Fuel Handling Building and Auxiliary Building (Canyon Area). The pre-staged DG's are protected from NEI 12-06 external hazards.

As described in the most recent six-month update (Reference 14), SGS is using an alternative to the criteria of NEI 12-06 Section 7.3.1, "Protection of FLEX Equipment," which recommends protection of FLEX equipment from high wind hazards via storage in a structure or in diverse locations. The two pre-staged DGs in the Canyon Area are in the eastern most area of the canyon, surrounded on all four sides by the Fuel Handling Building and Auxiliary Building. FLEX equipment in the Canyon Area, including the DGs, are designed for a site specific wind speed of 200 mph that has an exceedance probability of 10^{-7} for this location.

Design Change Package (DCP) 80111494, Supplement 7, "Salem Generating Station Canyon Area High Wind Hazard FLEX Equipment Storage and Deployment," includes a tornado missile evaluation specifically for the Canyon Area configuration. Based on this evaluation, a 1" solid steel rod traveling at 26 feet/sec is used to design the hardened protection of FLEX equipment and connections located in the sheltered Canyon Area. The FLEX DGs pre-staged in the Canyon Area are hardened to provide protection from this missile impact and are secured to protect against tornado wind speeds. The two FLEX DGs stored outside of the Canyon Area are not missile protected but are separated by 1200 feet or greater to ensure a single tornado does not impact more than one stored FLEX DG. Therefore, at least one of the unprotected FLEX DGs will be available for deployment to the canyon area following a tornado event.

Pre-staging the two FLEX DGs in the Canyon Area is an alternative to NEI 12-06 Revision 0, which describes the use of portable equipment. The FLEX DGs in the Canyon Area are shown in Figure 2 of the enclosed FIP. They are protected from all NEI 12-06 external hazards. The pre-staged FLEX DGs are hardened ("armored" as shown on FIP Figure 2) with missile protection on the top and all sides, and are provided with bracing systems to resist seismic and wind loads.

DCP 80111494, “Salem FLEX Generator Deployment (Canyon),” included the restraint and evaluation of gas bottles stored on the Auxiliary Building roof, to ensure that they would not become tornado missiles.

NEI 12-06 Section 5.3.1(1)(c) states that FLEX equipment may be stored outside a structure provided it is evaluated for seismic interactions to ensure equipment is not damaged by non-seismically robust components or structures. Storing or pre-staging FLEX DGs in the canyon area satisfies the requirements of Section 5.3.1(1)(c). The structures surrounding the canyon area are Seismic I buildings designed to withstand a Safe Shutdown Earthquake. There are no non-seismically robust components or structures positioned to interact with stored FLEX DGs in the Canyon Area.
DCP 80111494 provided bracing systems for the DGs in the Canyon Area to resist seismic and wind loads.

In the event a flood is predicted from a hurricane, two additional DGs (one N and one N+1) will be moved to the Canyon Area and flood protected via a temporary flood barrier (HESCO wall) and de-watering pumps. The feasibility of flood protecting the pre-staged and portable DGs as an anticipatory measure is addressed in Vendor Technical Document VTD 903021, “Response to Beyond Design Basis External Events FLEX Validation Document Based on NEI 12-06 Methodology Salem Generating Station.” DCP 80111494 evaluated the effects of constructing the HESCO wall on SGS structures, systems, and components (i.e., building walls and underground commodities), and determined there is no adverse impact.

2.43. SE #7 - Feeding Steam Generators from the Turbine Building Basement

<u>Item Description</u>

Provide the evaluation and timeline of the ability to pump water from the turbine building basement to the steam generators.

<u>SGS Units 1 and 2 Response</u>

PSEG provided Technical Evaluations 80111831-0120, “Time Required to Flooding the Turbine Building for FLEX Submersible Pump Operation” and 80111831-0130, “Time Required To Fill the Demineralized Water / Auxiliary Feedwater Alternate Piping” to the NRC staff as part of the audit process. These evaluations account for the time for flood water to fill the turbine building basement and the time to fill the demineralized water header using the submersible pumps.

Technical Evaluation 80111831-0120 concludes that sufficient water to support operation of the submersible pumps will flood the turbine building hotwell area within 15 minutes when flood level is greater than two feet above grade. The Auxiliary Feedwater Storage Tanks (AFSTs) are not susceptible to flooding debris impact at less than six feet above grade. The AFSTs are on a pedestal one foot above grade and the bottom five feet of the tanks are filled with concrete.

Technical Evaluation 80111831-0130 calculates that the submersible pumps will fill the Demineralized Water / Auxiliary Feedwater alternate feed line within 15 minutes. Therefore, sufficient time exists to establish an alternate Auxiliary Feedwater supply prior to steam generator dryout. Steam generator dryout occurs at 55 minutes following a loss of feedwater. Validation of the ability to meet the 55 minute time constraint with margin is documented in Vendor Technical Document VTD 903021, “Response to Beyond Design Basis External Events FLEX Validation Document Based on NEI 12-06 Methodology Salem Generating Station.”

2.44. SE #8 - Equipment Habitability for Steam Generator Power-operated Relief Valve Operation

Item Description

Provide the evaluation of the functionality of the SG PORVs.

SGS Units 1 and 2 Response

PSEG provided the evaluation of Steam Generator Power-operated Relief Valve (SG PORV) (MS10 valve) functionality via Technical Evaluation 80111831-0020, “UPDATED - Unit 1 and 2 Evaluation of Salem GOTHIC Results,” as part of the response to CI 3.2.4.2.C, Ventilation - Equipment Cooling (Item 2.30, above). Based on a comparison of GOTHIC temperature results and component data, Technical Evaluation 80111831-0020 concludes that operation of the SG PORVs is not challenged during an ELAP.

2.45. AQ-29 – Decay Heat Curve

Item Description

The NRC staff needs to review the plant-specific auxiliary feedwater storage tank technical evaluation, for water supplies for decay heat removal, which was not completed. Provide the technical evaluation for the AFST usage. Address how AFST volume and other analyses were calculated where decay heat is an input. Was the same ANS model used for these purposes, or were different models used for other applications, and how are they justified?

SGS Units 1 and 2 Response

PSEG provided Technical Evaluation 80111831-0100, “Evaluation of Auxiliary Feedwater Storage Tank (AFST) Capability to Supply Aux Feedwater During ELAP Cooldown,” to the NRC staff as part of the audit process. The decay heat curve used in 80111831-0100 utilizes ANS 5.1-1979 plus two sigma, consistent with assumption 4.2.1(4) in WCAP-17601-P (Reference 16), and the curve incorporates plant-specific parameters and assumes three year full power operation as part of the decay heat calculation. The computation of AFST water consumption in Technical Evaluation 80111831-0100 provides conservative results relative to the generic evaluation presented in WCAP-17601-P.

2.46. AQ-34 – Portable Boron Mixing Tank

Item Description

The NRC staff is looking for an evaluation showing that one 1000 gallon tank will provide sufficient volume to feed both units. Also, if the batch stream is diluted, there is a concern as to how the licensee can measure the flowrate of the pure water stream if there is no power.

SGS Units 1 and 2 Response

PSEG provided Technical Evaluation 80111831-0210, “Salem Response to NRC Mitigating Strategies Audit Question AQ-34, Portable Boron Mixing Tank,” to the NRC staff as part of the audit process. A single 1000 gallon portable boron mixing tank is required to produce concentrated boric acid for both Salem units to restore RCS inventory, make-up for RCS inventory loss due to RCP seal leakage, and maintain shutdown margin. The capability of the portable boron mixing tank combined with the available Boric Acid Storage Tank (BAST) level exceeds the required boric acid inventory to establish and maintain adequate shutdown margin and maintain RCS inventory, ensuring natural circulation flow in the RCS is maintained throughout the event.

The FLEX Charging Pump is a 56 gpm positive displacement pump with a 2-valve suction manifold. Each leg of the manifold contains a flow meter capable of allowing measurement and control of borated and non-borated water sources. The flow meters receive power from the pump skid FLEX power and will provide indication when required.

3 REFERENCES

1. NRC letter, “Salem Nuclear Generating Station, Unit Nos. 1 and 2 – Interim Staff Evaluation and Audit Report Relating to Overall Integrated Plan in Response to Order EA-12-049 (Mitigation Strategies) (TAC Nos. MF0868 and MF0869),” dated January 24, 2014
2. NRC Order Number EA-12-049, “Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events,” dated March 12, 2012

3. NRC Letter to PSEG, “Salem Nuclear Generating Station, Unit Nos. 1 and 2 - 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 (TAC Nos. MF0868, MF0869, MF0913, and MF0914),” dated October 10, 2014
4. NEI letter to NRC, “EA-12-049 Mitigating Strategies Resolution of Extended Battery Duty Cycles Generic Concern,” dated August 27, 2013 (ADAMS Accession No. ML13241A186)
5. NRC letter to NEI, “Battery Life White Paper Endorsement,” dated September 16, 2013 (ADAMS Accession No. ML13241A188)
6. Nuclear Energy Institute (NEI) Report NEI 12-06, “Diverse and Flexible Coping Strategies (FLEX) Implementation Guide,” Revision 0, dated August 2012
7. NRC letter to NEI, “Mitigation Strategies Order EA-12-049, NEI Position Paper: MAAP Endorsement Letter,” dated October 3, 2013 (ADAMS Accession No. ML13275A318)
8. NEI Position Paper, “Shutdown / Refueling Modes,” dated September 18, 2013 (ADAMS Accession No. ML13273A514)
9. NRC letter to NEI, “Endorsement Letter: Mitigation Strategies Order EA-12-049, NEI Position Paper: Shutdown / Refueling Modes,” dated September 30, 2013 (ADAMS Accession No. ML13267A382)
10. NEI letter to NRC, “EA-12-049 Mitigating Strategies Resolution of FLEX Equipment Maintenance and Testing Templates,” dated October 3, 2013 (ADAMS Accession No. ML13276A573)
11. NRC letter to NEI, “Maintenance and Testing Endorsement Letter in Regards to Mitigation Strategies Order EA-12-049,” dated October 7, 2013 (ADAMS Accession No. ML13276A224)
12. Westinghouse proprietary position paper, “Westinghouse Response to NRC Generic Request for Additional Information (RAI) on Boron Mixing in Support of the Pressurized Water Reactor Owners Group (PWROG),” transmitted to NRC via letter dated August 16, 2013 (ADAMS Accession No. ML13235A135)
13. NRC letter to PWROG, “Boron Mixing Endorsement Letter in Regards to Mitigation Strategies Order EA-12-049,” dated January 8, 2014 (ADAMS Accession No. ML13276A183)
14. PSEG Letter LR-N16-0043, “PSEG Nuclear LLC’s Sixth Six-Month Status Report for the Salem Generating Station in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049),” dated February 29, 2016

15. PSEG Letter LR-N14-0027, "PSEG Nuclear LLC's Second Six-Month Status Report for the Salem Generating Station in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)," dated February 25, 2014
16. Westinghouse Report WCAP-17601-P Revision 0, "Reactor Coolant System Response to the Extended Loss of AC Power Event for Westinghouse, Combustion Engineering and Babcock & Wilcox NSSS Designs," dated August 2012
17. NRC letter to PWROG Regarding NOTRUMP dated June 16, 2015 (NRC ADAMS Accession No. ML15061A442)
18. PWROG-14027-P, "No. 1 Seal Flow Rate for Westinghouse Reactor Coolant Pumps Following Loss of All AC Power Task 3: Evaluation of Revised Seal Flow Rate on Time to Enter Reflux Cooling and Time at which the Core Uncovers," Revision 3, April 2015
19. NEI letter APC-14-17, "Validation Document for FLEX Strategies," dated July 18, 2014
20. NRC letter, "Staff Assessment of National SAFER Response Centers Established in Response to Order EA-12-049," dated September 26, 2014 (ADAMS Accession No. ML14265A107)

Enclosure

EM-SA-100-1000 Attachment 1, "Final Integrated Plan – Beyond Design Basis FLEX Mitigating Strategies, Salem Generating Station Units 1 and 2"

Attachment 1 - Final Integrated Plan - Beyond-Design-Basis FLEX Mitigating Strategies, Salem Generating Station Units 1 and 2

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Final Integrated Plan - Beyond Design Basis FLEX Mitigation Strategies
Salem Generating Station Units 1 and 2

1. Background

On March 11, 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 at Units 1 and 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 US Nuclear Regulatory Commission (NRC) assembled the 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 Dai-ichi. The NTTF report (Reference 1) contained many recommendations to fulfill this charter, including assessing extreme external event hazards and strengthening station capabilities for responding to beyond-design-basis external events (BDBEE).

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

1. Licensees shall develop, implement, and maintain guidance and strategies to maintain or restore core cooling, containment, and SFP cooling capabilities following a BDBEE.
2. These strategies must be capable of mitigating a simultaneous loss of all alternating current (ac) power and loss of normal access to the ultimate heat sink 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 requires a three-phase approach for strategies to mitigate BDBEEs:

- Phase 1 - Initially cope relying on installed equipment and onsite resources.
- Phase 2 - Transition from installed plant equipment to onsite BDB equipment.
- Phase 3 - Obtain sufficient offsite resources to sustain functions indefinitely.

NRC Order EA-12-049 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 came first.

The Nuclear Energy Institute (NEI) developed NEI 12-06, Revision 0 (Reference 3), which provided guidelines for nuclear stations to assess extreme external event hazards and implement the mitigation strategies specified in NRC Order EA-12-049. The NRC issued Interim Staff Guidance JLD-ISG-2012-01 (Reference 4), dated August 29, 2012, which endorsed NEI 12-06 with clarifications on determining baseline coping capability and equipment quality. The Salem Generating Station (SGS) FLEX strategies are based on Revision 0 to NEI 12-06 (Reference 3); references to “NEI 12-06” in this document apply to Revision 0 unless specifically indicated otherwise.

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

NEI 12-02 (Reference 6) provided guidance for compliance with Order EA-12-051. The NRC determined that, with the exceptions and clarifications provided in JLD-ISG-2012-03 (Reference 7), conformance with the guidance in NEI 12-02 was an acceptable method for satisfying the requirements in Order EA-12-051. PSEG responded to the NRC staff’s Request for Additional Information (RAI) and affirmed SGS Units 1 and 2 compliance with NRC Order EA-12-051 (References 88 and 89).

2. NRC Order EA-12-049 - Diverse and Flexible Mitigation Capability (FLEX)

2.1 General Elements

2.1.1 *Assumptions*

The assumptions used to develop SGS FLEX strategies to respond to an ELAP with loss of ultimate heat sink (LUHS) event are stated below. These assumptions are consistent with NEI 12-06 (Reference 3), Section 3.2.1, *General Criteria and Baseline Assumptions.*

- The BDBEE occurs impacting all units at the site, including the Hope Creek Generating Station (HCGS).
- Both SGS reactors are initially operating at full power, unless there are procedural requirements to shut down due to an impending event. The reactors have been operating at 100% power for the past 100 days.
- Each reactor is successfully shut down when required (i.e., all rods inserted, no Anticipated Transients Without Scram). Main steam system valves (such as main steam isolation valves, turbine stops, atmospheric dumps, etc.) necessary to maintain decay heat removal upon shutdown

function normally, and reactor coolant system (RCS) overpressure protection valves respond normally, if required by plant conditions, and reseat.

- Onsite staff is at site administrative minimum shift staffing levels.

- No independent, concurrent events, e.g., no active security threat.

- All personnel onsite are available to support site response.

- The reactor and supporting plant equipment are either operating within normal ranges for pressure, temperature and water level, or available to operate, at the time of the event consistent with the design and licensing basis.

The following plant initial conditions and assumptions are established for the purpose of defining FLEX strategies and are consistent with NEI 12-06 Section 3.2.1, *General Criteria and Baseline Assumptions*:

- No specific initiating event is used. The initial condition is assumed to be a loss of offsite power (LOOP) with installed sources of emergency onsite AC power and station blackout (SBO) alternate AC power sources unavailable with no prospect for recovery.

- Cooling and makeup water inventories contained in systems or structures with designs that are robust with respect to seismic events, floods, and high winds and associated missiles are available. Permanent plant equipment that is contained in structures with designs that are robust with respect to seismic events, floods, and high winds and associated missiles, are available. The portion of the fire protection system that is robust with respect to seismic events, floods, and high winds and associated missiles is available as a water source.

- Normal access to the ultimate heat sink is lost, but the water inventory in the ultimate heat sink (UHS) remains available and robust piping connecting the UHS to plant systems remains intact. The motive force for UHS flow, i.e., pumps, is assumed to be lost with no prospect for recovery.

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

- Installed Class 1E electrical distribution systems, including inverters and battery chargers, remain available since they are protected.

- No additional accidents, events, or failures are assumed to occur immediately prior to or during the event, including security events.

- Reactor coolant inventory loss consists of unidentified leakage at the upper limit of Technical Specifications, reactor coolant letdown flow (until isolated), and reactor coolant pump seal leak-off at normal maximum rate.

- For the spent fuel pool, the heat load is assumed to be the maximum design basis heat load. In addition, inventory loss from sloshing during a seismic event does not preclude access to the pool area.

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

- Exceptions for the site security plan or other (license/site specific) requirements of 10CFR may be required.

- Deployment resources are assumed to begin arriving at hour 6 and unlimited resources available after 24 hours.

- This plan defines strategies capable of mitigating a simultaneous loss of all alternating current (AC) power and loss of normal access to the ultimate heat sink resulting from a BDBEE by providing adequate capability to maintain or restore core cooling, containment, and spent fuel pool (SFP) cooling capabilities at all units on a site. 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. Each unit's Emergency Operating Procedures (EOPs) have been revised, in accordance with established EOP change processes, to clearly reference and identify appropriate entry and exit conditions for these pre-planned strategies. Using the EOPs and associated procedures, the Shift Manager retains overall command and control of the actions responding to a BDBEE. Also, the impact of these strategies on the design basis capabilities of the unit have been evaluated under 10 CFR 50.59.

The plant Technical Specifications contain the limiting conditions for normal unit operations to ensure that design safety features are available to respond to a design basis accident and direct the required actions to be taken when the limiting conditions are not met. The result of the BDBEE may place the plant in a condition where it cannot comply with certain Technical Specifications and/or with its Security Plan, and, as such, may warrant invocation of 10 CFR 50.54(x) and/or 10 CFR 73.55(p).

2.2 STRATEGIES

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 spent fuel pool (SFP) using installed equipment, onsite FLEX equipment, and pre-staged offsite resources. This indefinite coping capability will address an ELAP (loss of offsite 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 normal access to the ultimate heat sink (LUHS). This situation could arise starting with external events that are within the existing design basis followed by additional failures or conditions that exceed design basis assumptions.

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 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 and onsite resources.
- Phase 2 - Transition from installed plant equipment to onsite BDB equipment.
- Phase 3 - Obtain additional capability and redundancy from offsite equipment until power, water, and coolant injection systems are restored.

The duration of each phase is specific to the installed and portable equipment utilized for the particular FLEX strategy employed to mitigate the plant condition.

The FLEX strategies described below are capable of mitigating an ELAP/LUHS resulting from a BDBEE by providing adequate capability to maintain or restore core cooling, containment, and SFP cooling capabilities at both units at SGS. Though specific strategies have been developed, due to the inability to anticipate all possible scenarios, the FLEX strategies are also diverse and flexible to encompass a wide range of possible conditions. These pre-planned strategies which have been developed to protect the public health and safety are incorporated into the SGS Emergency Operating Procedures (EOPs) in accordance with established EOP change processes, and their impact to the design basis capabilities of the unit evaluated under 10 CFR 50.59.

An overall diagram of the following FLEX strategies showing the connections is provided in Figure 1.

2.3 REACTOR CORE COOLING STRATEGY

Reactor core cooling involves the removal of decay heat through the secondary side of the Nuclear Steam Supply System (NSSS) and maintaining sufficient RCS inventory to ensure the continuation of natural circulation in the primary side of the NSSS. The FLEX strategy for reactor core cooling and decay heat removal is to release steam from the Steam Generators (SGs) using the SG Power Operated Relief Valves (PORVs) and the addition of a corresponding amount of Auxiliary Feedwater (AFW) to the SGs via the turbine driven AFW (TDAFW) pump. The AFW system includes the Auxiliary Feedwater Storage Tank (AFST) as the initial water supply to the TDAFW pump. Operator actions to verify, re-align, and throttle AFW flow are required by the EOPs and FSGs S1/S2.OP-FS.FLX-0002, *Alternate 13 AFW Suction Source* (FSG-2) and S1/S2.OP-FS.FLX-0003, *Alternate Low Pressure Feedwater* (FSG-3) following an ELAP/LUHS event to prevent SG dryout and/or overfill.

RCS cooldown will be initiated within the first 2 hours following a BDBEE that initiates an ELAP/LUHS event.

DC bus load stripping will be initiated within the first hour following a BDBEE to ensure battery life is extended to 6 hours. Portable generators will be used to repower instrumentation prior to battery depletion.

RCS makeup and boron addition will be initiated within 8 hours following a BDBEE to ensure natural circulation, reactivity control, and boron mixing is maintained in the RCS.

NOTE: The descriptions below are the same for both of the two Salem units. Any differences and/or unit specific information is included where appropriate.

2.3.1 *Phase 1 Strategy*

Following the occurrence of an ELAP and 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 SG PORVs. Natural circulation of the RCS will develop to provide core cooling and the TDAFW pump will provide flow from the AFST to the SGs to makeup for steam release.

Operators will respond to the ELAP and LUHS event in accordance with EOPs to confirm RCS, secondary system, and Containment conditions. A transition to 1/2-EOP-LOPA-1, *Loss of All AC Power*, will be made upon the diagnosis of the total loss of AC power. This procedure directs isolation of RCS letdown pathways, confirmation of natural circulation cooling including auxiliary feedwater flow to the SGs, verification of containment isolation, reduction of DC loads on the station Class 1E batteries, and establishes electrical equipment alignment in preparation for eventual power restoration. The operators re-align AFW flow to all steam generators, establish manual control of the SG PORVs, and initiate a rapid cooldown of the RCS to minimize inventory loss through the Reactor Coolant Pump (RCP) seals. 1/2-EOP-LOPA-4, *Extended Loss of AC Power,* also directs local manual control of AFW flow to the SGs and manual control of the SG PORVs to control steam release and the RCS cooldown rate, as necessary.

The key equipment relied upon to provide reactor core cooling and heat removal for the Phase 1 strategy are protected against the applicable external hazards as described below:

- The TDAFW Pump is located in the Auxiliary Building, a seismically qualified and flood protected structure.
- The Auxiliary Feedwater Storage Tank (AFST) is adequately protected from the effects of earthquakes, tornado wind loads, and floods; however, it is susceptible to damage from tornado missiles. The HCGS fire protection tanks and Diesel Driven Fire Pumps will be available following a tornado BDBEE in the event of an AFST failure.
- Vital instrument AC and DC busses are located in the seismic class I Auxiliary Building.
- SG PORVs are located in the seismic class I mechanical penetration area.

- Nitrogen bottles are connected to the air supply to the SG PORVs in the seismic class I mechanical penetration area to allow operation of the valves from the MCR upon a loss of air system pressure.
- New FLEX Fire Protection connections are located in the seismic class I Auxiliary Building to support use of the Hope Creek fire water tanks as a source of AFW.

<u>Secondary Side</u> - The Phase 1 FLEX strategy for reactor core cooling and heat removal relies on installed plant equipment and water sources for supplying AFW flow to the SGs and steam to the atmosphere. The TDAFW pump automatically starts on the loss of offsite power condition, and does not require either AC or DC electrical power to provide AFW to the SGs. The AFW system is normally aligned for the TDAFW pump to deliver flow to the SGs, and the air operated flow control valves fail open to maintain flow to all four SGs.

Steam release from the SGs will be controlled remotely from the Main Control Room (MCR) using air-operated SG PORVs equipped with local back-up nitrogen supply bottles. In accordance with 1/2-EOP-LOPA-1, *Loss of All AC Power*, an RCS cooldown will be initiated at a maximum rate of 100°F/hr to a minimum SG pressure of 290 psig, which corresponds to an RCS core inlet temperature of approximately 425°F. The rapid RCS cooldown minimizes the adverse effects of high temperature RCS coolant on Reactor Coolant Pump (RCP) shaft seal performance and reduces SG pressure to allow for eventual AFW injection using the FLEX AFW pump in the event that the TDAFW pump becomes unavailable. The minimum SG pressure of 290 psig (EOP setpoint O.08, Reference 76) is high enough to prevent nitrogen gas from the safety injection accumulators from entering the RCS.

Initially, AFW supply is provided by the installed AFST. The tank has a minimum usable capacity of approximately 200,000 gallons and will provide a suction source to the TDAFW pump for a minimum of 9 hours of RCS decay heat removal concurrent with a 100°F/hr RCS cooldown to a minimum SG pressure of 290 psig. After depletion of the usable AFST inventory, the TDAFW pump suction will be aligned to the Primary Water Storage Tank (PWST), Demineralized Water Storage Tank (DWST) or the SGS fire protection/fresh water storage tanks (FP/FWST) if available.

In the unlikely event the AFST, PWST, DWST and the SGS FP/FWST are all destroyed by a tornado missile event or otherwise unavailable, two Hope Creek Generating Station (HCGS) Fire Protection Tanks, each estimated to have a minimum useable inventory of approximately 263,120 gallons, will be aligned to the SGS fire protection system via the existing underground crosstie prior to steam generator dryout at 55 minutes from the ELAP.

<u>Primary Side (RCS)</u> - The RCS will be cooled down and depressurized until SG pressure reaches 290 psig, which corresponds to a core inlet temperature of approximately 425°F. RCS letdown isolation will be verified to have occurred automatically or initiated by remote-manual operation, and RCS leakage is assumed to be through the RCP seals. Natural circulation provides adequate core cooling until RCS makeup is established (Section 2.3.7.2).

Shutdown margin analyses and boration capability are discussed in Section 2.3.8.

<u>Electrical/Instrumentation</u> - Load shedding of all non-essential loads will begin within the first 30 minutes after the occurrence of an ELAP/LUHS event, using S1/S2.OP-AB.LOOP-0001, *Loss of Off-Site Power*, 1/2-EOP-LOPA-1, *Loss of All AC Power,* and FSG S1/S2 OP-FS.FLX-0004, *ELAP DC Bus Load Shed Management* (FSG-4) as the event diagnosis and response actions progress. A deep load shed would be completed within 2.5 hours after the occurrence of an ELAP/LUHS. With load shedding, the useable Class 1E station battery life has been calculated to be at least six hours for each unit (Section 2.3.10). The FLEX diesel generators (DGs) will be deployed and providing power to the battery chargers within six hours.

2.3.2 *Phase 2 Strategy*

The Phase 2 strategy for reactor core cooling and heat removal provides an indefinite supply of water for feeding SGs and a motor driven FLEX AFW pump for use in the event that the TDAFW pump becomes unavailable. One FLEX AFW pump is required for each SGS unit. Three pumps are maintained on site to meet N+1 criteria, and they are stored on elevation 84 feet of the Auxiliary Building for protection against all external hazards.

The TDAFW pump is expected to operate for an extended duration until SG steam pressure is insufficient to support TDAFW pump operation. The strategy includes using the FLEX DGs to provide power to the battery chargers for the A, B, and C 125 VDC and A and B 28 VDC vital buses. Phase 2 electrical bus repowering strategies are described later in this section.

The primary Phase 2 FLEX strategy establishes RCS makeup via the motor-driven FLEX Charging Pump. Three pumps are maintained on site to meet N+1 criteria for SGS Units 1 and 2, and they are stored on elevation 84 feet of the Auxiliary Building for protection against all external hazards. S1/S2.OP-FS.FLX-0001, *Long Term RCS Inventory Control* (FSG-1) provides guidance for deployment of the FLEX Charging Pumps to provide borated RCS makeup. The timeline to provide RCS makeup provides substantial margin to reflux cooling (Section 2.3.7.2).

Water Sources

The SGS mitigation strategies use various water sources. The preferred source of water to the TDAFW pump is the AFST. Other high-quality water sources include the DWST, PWST, SGS FP/FWST and the HCGS fire protection water tanks. Alternative water supply connections to the AFW system have been provided by the FLEX Mechanical Connections DCPs (References 32 and 33). After declaration of an ELAP and LUHS, operators will use the highest quality water available for injection to the SGs through the TDAFW pump or the FLEX AFW pump. The primary FLEX strategy uses the installed TDAFW pump and discharge valves. The alternate FLEX connections have the capability of supplying both the TDAFW and FLEX AFW pumps. The FLEX primary discharge connection and FLEX AFW pump supplies all four steam generators through different steam generator level control valves than the TDAFW pump. The primary and alternate FLEX connections support the FLEX strategies in all modes for which the steam generators are used as a heat sink.

An indefinite supply of water to the suction of the TDAFW pump or the FLEX AFW pump can be provided from the Delaware River. The Delaware River will remain available for any of the external hazards described by NEI 12-06. The diesel engine driven FLEX Service Water (SW) pump will be transported from the storage location to a location outside of the Service Water Intake Structure (SWIS) at the Delaware River. Suction hoses will be placed in the river and water will be drawn through strainers to limit pump damage and blockage from debris and frazil ice. Two suction hoses are used for one FLEX SW pump to facilitate operation if blockage occurs. Discharge hoses will be routed from the diesel engine driven FLEX SW pump discharge to a primary connection on the SW test header or to an alternate connection within the missile protected SWIS (in SW Bays 2 and 3) that can supply the SW nuclear headers. The SW connections in SW Bays 2 and 3 are seismically robust. The primary and alternate connections are sized to provide sufficient flow for Phase 2 requirements.

Water from the river can be pumped through the SW system to provide a direct suction source to the TDAFW pump or FLEX AFW pump. Water from the river can also be pumped to the SFP. The diesel engine driven FLEX SW pump is a nominal 1,500 gpm pump sized to provide a minimum total flow rate of 700 gpm to AFW, 112 gpm for RCS inventory makeup and 500 gpm for SFP spray, split between SGS Units 1 and 2 (Reference 34). As indicated in the sequence of events described in Table 3, the back-up supply of SG injection water will be made available prior to the depletion of the preferred water supply to the suction of the TDAFW pump, which would occur no sooner than 11 hours after the ELAP and LUHS. The preferred water source is the AFST for the first 9 hours. After 9 hours the PWST will supply the suction to the AFW system by removing the 12/22WR41 bonnet and installing a modified bonnet with a hose connection. The PWST will provide AFW system requirements until the SW system is capable of providing an indefinite supply of water. Hydraulic analysis of the flow path from the river through the SW system and to the various users (TDAFW pump, SFP, etc.) confirms that applicable performance requirements are met (Reference 34).

The above water supply strategy can be implemented following all applicable BDBEEs except the hurricane induced flood and tornado events. Alternate strategies for these events are summarized below.

During a hurricane induced flood event, the site would be inundated for approximately 11 hours and the available water storage tanks could fail. In this event, the turbine building will flood and fill with a sufficient volume of water to supply the AFW system until the flood waters recede and the diesel driven FLEX SW pump can be deployed to the Delaware River. Prior to the event, two 100% capacity submersible pumps with integral strainers will be pre-staged in each Unit (i.e., the N and N+1 pumps) at elevation 88 feet in the turbine building in accordance with SC.OP-AM.FLX-0050, *Predicted Hurricane Storm Surge*. A discharge hose will be routed to the demineralized water line that feeds the TDAFW pump at Unit 1 and the FP/FWST backup supply that feeds the TDAFW pump at Unit 2. These pipes are routed below grade in the turbine building and are not susceptible to hurricane wind induced missiles. The pumps take suction from the turbine building floor as shown in References 32 and 33. The appropriate valve lineup will be established by an operator prior to the onset of the event. The submersible pumps are sized for 350 gpm at 43.3 psig to supply either the TDAFW pump or the FLEX AFW pump and provide additional inventory to the FLEX charging pump as required. Technical Evaluations confirmed that sufficient flood water would be available in the turbine building prior to AFW tank failure and the submersible pump would provide an adequate supply to the AFW system (References 86 and 87).

During a tornado event, AFSTs, DWSTs, and FP/FWSTs may be damaged by missiles. A connection to the fire protection system will be used to supply water to the TDAFW pump. The SGS fire protection system is cross connected to the HCGS fire protection system via below grade piping which is reasonably expected to survive the tornado missile event. The HCGS fire protection tanks and diesel driven pumps are located over 1200 feet from the nearest tank at SGS providing adequate separation such that the HCGS fire protection tanks are not affected by tornado missiles impacting SGS (Reference 59). Two HCGS fire protection tanks each contain a useable inventory of approximately 263,120 gallons of water allowing at least 11 hours of water for AFW until the SW system is available to provide an indefinite water supply (Reference 60). The HCGS fire protection tanks are not credited for the HCGS FLEX response.

Water Injection

The TDAFW pump is assumed to not fail during the event. However, the motor-driven FLEX AFW pump will provide a back-up SG injection method in the event that the TDAFW pump can no longer perform its function. The minimum required SG injection flowrate after one hour is 300 gpm at 300 psig to support reactor core cooling and decay heat removal. The FLEX AFW pump is stored in the Auxiliary Building near the system connection established for discharge to the SG (described below). Hose will be routed from the pump suction to the AFW suction line. The FLEX AFW pump discharge is connected with hose to a permanent connection point between the discharge isolation valves between the motor driven AFW pumps and to the SFP. Electrical power supply for the FLEX AFW pump is discussed below. If the FLEX AFW pump is supplying SG make-up flow, SG level will be manually controlled by the associated AF21 valve. The FLEX AFW pump can provide 350 gpm at 350 psig.

AC/DC Power

The Phase 2 FLEX strategy for SGS Units 1 and 2 uses four 480 VAC FLEX DGs including one N+1 DG. Three DGs are required for both units and four DGs are available on site for SGS. Two portable FLEX DGs are pre-staged at their point of use in the Salem Unit 2 Canyon Area located between the Salem Unit 2 Fuel Handling Building and the Unit 2 Auxiliary Building. Two portable 480 VAC FLEX DGs are stored in diverse Outdoor FLEX Storage Areas (OFSAs). The Phase 2 480 VAC FLEX DGs are electrically equivalent to each other. An electrical one-line diagram based on References 36 and 37 is provided in Figure 3.

The FLEX DGs provide power to FLEX 480 VAC and 230 VAC loads. One FLEX DG provides power to the 480V/240V FLEX transformer. Following an ELAP with both units operating in Modes 1 through 4 (power operation through hot shutdown), S1/S2.OP-FS.FLX-0005, Initial Assessment and FLEX Equipment Staging (FSG-5) prioritizes alignment of a pre-staged FLEX DG to supply power to the 230 VAC FLEX loads including the battery chargers. When either unit enters Modes 5 or 6 (cold shutdown or refueling) FSG-5 designates the two pre-staged FLEX DGs as the N and N+1 to supply power to the 480 VAC loads for RCS makeup.

The 230 VAC loads are powered via a step-down 480V/240V transformer permanently installed in the Salem 2 Auxiliary Building at elevation 100 feet. Portable color-coded cables will be connected from one FLEX DG to missile protected, color-coded receptacles installed on the Auxiliary Building exterior wall. Permanent cable is installed from these receptacles to the 480V/240V FLEX transformer and from the transformer to a 240 VAC MCC. The 240 MCC is common to both units and located in the Unit 2 Auxiliary Building near the transformer. Permanent cable is installed from the 240 VAC MCC to various receptacles located at elevation 84 feet of the Auxiliary Buildings in each unit. During a BDBEE, 240 VAC FLEX MCC breakers are aligned and portable cables provide power from receptacles to battery chargers, vital instrumentation, ventilation, diesel fuel transfer pumps and 230 VAC motor operated valves.

The 480 VAC loads are powered via two permanently installed 480 VAC FLEX MCCs (one per unit) both located in the Salem Unit 2 Auxiliary Building. Portable color-coded cables are connected from two FLEX DGs to missile protected, color-coded receptacles installed on the Auxiliary Building exterior wall. Permanent cable is installed from the MCCs to receptacles and to the existing “A” 460 VAC vital bus in each unit. FLEX loads are powered using portable cables plugged into receptacles located in the Auxiliary Building or directly from the existing “A” 460 VAC vital bus. When the DG is connected to the 240 VAC FLEX MCCs and appropriate breaker alignment is completed, the portable generator can be started and portable cables and receptacles used to power the battery chargers, vital instrumentation, ventilation, diesel fuel transfer pumps and 230 VAC motor operated valves.

The FLEX DGs provide power to a single MCC per unit and a common 480 VAC / 230 VAC transformer. This design, and the use of the permanently installed MCCs and transformer to distribute power from the FLEX DGs, is consistent with NEI 12-06 Section 3.2.1.3, Item (8), which states the following:

"Installed electrical distribution system, including inverters and battery chargers, remain available provided they are protected consistent with current station design."

The FLEX MCCs and FLEX transformer are protected from external hazards. The new 230VAC MCC pans and FLEX receptacles with disconnect switches for the 28 VDC and 125 VDC Battery Chargers are safety-related. The other new FLEX electrical equipment is not safety-related (Class 1E) but is seismically qualified with augmented quality to provide assurance that it remains available following a seismic event.

Alternate connections are available via transfer switches located in the Auxiliary Building to feed either the 240 VAC FLEX MCC or one of the 480 VAC FLEX MCCs. S1/S2.OP-FS.FLX-0005, *Initial Assessment and FLEX Equipment Staging* (FSG-5) provides direction for aligning the FLEX DGs to supply power to the FLEX MCCs.

Two 480 VAC FLEX DGs are pre-staged at the point of deployment in the Salem Unit 2 Canyon Area. In the event that a flood from a hurricane is predicted, two additional DGs (one N and one N +1) will be moved to the Salem Unit 2 Canyon Area and flood protected. Following an ELAP from any BDBEE other than a hurricane flood, a third FLEX DG will be moved from its outdoor storage location and deployed to the Salem Unit 2 Canyon Area to provide power to the FLEX 480 VAC MCCs.

Pre-staging the two FLEX DGs in the Canyon Area is an alternative to NEI 12-06 Revision 0, which describes the use of portable equipment. The alternatives to NEI 12-06 associated with outdoor storage (Sections 2.6.3 and 2.6.4) apply to all FLEX DGs. The FLEX DGs in the Canyon Area are shown in Figure 2. The two pre-staged FLEX DGs are protected from all external hazards (Section 2.6). They are hardened ("armored" as shown on Figure 2) with missile protection on the top and all sides, and are provided with bracing systems to resist seismic and wind loads. Section 2.6 provides additional information regarding external hazard protection.

Correct phase rotation of the FLEX DGs was verified during modification acceptance testing.

2.3.3 *Phase 3 Strategy*

The Phase 3 coping strategy relies on two 4.16 KV generators per unit providing enough electrical power to re-power a Residual Heat Removal (RHR) pump and a Component Cooling Water (CCW) pump. The Unit 1 "B" 4 KV vital bus will be energized allowing for the "B" train of shutdown cooling to be placed in service. The Unit 2 "A" 4 KV vital bus will be energized allowing for the "A" train of shutdown cooling to be placed in service. S1/S2.OP-FS.FLX-0005, *Initial Assessment and FLEX Equipment Staging* (FSG-5) provides direction for staging, connecting, and loading the SAFER 4160 VAC DGs.

Core cooling will be continued via the diesel driven FLEX SW pump (augmented by additional capacity from the National SAFER Response Center (NSRC)) that will be providing water from the UHS through the SW nuclear header for as long as required. The SW nuclear test header Phase 3 primary connection is sized to support the required flow rates. Should the SW nuclear test header primary connection be damaged by airborne missiles during the event, the connection will be repaired prior to its use in Phase 3. The Phase 3 SW connection consists of a FLEX 10 valve manifold with connections sized to match the hose connectors supplied from the NSRC. The TDAFW pump or the FLEX AFW pump will provide SG make-up as long as required. When NSRC water treatment equipment arrives on site, demineralized water for the SG makeup can be established.

2.3.4 *Systems, Structures, Components*

2.3.4.1 Turbine Driven Auxiliary Feedwater Pump

The TDAFW pump will automatically start and deliver AFW flow to all four SGs following an ELAP/LUHS event. The TDAFW pump is installed at elevation 84 feet in the Auxiliary Building which is designed for protection from applicable design basis external hazards.

2.3.4.2 Steam Generator Power Operated Relief Valves (PORVs)

During an ELAP/LUHS event with the loss of all AC power and instrument air, reactor core cooling and decay heat will be removed from the SGs for an indefinite time period by manually opening and throttling the SG PORVs, which are equipped with backup nitrogen bottles. The SG PORVs are safety-related, missile protected, seismically qualified valves. Power to the SG PORV controllers in the MCR will be provided by the DC batteries in Phase 1 and by the 480 VAC FLEX DGs in Phases 2 and 3. Controlling the SG PORVs from the MCR will aid in minimizing field action and maximizing SG PORV control response.

2.3.4.3 Batteries

The safety-related Class 1E batteries and associated DC distribution systems are located within safety-related structures designed to meet applicable design basis external hazards and will be used to initially power required key instrumentation and applicable DC components. Load stripping of non-essential equipment has been calculated to provide a total service time of at least 6 hours (References 64 and 65).

2.3.5 *FLEX Strategy Connections*

2.3.5.1 Primary AFW Pump Connection

The primary connection to supply AFW to the SGs is located on the AFST supply line downstream of valve 1/2AF1, on elevation 84 feet of the Auxiliary Building (Figure 1). A flexible hose will be routed from the FLEX AFW Pump discharge to the Auxiliary Feedwater piping downstream of the 11/21 AFW and 12/22 AFW pumps. This connection is protected from all applicable hazards.

2.3.5.2 Alternate AFW Connection

In the event that the primary AFW connection is not available, an alternate connection location is provided. The alternate AFW connection for SG injection is a bonnet connection to 12/22WR41 valve. A flexible hose will be routed from this connection providing primary water storage tank water to the suction of the FLEX AFW pump. These valves are located on elevation 84 feet of the Auxiliary Building (Figure 1). This connection is protected from all applicable hazards.

2.3.5.3 Storm Surge Flooding Event (AFW Pump Suction)

A submersible pump can be installed in the Turbine Building on elevation 84 feet to draw water from the Turbine Building floor to take suction from flood waters in the Turbine Building. The pump will connect to a FLEX connection in the alternate supply line of the AFW system in the Turbine Building (Figure 1). This connection would be utilized during an external flooding event only.

2.3.5.4 Primary RCS Connection

The primary connections for RCS makeup are a Storz connection at the CV526 (CVCS suction) and a high pressure connection at the CV527 (CVCs discharge valves (Figure 1). These connections are located on elevation 84 feet of the Auxiliary Building (Figure 1). This connection is protected from all applicable hazards.

2.3.5.5 Alternate RCS Connection

The alternate RCS connections are Storz connections at the SJ433 (SI suction) and SJ434 (SI discharge) valves. These connections are located in the Auxiliary Building which is protected from all applicable hazards. Additionally, alternate FLEX connection points can supply suction to the FLEX charging pump. These include the bonnet connection to the 12/22WR41, Storz connections to the FP683, SW850 and CV524 valves. In addition, the Storz connection to the CV524 valves can supply water from the portable Boron Mixing tank to the Boric Acid Storage Tanks (BASTs).

2.3.5.6 Primary Electrical Connection

One 480 VAC FLEX DG feeds a 480V/240V transformer permanently installed in the Salem 2 Auxiliary Building. Missile protected receptacles are installed on the Auxiliary Building exterior wall to provide a connection point for a 480 VAC FLEX DG. Cable in conduit is installed from the receptacles to the transformer and from the transformer to a permanently installed 240 VAC MCC common to both units. An electrical one-line diagram is provided in Figure 3. This primary connection is protected from all external hazards.

2.3.5.7 Alternate Electrical Connection

Alternate connections are available via transfer switches located in the Waste Evaporator Room in the Auxiliary Building to feed either the

240 VAC FLEX MCC or one of the 480 VAC FLEX MCCs. These connections are protected from all external hazards.

2.3.5.8 4160 VAC Electrical Connection

The Phase 3 coping strategy is to establish the necessary long-term electrical capacity to meet all FLEX strategy needs until such time that normal power to the site can be restored. Two 4.16 KV AC portable DGs per unit will be provided by the NSRC to on-site Staging Area B (Figure 4) and delivered to an area just outside the solid radwaste roll-up door. These 4.16 KV DGs will be used to power the Salem Unit 1 “B” 4 KV Vital Bus and the Salem Unit 2 “A” 4 KV Vital Bus via connections in the Auxiliary Building. Two 4KV FLEX receptacle enclosures 1RECP1B5DA (next to the vital bus) and 1RECP1B5DA1 (in Drum Storage Area at elevation100 feet, Room 01-19) are installed. These connections are protected from all external hazards. The cable connections stored on site or supplied from NSRC are compatible with receptacle connections.

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. All indication is in the main control room (MCR). If indication is lost in the MCR, FSGs provides guidance for taking local readings.

- AFW Pump Suction and Discharge pressure - AFW pump suction and discharge pressure indication will be available.
- SG Water Level - SG wide range (WR) water level indication and SG narrow-range (NR) level indication will be available.
- SG Pressure - SG pressure indication will be available.
- RCS Temperature - RCS hot-leg and cold-leg temperature indication will be available.
- RCS Pressure - RCS wide range pressure indication will be available.
- Accumulator Pressure and Level - Accumulator pressure and level indication will be available.
- Core Exit Thermocouple Temperature - Core exit thermocouple temperature indication will be available.

- AFST Level - AFST water level indication will be available.
- RWST Level - RWST level indication will be available.
- Pressurizer Level: Pressurizer level indication will be available.
- Pressurizer Pressure: Pressurizer pressure indication will be available.
- Reactor Vessel Level Indication System (RVLIS): RCS level indication from the RVLIS will be available.
- Excore Nuclear Instruments: Indication of nuclear source range activity will be available from the MCR.

Portable BDB 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 procedures are based on inputs from the equipment suppliers, operating experience, and expected equipment function in an ELAP.

In the unlikely event that 125 VDC and 120 VAC Vital Bus infrastructure is damaged, FLEX strategy guidelines for alternately obtaining the critical parameters locally is provided in S1/S2.OP-FS.FLX-0007, *Loss of Vital Instrumentation or Control Power* (FSG-7).

2.3.7 *Thermal Hydraulic Analyses*

2.3.7.1 Secondary Makeup Water Requirements

Calculations (References 10, 60, 66, and 67) were performed to determine the inventory required for core decay heat removal, RCS cooldown, and to maintain steam generator levels and dryout times associated with the volumes of various onsite AFW water sources. Reference 66 shows that the existing Auxiliary Feedwater Storage Tank (AFST) usable volume of approximately 200,000 gallons would be depleted in approximately 9 hours at which time another source of water would be required. If the Primary Water Storage Tank (PWST) is available, the PWST will be aligned to the TDAFW pump or FLEX AFW pump, providing at least two hours of additional AFW (Reference 67).

In the unlikely event the AFST, PWST, DWST and FP/FWSTs are all destroyed by a tornado missile event, two Hope Creek Generating Station (HCGS) fire protection tanks, each estimated to have a minimum useable inventory of approximately 263,120 gallons, will be aligned to the SGS fire protection system via the existing underground crosstie (Reference 60). The two HCGS fire protection system tanks are located over 1200 feet from the nearest tanks at SGS and are shown by site specific evaluation (Reference 59) to be sufficiently separated to assure a tornado missile would not impact all of the tanks on site. Time validation (Reference 46) shows that the HCGS fire protection water can supply AFW prior to the 55 minute SG dryout time from WCAP-17601 (Reference 10).

2.3.7.2 RCS Response

The SGS FLEX strategies developed in response to NRC Order EA-12-049 were initially developed using Westinghouse WCAP-17601-P (Reference 10), which utilized the NOTRUMP code. The FLEX strategy is consistent with the NRC staff's letter to the PWROG regarding the use of NOTRUMP (Reference 12) and the PWROG 14027-P scaling methodology (Reference 13). Reflux cooling precedes core uncovery during an ELAP scenario and prevention of reflux cooling is therefore a conservative means of demonstrating adequate core cooling, e.g., as shown in WCAP-17601-P (Reference 10).

In Nuclear Safety Advisory Letter NSAL-14-1 (Reference 47), Westinghouse documented a concern that the generic leakoff flow rates (i.e., 21 gpm at normal operating pressure and leakage flow rate decreasing linearly with pressure) are not applicable to all plants due to the effects of plant-specific piping designs. Westinghouse evaluated plant-specific piping configurations and determined that flow rates applicable to the original SGS configuration were significantly higher than the generic values. PSEG installed flow restricting orifices in the RCP seal leakoff lines at SGS Units 1 and 2 and had a plant- specific evaluation performed to determine RCP seal leakage rates during an ELAP (Reference 49). Reference 49 shows the RCP number 1 seal leakage during an ELAP to be 14.5 gpm per pump at normal operating pressure, rising to 15.2 gpm per pump at 1500 psia, lowering to 5.04 gpm per pump at 310 psia, and 3.85 gpm per pump at an RCS pressure of 200 psia. The site specific RCP seal leakage results are used in determining Phase 2 RCS make-up requirements. A site specific calculation shows that natural circulation cooling of the RCS can be supported for 17.4 hours before reflux cooling conditions are reached for Salem Unit 1, which bounds Salem Unit 2 (Reference 48). The timeline to initiate RCS makeup within eight hours of the ELAP (Table 3) provides significant margin to reflux cooling and offsets uncertainty regarding the RCP seal leakage rates due to faceplate corrosion rate as calculated by Westinghouse.

The SGS FLEX strategies include initiation of RCS cooldown in less than two hours from initiation of an ELAP via 1/2-EOP-LOPA-1, *Loss of All AC Power*. The initial cooldown target is 425 °F (290 psig SG pressure EOP setpoint O.08 to prevent accumulator nitrogen injection) within the following 2 hours. SGS Units 1 and 2 also implement the Westinghouse Technical Bulletin 15-1 (Reference 77) recommended extended cooldown to 350 °F within 24 hours of an ELAP. EOP-LOPA-4, *Extended Loss of All AC Power*, S1/S2.OP-FS.FLX-0001, *Long Term RCS Inventory Control* (FSG-1) and S1/S2.OP-FS.FLX-0008, *Alternate RCS Boration* (FSG-8) include steps to address RCS boration and makeup during an extended cooldown following ECCS accumulator isolation. PSEG is participating in the ongoing PWROG actions to develop and implement revised ELAP cooldown recommendations as part of generic RCP seal leakage issue resolution.

In Modes 5 and 6, the secondary side of the plant may be unavailable to provide RCS cooling. The Phase 1 FLEX strategy is to provide for gravity RCS make-up from the RWST (if available) using the installed RHR piping, with an RCS vent path established in accordance with shutdown operating procedures. Section 2.16 provides additional information regarding shutdown and refueling mitigation strategies.

2.3.8 Shutdown Margin Analysis

The SGS FLEX strategy includes borated RCS makeup to restore inventory and ensure sub-criticality using FLEX charging pump within 8 hours of an ELAP (Table 3, #30). The maximum time after reactor trip / start of ELAP for initiation of borated makeup to ensure core subcriticality is 12 hours (EOP setpoint V.08, Reference 76). EOP setpoint V.08 was determined using the NRC endorsed PWROG position paper on boron mixing (References 15 and 16). The setpoint calculation assumed conservative End of Life (EOL) core conditions, an initial cooldown to 420° F, and the conservative assumption of no RCP seal leakage. The EOP setpoint also accounts for a one-hour boron mixing time. The setpoint of 12 hours occurs prior to the onset of reflux cooling.

RCS boration begins within eight hours of an ELAP and is performed using S1/S2.OP-FS.FLX-0008, *Alternate RCS Boration* (FSG-8). Shutdown margin boration requirements are based on an RCS temperature of 200° F to ensure the shutdown margin is maintained when the RCS is cooled below 350 °F. FSG-8 boration requirements conservatively bound typical cycle-to-cycle variation seen in shutdown boron requirements. NF-AP-100-7000, *Westinghouse NSSS Reload Design Control Implementation,* includes a reload specific check to verify the data used to determine return to criticality during an ELAP.

The solenoid operated reactor head vent valves are powered from redundant vital DC power and are used as the preferred means of venting to reduce RCS pressure and support borated makeup using FSG-8. The reactor head vent line is a 3/4-inch line with an 11/32 inch orifice that starts from the reactor and joins the 12-inch pressurizer relief line. The vent line is meant for removing noncondensibles and may also be used to support RCS venting as part of the BDB FLEX strategy. Reference 85 calculates head vent capacities at various reactor head conditions, including the following:

- 576 lb/hr (106.4 gpm) superheated steam at 300 psig and 425° F
- 10,620 lb/hr (25 gpm) at 1500 psig and 425° F

If the head vent valves are not available, FSG-8 directs the use of the pressurizer PORVs. Control power for the head vents and pressurizer PORVs is provided with FLEX power and is addressed in S1/S2.OP-FS.FLX-0007 *Loss of Vital Instrumentation or Control Power* (FSG-7) in the event that control power is lost.

A maximum required boration of 7870 gallons of 6775 ppm boron would be required from the BASTs to ensure a Keff of 0.987 is maintained at a RCS temperature of 200° F. This assumes a worst case end of life (EOL) initial RCS boron concentration of 0 ppm and a xenon-free condition. The BASTs, augmented by the boric acid solution produced by the FLEX portable mixing skid, would establish a boron concentration of 652 ppm with the boration beginning at approximately 8 hours after the event and be injected at 56 gpm by the FLEX charging pump (Reference 50). If required, the 11(21) boric acid transfer pump can be used to transfer this inventory to the suction of the FLEX charging pump using installed piping, and the hose connection from the installed charging pump suction at valve 1/2CV526 to the FLEX charging pump suction. As RCS pressure and RCP seal leakage decrease, borated water requirements will decrease. Boration completion time will vary with plant conditions and the FLEX strategy is capable of long term boration to the extent required.

2.3.9 *FLEX Pumps and Water Sources*

2.3.9.1 FLEX AFW Pump

Consistent with NEI 12-06, Appendix D, SG water injection capability is provided using a portable AFW pump through a primary and alternate connection. The FLEX AFW pump is a nominal 350 gpm, 380 psid pump. The FLEX AFW pumps are motor driven centrifugal pumps that are stored in the Auxiliary Building for protection against external hazards. The FLEX AFW pump will provide a back-up method for SG injection in the event that the TDAFW pump can no longer perform its function due to insufficient turbine inlet steam flow from the SGs. Hydraulic analyses (Reference 34) have confirmed that the FLEX AFW pump is sized to provide the minimum required SG injection flowrate to support reactor core cooling and decay heat removal. Three FLEX AFW pumps are available to satisfy the N+1 requirement.

2.3.9.2 FLEX Charging Pump

The PWROG Core Cooling Position Paper (issued in conjunction with WCAP-17601) recommends that the RCS Injection pump required delivery pressure be established at the saturation pressure of the reactor vessel head +100 psi driving head to allow RCS injection. Accordingly, the FLEX Charging Pump is a positive displacement pump capable of delivering a minimum flow of 56 gpm at a discharge pressure of 1600 psig. Hydraulic analysis of the FLEX Charging Pump with the associated hoses and installed piping systems confirm that the minimum flow rate and head capabilities exceed the FLEX strategy requirements for maintaining RCS inventory and boration.

The FLEX Charging Pumps are stored on elevation 84 feet in the Auxiliary Building for protection against external hazards. One pump is required for each SGS unit. Three FLEX Charging Pumps are on site to satisfy the N+1 requirement.

2.3.9.3 Diesel Driven FLEX SW Pump

Water from the river can be pumped through the SW system to provide a direct suction source to the TDAFW pump or FLEX AFW pump. Water from the river can also be pumped to the Spent Fuel Pool. The diesel driven FLEX SW pump is a nominal 1,500 gpm pump sized to provide a minimum total flow rate of 700 gpm to AFW, 112 gpm for RCS inventory makeup and 500 gpm for Spent Fuel spray, split between SGS Units 1 and 2. One diesel driven FLEX SW pump is capable of providing sufficient flow for both units. The HCGS FLEX strategy uses one FLEX SW pump of the same design. There are three pumps on site to meet the N+1 criteria for both stations. Storage, protection and deployment considerations are dependent on the specific external hazard as described in Section 2.6.

2.3.9.4 AFW Water Supplies

Auxiliary Feedwater Storage Tank (AFST)

The Auxiliary Feedwater Tank (AFST) provides an AFW water source at the initial onset of the event. The tank is a seismic category I tank that has been designed to withstand design basis tornado wind loads. AFST volume is maintained greater than or equal to 200,000 gallons per SGS Technical Specification 3/4.7.1.3 (Reference 9) and is normally aligned to provide emergency makeup to the SGs.

Demineralized Water Storage Tank (DWST)

The Demineralized Water Storage Tank (DWST) can provide an AFW water source if required. The DWST is a non-seismic, non-safety related tank, but if available could supply 500,000 gallons (Reference 35).

Primary Water Storage Tank

The Primary Water Storage Tank (PWST) can provide an AFW water source if required. The tank is a non-seismic, non-safety related tank, but if available could supply 205,000 gallons (Reference 67).

SGS Fire Protection/Fresh Water Storage Tanks

The Fire Protection/Fresh Water Storage Tanks (FP/FWSTs) can provide an AFW water source if required. The tanks are non-seismic, non-safety related tanks, but if available could supply 350,000 gallons.

Hope Creek Fire Protection Water Tanks

The Hope Creek Fire Protection Water Tanks can provide an AFW water source if required. The tanks are non-seismic, non-safety related tanks, but if available could supply 263,120 gallons (Reference 60).

Delaware River

Delaware River provides an indefinite supply of water. Table 2 includes water treatment equipment provided by SAFER.

2.3.9.5 Borated Water Supplies

Two sources of borated water have been evaluated for use during a Beyond-Design-Basis event. Each borated water source is discussed below, in order of usage preference.

Boric Acid Storage Tanks (BASTs)

The BASTs are located within the seismic class I Auxiliary Building and are protected against all external events. A maximum required boration of 7870 gallons of 6775 ppm boron would be required from the BASTs.

Portable Boric Acid Mixing Tank:

In the event that the BASTs become depleted, two portable boric acid mixing tank skids are available to provide a suction source for the FLEX Charging Pumps. One portable mixing tank skid is capable of supporting long term boration of both SGS units (Reference 50). The mixing tanks are stored in the SGS Auxiliary Building for protection against external hazards. A portable hose will be used to supply water from the temporary mixing tank's pump to the Boric Acid Storage Tank (BAST) FLEX connection or suction of the FLEX charging pump. Dilution water will be added to the mixing tank by the 11(21) primary water pump and a hose connection (preferred) or an available water source (DWST, SGS FP/FWSTs, HCGS fire protection water tanks or SW) should the PWST be unavailable. Bags of powdered boric acid will be mixed with dilution water to achieve the proper concentration for maintaining adequate shutdown margin while making up RCS inventory. Each tank is equipped with an agitator to facilitate mixing of the boric acid although complete dissolution of the powdered boric acid is not required since agitation will be continued throughout the injection process. The mixing tanks are each equipped with a heater to improve solubility and prevent tank freezing, if necessary.

Refueling Water Storage Tank

The RWST is seismically qualified, but located outside and vulnerable to externally generated missiles. The RWST would be used if available but it is not credited for any FLEX strategy.

2.3.10 *Electrical Analysis*

The Class 1E battery duty cycle of six (6) hours for SGS was calculated in accordance with the IEEE-485 methodology using manufacturer discharge test data applicable to the FLEX strategy as outlined in the NEI white paper on Extended Battery Duty Cycles (Reference 17).

The strategy to re-power the stations' vital AC/DC buses requires the use of diesel powered generators. For this purpose, three 480 VAC portable diesel generator will provide the power required during Phase 2 to both units at SGS.

The 480 VAC DGs are 750 KVA, 600 kW nominal rated generators. They are trailer-mounted with a 1075 gallon double-walled diesel fuel tank built into the trailer.

Additional replacement 480 V AC generators and 4160 VAC, 1,250 KVA (nominally 1 MW) diesel powered generators are available from the National SAFER Response Center (NSRC) for the Phase 3 strategy. The specific equipment from the NSRC is listed in Table 2. Section 2.3.3 describes the additional loads for Phase 3 core cooling that may be powered by the 4160 VAC generators.

The SGS FLEX electrical system analysis (Reference 72) demonstrates that the FLEX 480 VAC and 4160 VAC Diesel Generators (DGs) are appropriately sized to support the FLEX strategies with regards to load starting capability and steady state load margin.

2.4 SPENT FUEL POOL COOLING/INVENTORY

The FLEX strategy for maintaining SFP cooling is to monitor SFP level and provide sufficient makeup water to the SFP to maintain the normal SFP level.

2.4.1 *Phase 1 Strategy*

The SFP makeup requirements during ELAP events are based on the maximum design basis heat load in the SFP. The maximum boil off rate for a full core offload is less than 100 gpm. Assuming the technical specification minimum SFP water level, uncovering fuel would not occur for over 44 hours without fuel pool makeup flow. The Phase 1 coping strategy for spent fuel pool cooling is to monitor spent fuel pool level using instrumentation installed as required by NRC Order EA-12-051 (Reference 5).

2.4.2 *Phase 2 Strategy*

The diesel driven FLEX (SW) pump deployed to the Delaware River and the motor driven FLEX AFW pump located in the Auxiliary Building, as described in Section 2.3.2, could be aligned to provide makeup to the SFP. Water supply options are made available through the piping configurations discussed in Section 2.3.2. A new pipe with a hose connection is permanently installed at each SFP with an inlet hose connection located in the mechanical penetration area. Hose will be routed from the hose connection to the spray nozzles at the SFP. The SFP spray rig will be installed at the SFP before conditions in the Fuel Handling Building degrade. Filling the SFP will be accomplished through a new permanent hose connection on the SFP cooling system, downstream of valve SF901 at valve SF116. Even under the most conservative full core offload heat load conditions, operators will have sufficient time to arrange for SFP makeup from the various FLEX sources.

2.4.3 *Phase 3 Strategy*

The Phase 3 coping strategy relies on two large generators per unit providing enough electrical power to the required safeguards equipment. The generator will be used to initiate SFP cooling using the component cooling system and a SFP pump. The component cooling system will be cooled via river water pumped through the SW nuclear header from the diesel driven FLEX SW pumps (augmented by additional capacity from the NSRC) for as long as required. Water treatment equipment is included as part of the SAFER equipment delivered to SGS (Table 2).

2.4.4 *Structures, Systems, and Components*

2.4.4.1 Primary Connection

The new BDB SFP makeup connection line is a 4-inch line that tees into the existing 6-inch SFP makeup line (Figure 1). This connection is in the Auxiliary Building and is protected from all external hazards.

2.4.4.2 Alternate Connection

The alternate FLEX connection is a Storz connection to the spent fuel pool spray header. This connection is located in the Auxiliary Building and is protected from all external hazards.

2.4.4.3 Fuel Building Ventilation

As required by NEI 12-06, a vent pathway for steam and condensate from the SFP is established in accordance with S1/S2.OP-FS.FLX-0005, *Initial Assessment and FLEX Equipment Staging* (FSG-5). During FLEX Phase 2, the “A” 460 VAC vital bus is energized via the 480 VAC FLEX DG. The 11 and 21 Fuel Handling Building Exhaust Fans are available to be operated to provide a vent pathway for steam and condensate.

2.4.5 *Key Spent Fuel Pool Parameters*

The key parameter for the SFP makeup strategy is the SFP water level. The SFP water level is monitored by the instrumentation that was installed in response to Order EA-12-051, *Reliable Spent Fuel Pool level Instrumentation* (Reference 5). References 88 and 89 address SGS Units 1 and 2 compliance with NRC Order EA-12-051.

2.4.6 *Thermal-Hydraulic Analyses*

The SFP makeup requirements during ELAP events are based on the maximum design basis heat load in the spent fuel pool. The maximum boil off rate for a full core offload is less than 100 gpm. Assuming the technical specification minimum SFP water level, uncovering fuel would not occur for over 44 hours without fuel pool makeup flow. Deployment of the SFP hose connection within 24 hours with a design flow of 500 gpm for the SFP will provide for adequate makeup to restore the SFP level and maintain an acceptable level of water for shielding purposes.

2.4.7 *FLEX Pumps and Water Supplies*

2.4.7.1 FLEX AFW Pump (Refer to 2.3.9.1)

The FLEX AFW pump is a nominal 350 gpm, 380 psid pump that is shared between several functions. The FLEX AFW pump can provide makeup to the SFP within the required time frame (Section 2.4.1 and Table 3).

2.4.7.2 FLEX Diesel Driven SW Pump (Refer to 2.3.9.3)

Water from the river can be pumped through the SW system to provide a direct suction source to the SFP.

2.4.7.3 Delaware River

The diesel driven FLEX pump deployed to the Delaware River could be aligned to provide makeup to the SFP. Refer to Section 2.15 for discussion of water quality.

2.4.8 *Electrical Analysis*

The SFP will be monitored by instrumentation installed in response to Order EA-12-051. The SFP level instruments are powered by Class 1E Vital Instrument Buses, which are fed from UPS backed inverters that are to be re-powered by FLEX DGs in the event of an ELAP. In addition, the dedicated, replaceable battery backup provides power for seven days of operation in minimum power mode, providing sufficient capacity to support instrument channel operation through the use of replaceable batteries until off-site resource availability is assured.

Phase 2 AC power via the 480 VAC FLEX DGs is available to support the SFP cooling function of the FLEX AFW pump. During Phase 3, the 4160 VAC generators from the NSRC will be available to support SFP cooling using the component cooling system and a SFP pump. The SGS FLEX electrical system analysis (Reference 72) demonstrates that the FLEX 480 VAC and 4160 VAC Diesel Generators (DGs) are appropriately sized to support the FLEX strategies with regards to load starting capability and steady state load margin.

2.5 CONTAINMENT INTEGRITY

The SGS design basis for containment cooling is to ensure the containment pressure will not exceed its design basis value of 47 psig at 271° F (100% relative humidity). PSEG used NRC-endorsed MAAP analysis to support the SGS FLEX strategies and timelines for containment integrity. Technical Evaluation 80111831-0030 (Reference 82) evaluated containment response to an ELAP during Modes 5 and 6 (Cold Shutdown and Refueling). The Mode 5 and 6 MAAP analysis indicates that containment pressure can be maintained below the design pressure of 47 psig and well below the test pressure of 54 psig using the installed containment vent paths through the personnel airlocks.

Technical Evaluation 80111831-0040 (Reference 83) evaluated containment response to an ELAP in Modes 1 through 4 (Power Operation to Hot Shutdown) and concluded that containment pressure can be maintained substantially below the design pressure using only FLEX RCS cooldown via the steam generators. Technical Evaluation 80111831-0041 (Reference 84) confirmed that the conclusion of 80111831-0040 remains valid with consideration of plant-specific RCP seal leakage.

NOTE: The descriptions below are the same for both of the two Salem units. Any differences and/or unit specific information is included where appropriate.

2.5.1 *Phase I*

The MAAP analysis demonstrates that containment temperature and pressure response are slow and no operator actions are required during Phase 1.

2.5.2 *Phase 2*

<u>Modes 1 through 4</u>

Since the containment temperature and pressure response will be slow in Modes 1 through 4, operator actions to reduce containment pressure and temperature will not be required during Phase 2. Containment analysis using MAAP demonstrates that containment integrity can be maintained until containment cooling can be restored during Phase 3 (References 83 and 84).

Modes 5 and 6

With the steam generators unavailable as a heat removal source, containment temperature and pressure will rise due to the energy release to containment. M AAP results show that containment pressure will be maintained less than design pressure by establishing two vents from the containment to atmosphere at 6 hours following the event (Reference 82).

Connections

Two 2.25” inch vents will be es tablished from the personnel air locks at elevation 100 feet and 130 feet, through one mechanical penetration in each air lock to atmosphere via implementation of S1/S2.OP-FS.FLX-0012, *Alternate Containment Cooling* (FSG-12).

2.5.3 *Phase 3*

The Phase 3 coping strategy relies on two 1.0 MWe generators per unit operating in parallel to provide enough electrical power to the required safeguards equipment. The generators will be used to re-power containment cooling through the use of the installed Containment Fan Coil Units and Delaware River water supplied through the SW system as described in Section 2.3.3. In addition to the Phase 2 Diesel Driven FLEX SW pumps, supplemental pumping capability will be supplied from the NSRC to support this function.

SGS will implement resources received from the NSRC to provide power to the containment ventilation system thereby ensuring pressure control in containment. This is assumed to occur after 72 hours from the event, as indicated in the timeline in Table 3.

2.5.4 *Structures, Systems, Components*

Two 2.25” inch vents will be established from the personnel air locks at elevation 100 feet and 130 feet, through one mechanical penetration in each airlock to atmosphere via implementation of S1/S2.OP-FS.FLX-0012, *Alternate Containment Cooling* (FSG-12).

2.5.5 *Key Containment Parameters*

Instrumentation providing the following key parameter is credited for all phases of the Containment Integrity strategy. If indication is lost in the MCR, procedural guidance is available for taking local readings.

- Containment Pressure: Containment pressure indication is available in the MCR throughout the event under all postulated environmental conditions. Should containment pressure indication be lost, alternate monitoring will be established per S1/S2.OP-FS.FLX-0007 *Loss of Vital Instrumentation or Control Power* (FSG-7).

2.5.6 *Thermal-Hydraulic Analyses*

See discussion in Section 2.5.1 and 2.5.2.

2.5.7 *FLEX Pump and Water Supplies*

2.5.7.1 FLEX Diesel Driven SW Pump (Refer to 2.3.9.3)

FLEX Diesel Driven SW pumps can be used for containment cooling as discussed in Section 2.5.3.

2.5.7.2 Delaware River

Delaware River water is supplied through the service water system to provide containment cooling as discussed in Section 2.5.3.

2.5.8 *Electrical Analysis*

One 4 KV bus is required for each unit to repower the Containment cooling options described above. The 4160 VAC generators being supplied from the NSRC will provide adequate power to perform the Phase 3 Containment cooling strategies. The necessary components to implement the various Containment cooling options have been included in the calculations to support the sizing of the 4160 VAC generators being provided by the NSRC. Accordingly, two (2) 1-MW 4160 VAC generators and a distribution panel (including cable and connectors) are provided from the NSRC per unit. The Phase 3 electrical one-line diagram is provided in Figure 3, Sheet 3.

2.6 CHARACTERIZATION OF EXTERNAL HAZARDS

SGS screens in for each of the NEI 12-06 external hazards, i.e., seismic, flooding, severe storms with high winds, snow, ice and extreme cold, and high temperatures.

2.6.1 *Seismic*

The NRC requested licensees to re-evaluate the seismic hazard at their sites based on updated seismic hazard information and present-day regulatory guidance and methodologies. This request was prompted by NTTF Recommendation 2.1 (Reference 1).

The seismic hazard was re-evaluated for SGS and submitted to the NRC on March 28, 2014 (Reference 39). The design basis Safe Shutdown Earthquake (SSE) as defined in SGS UFSAR (Reference 18), Section 2.5.2, has a peak ground acceleration (PGA) of 0.20 g at the foundation level. The SGS Category I structures are evaluated using dynamic analysis with a time history input that is conservative relative to the design basis SSE response spectrum (UFSAR Figure 3.7-2).

The conclusion of the seismic re-evaluation required implementation of the Augmented Approach as described in Reference 40 and endorsed by the NRC by Reference 41. As described in the Augmented Approach, all of the equipment and systems required to implement the FLEX primary path have been re-evaluated and documented in Reference 42. In May of 2014, the NRC documented their initial screening of the re-evaluated seismic hazard and determined that the Augmented Approach was warranted for SGS (Reference 43). Subsequently, the NRC and industry determined that the Augmented Approach may not be warranted for some plants that initially screened in for a seismic risk evaluation and application of the Augmented Approach. Accordingly, PSEG and the NRC concurred that the Augmented Approach was not required for SGS (References 44 and 45). However, the NRC reiterated that the FLEX installed equipment should meet the re-evaluated seismic hazard in Reference 45.

The seismic reevaluations have not required any changes to the FLEX strategies.

FLEX equipment is stored at locations designed or evaluated to withstand the effects of a seismic event, including potential liquefaction. FLEX Charging Pumps, Auxiliary Feed Pumps, and new electrical distribution equipment are located in the Seismic Category I Auxiliary Buildings. The submersible pumps stored in the Turbine Building are only credited for the flooding event and are not required for the FLEX response to a seismic event.

NEI 12-06 Section 5.3.1(1)(c) states that FLEX equipment may be stored outside a structure provided it is evaluated for seismic interactions to ensure equipment is not damaged by non-seismically robust components or structures. Two FLEX DGs are pre-staged outdoors in the Canyon area. The Canyon area is between the Unit 2 Auxiliary and Fuel Handling buildings, which are Seismic Category I. There are no non-seismically robust components or structures positioned to interact with stored FLEX DGs in the Canyon area. Access to the Canyon area through the seismically robust Salem Unit 2 Auxiliary Building ensures access to the connection points for the FLEX DGs as well as the FLEX DGs for control capability.

Phase 2 FLEX equipment is also stored outdoors at two locations within the protected area, and one location outside the protected area. These storage areas will withstand the effects of a seismic event. Large portable FLEX equipment is secured for a seismic event and located so that it is not damaged by other items in a seismic event.

Installed FLEX equipment credited following a seismic event is seismically robust, consistent with SGS's current seismic design practices. Installed FLEX equipment has been evaluated and protected from seismic interactions based on its location within the Auxiliary Building to ensure that unsecured or non-seismic components do not damage the equipment.

Other than the Canyon area, outdoor storage locations are as follows:

- east of the Salem Oil Water Separator Building (OFSA1, Storage Area #1 - outside the protected area)
- west of SGS (OFSA2, Storage Area #2 - inside the protected area)
- near the Hope Creek Unit 2 reactor building west wall, north of SGS (OFSA3, Storage Area #3 - inside the protected area)

A liquefaction analysis of the outdoor storage locations demonstrated that the FLEX equipment can be deployed to the point of use, meeting the requirements of NEI 12-06. All areas adjacent to Class I structures around the SGS site have highly compacted backfill. Deployment pathways for FLEX equipment were selected to avoid the potential for debris from failed non-seismically designed structures. Onsite debris removal equipment is available to clear pathways.

To address the potential for seismically induced internal flooding hazards, PSEG Nuclear reviewed large internal flooding sources that are not seismically robust and do not require AC power, e.g., gravity drainage from lake or cooling basins for non-safety-related cooling water systems (NEI 12-06, Section 5.3.3). There are no internal flooding sources of this type that are within the SGS flood protected boundary. FLEX equipment storage locations outside of flood-protected structures were evaluated for the potential impact of failure of large, non-seismic tanks. The largest non-seismic tanks are the two demineralized water storage tanks (DWSTs), each with a 500,000 gallon capacity. The DWSTs are greater than 400 feet away from the closest outdoor FLEX equipment storage area and significant open areas exist between the storage sites and non-seismic tanks. Considering the separation distances, open spaces and intervening structures, it is unlikely that significant flooding and equipment damage will occur at the storage locations.

The SGS FLEX strategy does not rely on AC power for ground water mitigation within the plant flood protected areas. For a hurricane event, dewatering pumps to remove accumulated rainwater from the Canyon Area (outdoor area between the SGS Unit 2 Fuel Handling Building and Auxiliary Building) will be powered by the FLEX DG or station power (if available).

2.6.2 *External Flooding*

The NRC requested licensees to re-evaluate all appropriate external flooding sources, including the effects from local intense precipitation (LIP) on the site, probable maximum flood (PMF) on streams and rivers, storm surges, seiches, tsunami, and dam failures (Reference 38). The NRC requested that the re-evaluation apply present-day regulatory guidance and methodologies. This request was prompted by NTTF Recommendation 2.1 (Reference 1).

The external flooding hazard was re-evaluated and submitted to the NRC on March 11, 2014 (Reference 19). The SGS plant area has a nominal grade elevation of 99.5 ft. Public Service Datum (PSD). Current design basis maximum flood levels result from the hurricane storm surge event, with a still water elevation of 113.8 ft. PSD. Maximum design basis flood levels due to storm surge wave run-up are 120.4 ft PSD at the power block (Auxiliary Building) and 127.3 ft. PSD at the Service Water Intake Structure (SWIS). The reevaluated storm surge flood levels are bounded by the design basis flood levels (Reference 19)

The current design basis does not include an expected flooding event due to Local Intense Precipitation (LIP). The maximum flood level for the reevaluated LIP event is 102 ft, Public Service Datum (PSD), which is well below the flood-protected elevations (Reference 19).

Although the current licensing basis flood height does not increase, some of the hazards and associated effects originally required an Integrated Assessment in accordance with NRC interim staff guidance JLD-ISG-2012-05 (Reference 61). In Reference 62, the Commission affirmed that licensees need to address the reevaluated flooding hazards within their mitigating strategies for BDBEEs, including the reevaluated flood hazards. In addition, the guidance of JLD-ISG-2016-01 (Reference 63) supersedes JLD-ISG-2012-05 (Reference 61) guidance for performing a flooding integrated assessment.

The FLEX strategies are based on the current design basis flood level, but PSEG revised changes to severe weather procedures to consider the results of the re-evaluated external flood hazard and to ensure that FLEX strategy initiation and execution appropriately considers the re-evaluated external flood hazard.

The current licensing basis, described in UFSAR Subsection 2.4.2, states the probable maximum hurricane event is the only applicable external flooding event for SGS. Flood hazard re-evaluations (Reference 19) show the LIP event and storm surge event affect SGS.

The FLEX DGs pre-staged in the Canyon area are above LIP flood depths and are not vulnerable to an external flooding event other than from a hurricane driven storm surge event. A hurricane event is assumed to have greater than 48 hours of warning time and flooding is expected to persist above site grade for approximately 11 hours. PSEG Nuclear will deploy and flood-protect four FLEX DGs within the Canyon area after a hurricane event that meets specified criteria is predicted and before the hurricane reaches SGS. Flood protection will be accomplished by the erection of a 16 ft. high temporary flood barrier at the open end of the Canyon area. Based on the location of the temporary wall relative to storm surge fetch lines, the height of the wall provides adequate protection against the design basis and re-evaluated storm surge flood depths (Supplement 17 of DCP 80111494, Reference 70).

Once the flood barrier is erected, the FLEX DGs deployed in the Canyon area, including the N+1 FLEX DG, will not be vulnerable to an external flooding event. Pumps to remove accumulated rainwater during the hurricane event will be located in the Canyon area and will be powered by the FLEX DG or station power (if available).

FLEX equipment other than the diesel driven FLEX SW pumps will be deployed prior to the hurricane. The diesel driven FLEX SW pump, including the N+1 pump, will be moved from the normal outdoor storage locations to the flood protected HCGS Unit 2 Reactor building before the arrival of a hurricane and deployed after flood waters recede.

Prior to an anticipated hurricane event, actions are taken to move equipment and restock supplies in accordance with site severe weather procedures and FSGs.

2.6.3 *Severe Storms with High Wind*

Per the current design basis, a wind load of 30 pounds per square foot, equivalent to 108 mph was applied to Category I structures. The Containment, Auxiliary, and Fuel Handling Buildings have been checked against a tornado loading based on a peripheral wind velocity of 300 mph and a translational velocity of 60 mph (UFSAR Section 3.3).

As described in UFSAR Section 3.5, Category I structures including Containment, Auxiliary, and Fuel Handling Buildings are also designed to withstand tornado missiles. A wooden utility pole has been used as the critical object for penetration analysis. The pole is 40 feet long, 12 inches in diameter, weighing 50 pounds per cubic foot, traveling in a vertical or horizontal direction at 150 mph. In addition, the exterior walls of the safety-related plant structures, which have a minimum thickness of 18 inches, have been evaluated against the following two missiles:

1. Steel rod, one inch diameter, three feet long, weight eight pounds, traveling horizontally at 316 feet per second and vertically at 252 feet per second, at all elevations: and

2. Utility pole, 13-1/2 inches diameter 35 feet long, weight 1490 pounds, traveling horizontally at 211 feet per second and vertically at 169 feet per second, at all elevations less than 30 feet above grade within 1/2 mile of the facility structures.

A passenger car missile is also used in the evaluation. Additional details of tornado missile protection, including the use of service water from the Delaware River for auxiliary feedwater as a last resort, are provided in UFSAR Section 3.5.

SGS is located at latitude 39° 27 min 46 sec north and longitude 75° 32 min 08 sec west (UFSAR Section 2.1). Using Figures 7-1 and 7-2 from NEI 12-06, PSEG determined that SGS could experience hurricane winds of approximately 160 mph (Figure 7-1), and could experience tornado force winds of approximately 166 mph (Region 2 in Figure 7-2).

SGS is using an alternative to the criteria of NEI 12-06 Section 7.3.1, “Protection of FLEX Equipment,” which recommends protection of FLEX equipment from high wind hazards via storage in a structure or in diverse locations. FLEX equipment required to mitigate a BDBEE at SGS is stored at its point of deployment in a robust structure (e.g., new distribution equipment and pumps stored in the Auxiliary Building), pre-staged in the Canyon area, or stored in locations separated by sufficient distance to minimize the probability that a single event would damage all of the FLEX equipment needed to mitigate the event.

Two FLEX DGs, electrical connections and distribution equipment are stored in the Canyon area. The stored FLEX DGs, electrical connections and distribution equipment are installed or stored in the eastern most area of the Canyon, towards the Service Water Accumulator Building, surrounded on all four sides by the Fuel Handling and Auxiliary Buildings. FLEX equipment and connections located in the sheltered Canyon area are designed for a site specific wind speed of 200 mph that has an exceedance probability of 10^{-7} for this location.

Stored equipment in the Canyon area is protected from missiles with a maximum height of 30 feet above grade by its location between the robust Seismic Category I Auxiliary and Fuel Handling buildings. The locations for stored equipment were chosen so that they are protected by Category I structures in all horizontal trajectory line directions. There is no straight line trajectory for an automobile or utility pole type of missile to impact the stored equipment. A tornado missile evaluation was completed specifically for the Canyon configuration based on the SGS design basis (Supplement 7 of DCP 80111494, Reference 70). Based on this evaluation, a 1" solid steel rod traveling at 26 feet/sec is used to design the hardened protection of FLEX equipment and connections located in the sheltered Canyon area. The FLEX DGs pre-staged in the Canyon area are hardened to provide protection from this missile impact and are secured to protect against tornado wind speeds. The two FLEX DGs stored outside of the Canyon area are not missile protected but are separated by 1200 feet or greater to ensure a single tornado does not impact more than one stored FLEX DG. Therefore, at least one of the unprotected FLEX DGs will be available for deployment to the Canyon area following a tornado event.Figure 4 shows the locations of the OFSAs and the Canyon Area.

The two FLEX DGs deployed to the Canyon area prior to the hurricane event are not designed with inherent missile protection but they will be secured for protection from hurricane wind speeds. However, consistent with NEI 12-06, Section 7.3.2(1) these two FLEX DGs are located in an area where protective actions will be taken to reduce the potential for wind impacts. This area of the Canyon is protected on three sides by the Auxiliary Building (approximately 40 feet above grade) and Fuel Handling Building (approximately 80 feet above grade). The western side will have an earthen based flood wall constructed to an elevation of 16 feet above grade that will stop a hurricane missile. The flood wall has been used in other applications to safeguard personnel, vehicles, equipment, facilities and other critical assets in military operations. Therefore, hurricane missile protection is provided on all sides, with the area above the flood wall as the only vulnerability to the two DGs staged in the open area of the Canyon. This vulnerability is reasonable given the following:

- Section 3.1 of NUREG/CR-7004, "Technical Basis for Regulatory Guidance on Design-Basis Hurricane-Borne Missile Speeds for Nuclear Power Plants" (Reference 51) notes that, unlike tornados, forces that increase the elevation of hurricane missile with respect to ground are negligible, and updraft winds speeds are neglected. A footnote to this section discusses automobile missiles in general and concludes that automobiles may be rolled around at ground level during a hurricane, but will not go airborne. Therefore, hurricane wind missiles in general will be lower to the ground, which is protected to 16 feet above grade.

- The area to the west of the Canyon is the location of safety-related water storage tanks which protect much of the Canyon area from a western missile strike. The area to the west that is not blocked by these safety-related tanks is open and is level to the protected area fence line with a downward slope to the Delaware River from the fence line. There is only transient vehicle activity such as security patrols and deliveries in this area. Transient vehicle activity would be limited during the extreme winds of a BDB hurricane. The Delaware River is over 2 miles wide at this location making a missile originating on the opposite shore a non-credible event.

Based on these considerations, the two FLEX DGs staged in the open area of the Canyon are located in areas where protective actions have been taken to reduce the potential for wind impacts.

The strategy for maintaining AFW sources available following a tornado event is described in Section 2.3.2. Reference 59 provides a basis for adequate separation of the SGS AFSTs and the Hope Creek Generating Station (HCGS) Fire Water tanks, based on a conservative plant-specific tornado evaluation and a tank separation distance of approximately 2,240 ft.

2.6.4 *Ice, Snow and Extreme Cold*

The current licensing basis for local meteorology including severe weather described in UFSAR Section 2.3. An evaluation of outdoor FLEX equipment in extreme temperature conditions (Reference 71) considered a low temperature of -4 °F based on Hope Creek UFSAR Table 2.3-11, which is bounding for the site. SGS is located at latitude 39° 27 min 46 sec north and longitude 75° 32 min 08 sec west (UFSAR Section 2.1). Based on NEI 12-06 Figure 8-2, the site is located in an area with maximum ice storm severity level 3, i.e., "Low to medium damage to power lines and/or existence of considerable amount of ice."

The SGS plan for storage locations includes either storage at the point of deployment, storage in the Canyon area, or storage at diverse locations within the protected area or adjacent to the protected area. Reference 71 established the minimum outdoor temperature as -4°F.

SGS is using an alternative to the criteria of NEI 12-06 Section 8.3.1, "Protection of FLEX equipment", which recommends storage of the N FLEX equipment within a structure to provide protection against snow, ice and extreme cold hazards as described in correspondence with the NRC in August of 2014 (Reference 58).

Equipment stored outdoors is designed for outdoor storage in cold environments consistent with normal design practices, e.g., using diesel engine block heaters and space heaters.

FLEX strategies include providing power for installed heat tracing for water sources required for the strategies (AFST and RWST).

Snow removal is a normal activity at the plant site because of the climate. Reasonable access to FLEX equipment will be maintained throughout a snow event in accordance with MA-AA-716-002-1002, *Facilities Maintenance Guidelines*. Ice management will be performed as required such that large FLEX equipment can be moved by vehicles. Debris removal equipment can move through moderate snow accumulation and can also be used to move FLEX equipment.

PSEG integrated the FLEX capabilities into existing site cold weather procedures and established periodic FLEX equipment status checks that include diesel keep warm systems and verification that access to equipment is not impaired by snow or ice. The following procedures were revised to support outdoor FLEX equipment operational functionality and deployment during periods of cold weather including snow and ice:

- OP-AA-108-111-1001, *Severe Weather and Natural Disaster Guidelines*
- SC.OP-PT.ZZ-0002, *Station Preparations for Seasonal Conditions*
- SC.OP-PM.FLX-0001, *FLEX Standby Equipment Status Checks*
- MA-AA-716-002-1002, *Facilities Maintenance Guidelines*

2.6.5 *High Temperatures*

The current licensing basis for local meteorology including severe weather is described in UFSAR Section 2.3. An evaluation of outdoor FLEX equipment in extreme temperature conditions (Reference 71) considered a high temperature of 100 °F based on UFSAR Table 2.3-5.

The SGS FLEX equipment storage locations include the point of deployment in the Auxiliary Building, the Canyon area, and locations within or adjacent to the protected area. These locations are either outdoors or are shown by evaluation to maintain reasonable temperatures for storage and deployment of FLEX equipment following a loss of ventilation due to an ELAP. GOTHIC analyses address temperatures in SGS plant areas where FLEX equipment is deployed and considers personnel heat stress during deployment (Reference 68). All FLEX equipment has been procured to be suitable for use at the peak temperature. Therefore, high temperature does not impact the deployment of FLEX equipment.

2.7 PROTECTION OF FLEX EQUIPMENT

Protection of FLEX Equipment is addressed in Section 2.6 for each of the applicable external hazards. Towing and debris removal equipment are stored so that one set of equipment (one towing vehicle, one debris removal vehicle, and one forklift) will survive all hazards.

2.8 PLANNED DEPLOYMENT OF FLEX EQUIPMENT

2.8.1 *Haul Paths*

Pre-determined, preferred haul paths have been identified and documented in the FLEX Support Guidelines (FSGs). Figure 4 shows the haul paths from the storage locations to the various deployment locations.

Phase 3 of the FLEX strategies involves the receipt of equipment from offsite sources including the NSRC and various commodities such as fuel and supplies. Delivery of this equipment can be through airlift or via ground transportation. Debris removal for the pathway between the site and the NSRC receiving locations (staging areas) and from the various plant access routes may be required. The same debris removal equipment used for onsite pathways may also be used to support debris removal to facilitate road access to the site once necessary haul routes and transport pathways onsite are clear.

2.8.2 *Accessibility*

The potential impairments to required access are: 1) doors and gates, and 2) site debris blocking personnel or equipment access. The coping strategy to maintain site accessibility through doors and gates is applicable to all phases of the FLEX coping strategies, but is essential as part of the immediate activities required during Phase 1.

Doors and gates serve a variety of barrier functions on the site. One primary function, security, is discussed below. Other barrier functions include fire, flood, radiation, ventilation, tornado, and high energy line break. These doors and gates are typically administratively controlled to maintain their function as barriers during normal operations. Following a B DBEE and subsequent ELAP event, FLEX coping strategies require the routing of hoses and cables through various barriers in order to connect portable BDB equipment to station fluid and electric systems. F or this reason, certain barriers (gates and doors) will be ope ned and remain open. This deviation from normal administrative controls is acknowledged and i s acceptable during the implementation of FLEX coping strategies.

The ability to open do ors for ingress and e gress, ventilation, or temporary cables/hoses routing is necessary to implement the FLEX coping strategies. During an E LAP, personnel and v ehicle access to the Protected Area is controlled by the Security Plan and implementing procedures which include provisions for alternate means of access control. Internal locked areas are also subject to Security control during an E LAP and may be ac cessed via keys controlled by the Operations Shift Manager in accordance with administrative controls in OP-SA-108-101-1002, *Key Control - Salem*.

2.9 DEPLOYMENT OF STRATEGIES

2.9.1 *Fueling of Equipment*

Portable equipment used in Phase 2 is equipped with fuel storage tanks sufficient for at least 9 hours of operation without refueling to minimize actions required to keep equipment running (Reference 8). A fuel line will be routed from the diesel fuel oil (DFO) day tank supply lines in the Auxiliary Building to elevation 100 feet truck bay area. In addition, a connection is provided at the SGS Unit 2 Canyon area to supply fuel to equipment staged at that area. The installed 12 (22) DFO transfer pump will be re-powered via the FLEX MCC to pump fuel oil from either of the two 30,000 gallon DFO storage tanks to the supply lines and the DFO day tank. Personnel can fill equipment through hose runs or by use of a portable fuel transfer trailer.

Technical Evaluation 80111831-0060 (Reference 81) concludes that installed sources of fuel can supply FLEX equipment for approximately five days after an ELAP, after which offsite resources are assumed available to resupply the diesel fuel oil.

2.10 OFFSITE RESOURCES

2.10.1 *National SAFER Response Center*

The industry has established two (2) National SAFER Response Centers (NSRCs) to support utilities during BDB events. P SEG 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 will be able to be fully deployed when requested, the fifth set will have equipment in a maintenance cycle. In addition, onsite BDB equipment hose and cable end fittings are standardized with the equipment supplied from the NSRC.
In the event of a BDB external event and subsequent ELAP/LUHS condition, equipment will be moved from a NSRC to a local staging area established by the Strategic Alliance for FLEX Emergency Response (SAFER) team. From there, equipment can be taken to the PSEG site and staged at the SAFER onsite Staging Area "B" (Figure 4) by helicopter if ground transportation is unavailable. Communications will be established between the site and the SAFER team and required equipment moved to the site as needed. First arriving equipment will be delivered to the site within 24 hours from the initial request. The order in which equipment is delivered is identified in the *SAFER Response Plan for Salem Generating Station* (Reference 20).

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 BDB external event at SGS is listed in Table 2. Table 2 identifies the equipment that is specifically credited in the FLEX strategies for SGS, but also lists the equipment that will be available for backup/replacement if needed. Since all the equipment will be located at the local staging area, the time needed for the replacement of a failed component will be minimal.

2.11 HABITABILITY AND OPERATIONS

2.11.1 *Equipment Operating Conditions*

Following a BDBEE and subsequent ELAP/LUHS event at SGS, ventilation providing cooling to occupied areas and areas containing FLEX strategy equipment will be lost. Per the guidance 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 resulting in an ELAP/LUHS. The primary concern with regard to ventilation is the heat buildup which occurs when forced ventilation is lost in areas that continue to have heat loads. A loss of ventilation analysis was 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 qualification limits.

The key areas identified for all phases of execution of the FLEX strategy activities are the Main Control Room (MCR), Auxiliary Building (includes battery rooms, battery chargers, and inverters), and the Fuel Handling

Building. These areas have been evaluated (Reference 68) to determine the temperature profiles following an ELAP/LUHS event. With the exception of the TDAFW pump room located in the Auxiliary Building, results of the calculation have concluded that temperatures remain acceptable based on conservative input heat load assumptions for all areas with no actions being taken to reduce heat load or to establish either active or passive ventilation (e.g., portable fans, open doors, etc.).

The key actions identified in Reference 68 are as follows:

1) Opening the TDAFW pump room door within 30 minutes and installing a portable fan in the doorway at approximately 10 hours provides accessibility and ensures equipment reliability. The TDAFW pump room is the only area for which portable ventilation is used as a compensatory measure.

2) Restore a FHB exhaust fan for building pressure control.

3) Operation of a Control Area ventilation fan for Control Room Envelope temperature control for personnel stay times.

4) Restore a switchgear supply fan to moderate temperatures for access to the elevation 84 feet switchgear area.

GOTHIC analysis of the battery rooms show that peak temperature remains below 120 °F and no ventilation or other compensatory measures are required to support equipment performance or personnel stay times (Reference 68). Although not required for temperature considerations, the Phase 2 strategy includes re-energizing the battery room exhaust fans at approximately 6 hours after the event to control hydrogen buildup in the battery rooms. Battery room ventilation is established when energizing the battery chargers using S1/S2.OP-FS.FLX-0005, *Initial Assessment and FLEX Equipment Staging* (FSG-5).

Low battery room temperature is addressed in Technical Evaluation 80111831-0080, *Effect of a Severe Low Outside Ambient Temperature on Station Batteries* (Reference 73), which assumes that the batteries are at a design charge level at the initiation of an ELAP due to severe cold weather. The temperature in the battery rooms is assumed to be the procedural minimum temperature of 65 °F at the time the ELAP occurs. The 28 VDC and 125 VDC battery sizing calculations (References 74 and 75) assume a 65 °F initial room (electrolyte) temperature. Technical Evaluation 80111831-0080 concludes that the battery rooms do not decrease below the initial 65 °F during the time required for battery operation.

2.12 HABITABILITY

Habitability was evaluated as discussed in Section 2.11.1 in conjunction with equipment operabilty and determined to be acceptable.

2.13 LIGHTING

Lighting is required for operator actions and access in the plant to implement actions associated with the SBO procedure. Emergency lighting is provided by local battery-powered emergency lighting. The availability of this lighting is at least 8 hours.

The MCR and other areas of the Auxiliary Building have emergency lighting available from the 125 VDC system via the Emergency Lighting Inverters. The 125 VDC system will have power supplied to the battery chargers from the FLEX diesel generator.

Portable battery powered lights will also be available for use in areas that require operator access to perform Phase 2 equipment connections.

2.14 COMMUNICATIONS

In a letter to licensees in March 2012 (Reference 38), the NRC requested licensees to assess their current communications systems and equipment used during an emergency event considering the potential extensive damage to normal and emergency communications systems both onsite and in the area surrounding the site resulting from a large scale natural event. This request was prompted by NTTF Recommendation 9.3 (Reference 1).

NEI 12-01 (Reference 25) provides guidelines for addressing BDBEE accident response communication capabilities. PSEG Nuclear submitted the communications assessment to the NRC on October 31, 2012 (Reference 52) based on the guidance of NEI 12-01. In response to NRC generic technical issues for resolution (Reference 53), PSEG Nuclear provided a follow-up response with planned enhancements for communications to the NRC on February 21, 2013 (Reference 54). The NRC issued their staff assessment of the communications assessment for SGS on June 3, 2013 (Reference 55).

Prior to the communications enhancements, existing on-site radio systems and equipment were assumed to be unavailable if they were subjected to, and not protected from, seismic, wind or flooding effects during a BDBEE. Portions of the existing Operations and Fire Department UHF plant radio system infrastructure were assumed to remain available in areas where equipment is reasonably protected from the effects of a postulated BDBEE.

Communications enhancements were implemented via Design Change Package (DCP) 80110936, which provided a direct connection between the MCR base station and the UHF repeaters. This change enables radio communication between the MCR and other areas within the SGS power block by eliminating the dependence on the connection through an electronics bank susceptible to BDB flooding.

DCP 80110936 also installed satellite phones for Salem Unit 1 and 2 in accordance with the recommendations of the NRC-endorsed NEI 12-01. The DCP installed three satellite phones in the MCR, five in the Technical Support Center (TSC) and two in the backup Operations Support Center (OSC) (Operations Conference Room in the MCR). The satellite phones operate through the use of external antennas and are powered through the 1A and 2A Vital Inverters (note that the 1A Vital Inverter supplies all the equipment except for one DC remote control desk-set, supplied by the 2A Vital Inverter).

2.15 WATER SOURCES

2.15.1 *Water Sources - Secondary Side*

Section 2.3.9.4 provides a list of potential water sources that may be used to provide cooling water to the Steam Generators (SGs), their capacities, and an assessment of availability following the applicable hazards identified in Section 2.6. Descriptions of the preferred water usage sources are provided in Section 2.3.9.4 and are in the sequence in which they would be used, based on their availability after an ELAP/LUHS event.

2.15.2 *Water Sources- Primary Side*

As discussed in Section 2.3.9.5, two sources for borated water have been evaluated for use during a BDBEE: the Boric Acid Storage Tanks (BASTs) (one per unit) and the BDB Boric Acid Mixing Tanks that are stored in the SGS Auxiliary Building in the drumming and storage area.

Clean water sources for use in batching borated water in the Boric Acid Mixing Tanks would be used as discussed in Section 2.3.9.5.

2.15.3 *Spent Fuel Pool (SFP)*

At SGS, any water source available is acceptable for use as makeup to the SFP; however, the primary source would be as previously discussed in Section 2.4.7. Water quality is not a significant concern for makeup to the SFP. Likewise, boration is not a concern since boron is not being removed from the SFP when boiling.

2.16 SHUTDOWN AND REFUELING MODES ANALYSIS

SGS is abiding by the Nuclear Energy Institute position paper entitled "Shutdown/Refueling Modes," dated September 18, 2013, addressing mitigation strategies in shutdown and refueling modes (Reference 21). This position paper has been endorsed by the NRC staff (Reference 22).

SGS has provided for shutdown risk enhancements by employing the actions contained in NEI Position Paper for shutdown and refueling modes (Reference 21). PSEG procedures OU-AA-103, *Shutdown Safety Management Program* and OU-SA-105, *Shutdown Safety Management Program - Salem Annex* allow for consideration of FLEX equipment and procedures when planning and scheduling outage activities. S1/S2.OP-AB.RHR-0001, *Loss of RHR* and S1/S2.OP-AB.RHR-0002, *Loss of RHR at Reduced Inventory* revisions provide instructions for RCS injection during an ELAP condition using the FLEX AFW pump. The FLEX AFW pump and associated hoses will be pre-staged prior to entry into a reduced RCS inventory condition as directed in S1/S2.OP-SO.RC-0006, *Draining the Reactor Coolant System <101 Ft Elevation With Fuel In the Vessel*.

Mode 5 (Cold Shutdown) and Mode 6 (Refueling) with the cavity not flooded

The Phase 1 core cooling strategies using the TDAFW Pump and SG PORVs will either not be possible due to secondary system unavailability or will only be used once plant heat up has occurred and secondary side steam is available. Portable equipment for Phase 2 FLEX strategies is capable of performing required functions while in Mode 5 and Mode 6 with the refueling cavity not flooded. Gravity feed and spill from the RWST through a RCS vent path may be available for decay heat removal as a Phase 1 strategy. Prioritization of primary system versus secondary system injection strategies with Phase 2 portable equipment will be considered based on RCS and Secondary system configuration.

Mode 6 - Refueling with the cavity flooded

The Phase 1 core cooling strategy does not rely on installed equipment other than the reactor vessel and associated refueling cavity water inventory. Due to the lower decay heat level in the reactor and larger volume of water in the refueling cavity, response times for portable Phase 2 equipment for core cooling are expected to be bounded by Mode 1 requirements. SFP cooling assumptions for decay heat assume a freshly off-loaded core and are sufficient to ensure adequate fuel pool makeup with portable equipment in Mode 6.

SFP makeup and time for boil-off to result in fuel uncovery are described in Section 2.4

2.17 SEQUENCE OF EVENTS

Table 3 presents a Sequence of Events (SOE) Timeline for an ELAP/LUHS event at SGS. Validation of each of the FLEX time constraint actions has been completed (Reference 46) in accordance with the FLEX Validation Process document issued by NEI (Reference 28), and includes consideration for staffing.

2.18 PROGRAMMATIC ELEMENTS

2.18.1 *Overall Program Document*

EM-SA-100-1000, *Response to Beyond Design Basis External Events Program Document - Salem Generating Station* provides a description of the Diverse and Flexible Coping Strategies (FLEX) Program for SGS. The key elements of the program include:

- Maintenance of the FSGs including any impacts on the interfacing procedures (EOPs, APs, EDMGs, SAMGs, etc.)
- Maintenance and testing of FLEX equipment (i.e., SFP level instrumentation, emergency communications equipment, portable FLEX equipment, FLEX support equipment, and BDB support vehicles)
- Portable equipment deployment routes, staging areas, and connections to existing mechanical and electrical systems
- Validation of time sensitive operator actions
- The FLEX storage locations and the National SAFER Response Center
- Hazards Considerations (Flooding, Seismic, High Winds, etc.)
- Supporting evaluations, calculations and BDB drawings
- Tracking of commitments and equipment unavailability
- Staffing, Training and Emergency Drills
- Configuration Management
- Program Maintenance

In addition, the program description includes (1) a list of the BDB FLEX basis documents that will be kept up to date for facility and procedure changes, (2) a historical record of previous strategies and their bases, and (3) the bases for ongoing maintenance and testing activities for the FLEX equipment.

The instructions required to implement the various elements of the FLEX Program and thereby ensure readiness in the event of a Beyond Design Basis External Event are contained in EM-AA-100, *Emergency Management,* and associated T&RMs.

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.

2.18.2 ***Procedural Guidance***

The inability to predict actual plant conditions that require the use of FLEX equipment makes it not feasible to provide specific procedural guidance. The FLEX Support Guidelines (FSGs) provide guidance that can be employed for a variety of conditions. Clear criteria for entry into FSGs ensures that FLEX strategies are used only as directed for BDB external event conditions, and are not used inappropriately in lieu of existing procedures. When FLEX equipment is needed to supplement EOPs or Abnormal Procedures (ABs), the EOP or AB directs the entry into and exit from the appropriate FSG. The existing command and control procedure structure will be used to transition to SAMGs if FLEX mitigation strategies are not successful.

FSGs have been developed in accordance with Pressurized Water Reactor Owner's Group (PWROG) guidelines. The FSGs provide instructions for implementing available, pre-planned FLEX strategies to accomplish specific tasks in the EOPs or ABs. FSGs are used to supplement (not replace) the existing procedure structure that establishes command and control for the event. If plant systems are restored, exiting the FSGs and returning to normal plant operating procedures will be addressed by the plant's emergency response organization and operating staff dependent on the actual plant conditions at the time.

Procedural Interfaces have been incorporated into 1/2-EOP-LOPA-1, *Loss of All AC Power* and 1/2-EOP-LOPA-4, *Extended Loss of All AC Power*, to the extent necessary to include appropriate reference to FSGs and provide command and control for the ELAP. Additionally, procedural interfaces have been incorporated into existing ABs to include appropriate references to FSGs.

FSG maintenance is performed by Operations as described in EM-AA-100-1002. FSGs have been reviewed and validated to the extent necessary to ensure that implementation of the associated FLEX strategy is feasible.

Specific FSG validation was accomplished via table top evaluations and walk-throughs of the guidelines when appropriate.

2.18.3 *Staffing*

The minimum on-shift staffing complement for SGS and HCGS is defined in the *PSEG Nuclear Emergency Plan*, Section 3.0, Figure 3-1 and Procedures FP-AA-012, *Fire Protection Organization Duties and Staffing*, OP-SA-112-101-1001, *Shift Turnover Responsibilities*, for SGS, and OP-HC-112-101-1001, *Shift Turnover Responsibilities* for HCGS.

The minimum on-shift staffing was evaluated in accordance with the process defined in NEI 12-01 for both single and multi-unit events (Reference 25). The minimum staffing defined by the referenced procedures is adequate to accomplish the coping and mitigation strategies for BDBEEs with the addition of one on-shift debris removal operator and one on-shift towing operator for a total of two personnel for SGS and HCGS combined. Reference 26 provides the staffing study that serves as the basis for the size and configuration of the minimum on shift staff.

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

A. An extended loss of AC power (ELAP)

B. An extended loss of access to ultimate heat sink (LUHS)

C. Impact on all three units on site (SGS Units 1 and 2, and HCGS are in operation at the time of the event)

D. Impeded access to the units by offsite responders as follows:

- 0 to 6 Hours Post Event - No site access.
- 6 to 24 Hours Post Event - Limited site access. Individuals may access the site by walking, personal vehicle or via alternate transportation capabilities (e.g., private resource providers or public sector support).
- 24+ Hours Post Event - Improved site access. Site access is restored to a near-normal status and/or augmented transportation resources are available to deliver equipment, supplies and large numbers of personnel.

The staffing assessments noted above were performed in conjunction with the development of procedures and guidelines that address NRC Order EA-12-049. Once the FSGs were developed, a validation assessment of the FSGs was performed using the staff resources consistent with the staffing study and communications equipment available post-BDBEE. The validation process was performed and documented (Reference 46) in accordance with NEI Guidance (Reference 28).

2.18.4 *Training*

PSEG's Nuclear Training Program has been revised to assure personnel proficiency in utilizing FSGs and associated FLEX equipment for 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 has been provided and periodic training will be provided to site emergency response leaders on BDB emergency response strategies and implementing guidelines. Personnel assigned to direct the execution of the FLEX mitigation strategies for BDB external events have received the necessary training to ensure familiarity with the associated tasks, considering available job aids, instructions, and mitigation strategy time constraints.

In accordance with Section 11.6 of NEI 12-06, ANSI/ANS 3.5, *Nuclear Power Plant Simulators for use in Operator Training* (Reference 29), 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.

Performance enhancing activities (which may include drills, exercises, table-top drills, out-of-sequence focused drills, etc.) to provide knowledge and skill development for FLEX responses will be incorporated into the overall PSEG Nuclear drill and exercise program. PSEG Nuclear follows the training requirements set forth in 10 CFR 50.47(b)(14) and 10 CFR 50 Appendix E Section F.2.j.

2.18.5 *Equipment List*

The equipment stored and maintained at the on-site storage locations necessary for the implementation of the SGS FLEX strategies is listed in Table 1. Table 1 identifies the quantity, and applicable strategy for the major BDB equipment components, as well as various clarifying notes. Specific details regarding fittings, tools, hose lengths, consumable supplies, etc. are not provided in Table 1. PSEG addressed the FLEX equipment design attributes of NEI 12-06 Section 11.2 as part of the station design process, (e.g., References 32, 33, 36, 37, and 70).

2.18.6 *N+1 Equipment Requirement*

NEI 12-06 invokes an N+1 requirement for the major BDB FLEX equipment that directly performs a FLEX mitigation strategy for core cooling, containment, or SFP cooling in order to assure reliability and availability of the FLEX equipment required to meet the FLEX strategies. PSEG has purchased sufficient equipment to address all functions at all units on-site, plus one additional spare, i.e., an N+1 capability, where "N" is the number of equipment required by FLEX strategies for all units on-site. SGS Units 1 and 2 and HCGS are co-located on a common site (i.e., the stations are in a common Protected Area, use a common Emergency Plan, Security Plan, etc.). For major FLEX equipment common to both stations (FLEX diesel generators and diesel driven FLEX SW pumps), the N+1 requirement is met by providing at least one spare in addition to the minimum set of equipment needed for both stations.

Where a single resource is sized to support the required function of both SGS units, a second resource has been purchased to meet the N+1 capability. In addition, where multiple strategies to accomplish a function have been developed, (e.g., two separate means to repower instrumentation) the equipment associated with each strategy does not require N+1 capability.

The N+1 capability applies to the FLEX equipment that directly supports maintenance of the key safety functions identified in Table 3-2 of NEI 12-06. Other FLEX support equipment provided for mitigation of BDB external events, but not directly supporting a credited FLEX strategy, is not required to have N+1 capability.

PSEG is using the NRC-endorsed alternative to NEI 12-06 Revision 0, N+1 criteria for cables and hoses. For the cables associated with FLEX equipment required for FLEX strategies, SGS uses Method 2 as described in Reference 56 and endorsed by the NRC in Reference 57. The +1 capability is accomplished by having cables of sufficient length to replace any damaged cable of that same configuration, as shown in References 78 and 79 for SGS Units 1 and 2, respectively.

For the hoses associated with FLEX equipment required for FLEX strategies, SGS uses Method 1 as described in Reference 56 and endorsed by the NRC in Reference 57. For each hose type, the hose runs were sorted by safety function as defined in NEI 12-06, Table 3-2. The amount of hose required for each safety function was then determined by identifying the longest run of that type hose required for each unit combined with any additional lengths required for concurrent routings of the same type hose. The total length of each hose type required for the station was determined. The +1 capability was satisfied by adding 10% of the total length required for each hose type and safety function (Reference 80).

The N+1 requirement does not apply to the BDB FLEX support equipment, vehicles, and tools. However, these items are covered by an administrative procedure and are subject to inventory checks, unavailability requirements, and any maintenance and testing that are needed to ensure they can perform their required functions.

2.18.7 *Equipment Maintenance and Testing*

FLEX mitigation equipment is subject to initial acceptance testing and subsequent periodic maintenance and testing to verify proper function.

The equipment was tested at the factory to ensure it meets the requirements specified in the purchase order. The DCP testing requirements are identified using CC-AA-107, *Configuration Change Acceptance Testing Criteria*. FLEX equipment is in the Preventive Maintenance (PM) program which defines periodic testing and maintenance and follows EPRI template requirements (Reference 31). The preventive maintenance requirements as defined by MA-AA-716-210, *Preventive Maintenance (PM) Process*, are entered into SAP to document the required information.

FLEX and SFP Level Instrumentation allowable outage times and required actions are maintained in OP-SA-108-115-1001, *Operability Assessment and Equipment Control Program,* to meet the requirements in NEI 12-06 and NEI 12-02.

FLEX equipment can be used for other purposes as long as controls are put in place to ensure equipment is able to be deployed to the proper locations within the time requirements of the FLEX strategies. Connecting FLEX equipment to plant systems outside of a BDB ELAP may require the Shift Manager/Emergency Coordinator to invoke 10CFR50.54(x) and/or 10CFR73.55(p). The equipment must be returned to the proper storage area if severe weather is predicted or when not in use. Use of portable diesel equipment must be used in accordance with New Jersey Department of Environmental Protection (NJDEP) air permits. FLEX equipment must be tracked when alternate use of equipment and connections is permitted using the tracking form contained in OP-SA-108-115-1001.

The exception to this tracking requirement is the earth moving equipment and towing equipment. This equipment is maintained by the site services group and the requirements to separate this equipment by 1200 feet during severe weather and when not in use is controlled by MA-AA-716-002-1002, *Facilities Maintenance Guidelines*.

3. References

1. NRC Near Term Task Force Report (NTTF), *Recommendations for Enhancing Reactor Safety in the 21st Century; The Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident*, dated July 12, 2011 (ADAMS Accession No. ML111861807).

2. NRC Order Number EA-12-049, *Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events*, dated March 12, 2012.

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

4. NRC Interim Staff Guidance JLD-ISG-2012-01, *Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events*, Revision 0, dated August 29, 2012.

5. NRC Order Number EA-12-051, *Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation*, dated March 12, 2012.

6. NEI 12-02, Revision 1, *Industry Guidance for Compliance with NRC Order EA-12-051, 'To Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation',* Nuclear Energy Institute, August 2012.

7. NRC Interim Staff Guidance JLD-ISG-2012-03, *Compliance with Order EA-12-051, Order Modifying Licenses with Regard to Reliable Spent Fuel Pool Instrumentation*, Revision 0, dated August 29, 2012.

8. SAP Order Operation 80108711-0350*, Evaluation of FLEX Portable Equipment Fuel Usage Against NEI 12-06 Requirements*.

9. Salem Generating Station Technical Specifications.

10. WCAP-17601, Revision 0, *Reactor Coolant System Response to the Extended Loss of AC Power Event for Westinghouse, Combustion Engineering and Babcock & Wilcox NSSS Designs*, August 2012.

11. WCAP-17792-P, Revision 0, *Emergency Procedure Development Strategies for the Extended Loss of AC Power Event for all Domestic Pressurized Water Reactor Designs.*

12. NRC letter to PWROG Regarding NOTRUMP dated June 16, 2015 (ADAMS Accession No. ML15061A442).

13. PWROG-14027-P, *No. 1 Seal Flow Rate for Westinghouse Reactor Coolant Pumps Following Loss of All AC Power Task 3: Evaluation of Revised Seal Flow Rate on Time to Enter Reflux Cooling and Time at which the Core Uncovers,* Revision 3, April 2015.

14. Pressurized Water Reactor Owner's Group Report, PWROG-14015-P, Revision 1, No. 1 Seal Flow Rate for Westinghouse Reactor Coolant Pumps Following Loss of All AC Power, Task 2: Determine Seal Flow Rates, September 2014.

15. Westinghouse Response to NRC Generic Request for Additional Information (RAI) on Boron Mixing in Support of the Pressurized Water Reactor Owners Group (PWROG), dated August 16, 2013 (ADAMS Accession No. ML13235A135).

16. Letter to Mr. J. Stringfellow (Westinghouse) from Mr. J. R. Davis (NRC) dated January 8, 2014 endorsing the Westinghouse Position Paper on Boron Mixing (ADAMS Accession No. ML13276A183).

17. Letter to Mr. J. E. Pollock (NEI) from Mr. J. R. Davis (NRC) dated September 16, 2013 endorsing NEI White Paper entitled *Battery Life Issue* (ADAMS Accession No. ML13241A182).

18. Salem Generating Station Updated Final Safety Analysis Report (UFSAR).

19. PSEG Letter LR-N14-0042, *PSEG Nuclear LLC's Response to Request for Information Regarding Flooding Aspects of Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident - Salem Generating Station Flood Hazard Reevaluation*, dated March 11, 2014.

20. Vendor Technical Document (VTD) 903060, Volume 1, *SAFER Response Plan for Salem Generating Station.*

21. NEI Position Paper: *Shutdown/ Refueling Modes*, dated September 18, 2013 (ADAMS Accession No. ML13273A514).

22. Letter to Mr. J.E. Pollock (NEI) from Mr. J. R. Davis (NRC) dated September 30, 2013 endorsing NEI Shutdown/Refueling Modes Position Paper, (ADAMS Accession No. ML13267A382).

23. NEI Guideline 96-07, Revision 1, *Guidelines for 10CFR50.59 Implementation*, November 2000.

24. NEI Guideline 97-04, Revision 1, *Design Basis Program Guidelines*, February 2001.

25. NEI 12-01, Rev. 0, *Guidelines for Assessing Beyond Design Basis Accident Response Staffing and Communications.*

26. PSEG Letter LR-N14-0141, *Salem Generating Station's Response to March 12, 2012, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, Enclosure 5, Recommendation 9.3, Emergency Preparedness - Staffing, Requested Information Items 1, 2, and 6 - Phase 2 Staffing Assessment*, dated June 16, 2014.

27. NEI 10-05, Rev. 0*, Assessment of On-Shift Emergency Response Organization Staffing and Capabilities,* June 2011*.*

28. NEI guidance document APC 14-17, *FLEX (Beyond Design Basis) Validation Process*.

29. ANSI/ANS 3.5-2009, *Nuclear Power Plant Simulators for use in Operator Training.*

30. INPO AP 913, Revision 3, *Equipment Reliability Process Description*, Institute of Nuclear Power Operations, March 2011.

31. *Preventive Maintenance Basis for FLEX Equipment - Project Overview Report* (EPRI Report 3002000623), September 2013.

32. DCP 80110341, *Salem Unit 1 FLEX Mechanical Connections*.

33. DCP 80110419, *Salem Unit 2 FLEX Mechanical Connections.*

34. PSEG Calculation S-C-FLX-MDC-2338, *Salem Common FLEX Hydraulic Analyses - Beyond Design Basis*.

35. PSEG Letter LR-N13-0034, *PSEG Nuclear LLC's Overall Integrated Plan for the Salem Generating Station in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)*, dated February 28, 2013.

36. DCP 80110420, *Salem Unit 1 FLEX Electrical Connections*.

37. DCP 80110421, *Salem Unit 2 FLEX Electrical Connections*.

38. NRC Letter to All Power Reactor Licensees*, Request for Information Pursuant to Title of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near Term Task Force Review of Insights from the Fukushima Daiichi Accident*, March 12, 2012.

39. PSEG Letter LR-N14-0051, *PSEG Nuclear LLC's Seismic Hazard and Screening Report (CEUS Sites) Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident - Salem Generating Station*, dated March 28, 2014.

40. EPRI Report 3002000704, *Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Force Recommendation 2.1: Seismic*, May 2013.

41. NRC Letter, *Electric Power Research Institute Final Draft Report XXXXXXX, "Seismic Evaluation Guidance: Augmented Approach for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic," as an Acceptable Alternative to the March 12, 2012, Information Request for Seismic Reevaluations*, dated May 7, 2013 (ADAMS Accession No. ML13106A331).

42. VTD 903076, *Expedited Seismic Evaluation Process (ESEP) Summary Report for Salem Generating Station Units 1 and 2: Volume 1 of 2, Volume 2 of 2*, dated January 28, 2015.

43. NRC Letter, *Screening and Prioritization Results Regarding Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Seismic Hazrd Re-Evaluations for Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident*, dated May 9, 2014 (ADAMS Accession No. ML1411A147).

44. LR-N14-0227, *PSEG Nuclear LLC's Seismic Hazard and Screening Report - Supplemental Response to NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident - Salem Generating Station*, dated October 30, 2014.

45. NRC Letter, *NRC Response to Licensees Regarding Notification of Regulatory Commitments Change Associated with Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendation 2.1 of the Near Term Task Force Review of Insights from the Fukushima Dai-Ichi Accident*, dated December 15, 2014 (ADAMS Accession No. ML14310A033).

46. VTD 903021*, Salem Validation of FLEX Strategies.*

47. Westinghouse NSAL-14-1*, Impact of Reactor Coolant Pump No. 1 Seal Leakoff Piping on Reactor Coolant Pump Seal Leakage During a Loss of All Seal Cooling,* dated February 10, 2014.

48. Technical Evaluation 80111831-220*, Plant Specific Determination of Time to Reflux Cooling using PWROG 14027-P Methodology.*

49. PSEG Calculation S-C-CVC-MDC-2335*, Westinghouse Analysis on R eactor Coolant Pump Seal Leakoff Orifices.*

50. Technical Evaluation 80111831- 210*, FLEX Boration Strategy.*

51. NUREG/CR-7004*, Technical Basis for Regulatory Guidance on Design-Basis Hurricane-Borne Missile Speeds for Nuclear Power Plants.*

52. PSEG Letter LR-N12-0351, *PSEG Nuclear LLC's Assessment Report for Communications During an Extended Loss of AC Power,* dated October 31, 2012.

53. NRC Letter, *Follow-up Letter on Technical Issues for Resolution Regarding Licensee Communication Submittals Associated with Near-Term Task Force Recommendation 9.3 (TAC No. ME7951),* dated January 23, 2013 (ADAMS Accession No. ML13010A162).

54. PSEG Letter LR-N13-0026, *PSEG Nuclear LLC's Response to NRC Follow-up Letter on T echnical Issues for Resolution Regarding Licensee Communication Submittals Associated with Fukushima Near-Term Task Force Recommendation 9.3,* dated February 21, 2013.

55. NRC Letter, *Hope Creek Generating Station and Salem Nuclear Generating Station, Unit Nos. 1 and 2 - Staff Assessment in Response to Request for Information Pursuant to 10 CFR 50.54(f) - Recommendation 9.3 Communications Assessment (TAC Nos. ME9959, ME9984, and ME9985),* dated June 3, 2013 (ADAMS Accession No. ML13130A387).

56. NEI Letter to NRC, *Alternative Approach to NEI 12-06 Guidance for Hoses and Cables*, dated May 1, 2015 (ADAMS Accession No. ML15126A135).

57. NRC Letter, *NRC Endorsement of Alternative Approach for Hoses and C ables*, dated May 18, 2015 (ADAMS Accession No. ML15125A442).

58. PSEG Letter LR-N14-0187, *PSEG Nuclear LLC's Third Six-Month Status Report for the Salem Generating Station in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order EA-12-049)*, dated August 26, 2014.

59. VTD 903078, S&L Calculation 2014-09588, *FLEX Water Storage Tornado Wind Hazard Evaluation, Revision 1.*

60. Technical Evaluation 80111831-0010, *Documentation of Available Water in Hope Creek Fire Water Tanks for Salem FLEX Implementation.*

61. NRC Interim Staff Guidance JLD-ISG-2012-05, *Guidance for Performing the Integrated Assessment for External Flooding*, Revision 0, dated November 30, 2012

62. NRC Staff Requirements Memoranda to COMSECY-14-0037, *Integration of Mitigating Strategies for Beyond-Design-Basis External Events and the Reevaluation of Flooding Hazards*, dated March 30, 2015.

63. NRC Interim Staff Guidance JLD-ISG-2016-01, *Guidance for Activities Related to Near-Term Task Force Recommendation 2.1, Flooding Hazard Reevaluation; Focused Evaluation and Integrated Assessment,* Revision 0, dated July 11, 2016.

64. Technical Evaluation 80111831-0050, *Salem Unit 1 ELAP DC Coping Analysis.*

65. Technical Evaluation 80111831-0051, *Salem Unit 2 ELAP DC Coping Analysis.*

66. Technical Evaluation 80111831-0100, *Evaluation of Auxiliary Feedwater Storage Tank (AFST) Capability To Supply Aux Feedwater During ELAP Cooldown*

67. Technical Evaluation 80111831-0110, *Evaluation of Primary Water Storage Tank (PWST) Capability to Supplement Aux Feedwater During ELAP.*

68. Technical Evaluation 80111831-0020, *UPDATED- Unit 1 AND 2 Evaluation of Salem Gothic Results.*

69. NRC Letter to PSEG, *Salem Nuclear Generating Station, Units 1 and 2 Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request Flood-Causing Mechanism Reevaluation (TAC NOS. Mf3790 and Mf3791),* dated September 15, 2015.

70. DCP 80111494, *Salem FLEX Generator Deployment (Canyon).*

71. Technical Evaluation 80102074-0025, *Outdoor Storage of FLEX Equipment in Extreme Cold and Hot Weather.*

72. PSEG Calculation ES-15.019, *FLEX Electrical System Analysis - Salem 1 and 2.*

73. Technical Evaluation 80111831-0080, *Effect of a Severe Low Outside Ambient Temperature on Station Batteries*.

74. PSEG Calculation ES-3.005, *28 VDC Beyond Design Base Event Battery Sizing Calculation.*

75. PSEG Calculation ES-4.008, *125 VDC Salem BDBEE Battery Sizing Calculation*.

76. VTD 320832, *Emergency Operating Procedure Setpoint Document.*

77. Westinghouse Technical Bulletin TB-15-1, *Reactor Coolant System Temperature and Pressure Limits for the No. 2 Reactor Coolant Pump Seal,* March 3, 2015.

78. Technical Evaluation 80111831-0230, *Salem Unit 1 FLEX Electrical N+1 Portable Cable Requirements.*

79. Technical Evaluation 80111831-0235, *Salem Unit 2 FLEX Electrical N+1 Portable Cable Requirements.*

80. Technical Evaluation 80111831-0240, *Salem FLEX Equipment N+1 Requirements for Hoses*.

81. Technical Evaluation 80111831 0060, *Evaluation of FLEX Portable Equipment Fuel Usage Against NEI 12 06 Requirements.*

82. Technical Evaluation 80111831-0030, *Evaluation of MAAP Results Against the Requirements of NEI 12-06 - Modes 5-6.*

83. Technical Evaluation 80111831-0040, *Evaluation of MODE 1-4 MAAP Results Against NEI 12-06 Requirements.*

84. Technical Evaluation 80111831-0041, *MODE 1-4 MAAP Results - Westinghouse Flow Orifice Assessment Incorporated.*

85. VTD 903048, *Salem Nuclear Generating Station Reactor Head Vent Line Thermal Hydraulic Analysis.*

86. Technical Evaluation 80111831-0120, *Time Required to Flood the Turbine Building for FLEX Submersible Pump Operation.*

87. Technical Evaluation 80111831-0130, *Time Required To Fill the Demineralized Water / Auxiliary Feedwater Alternate Piping.*

88. PSEG Letter LR-N14-0237, *Salem Generating Station Unit 1 C ompliance with March 12, 2012 NRC Order to Modify Licenses with Regard to Reliable Spent Fuel Pool Instrumentation (Order Number EA-12-051) and Responses to Requests for Additional Information for Salem Units 1 and 2*, dated January 15, 2015

89. PSEG Letter LR-N15-0239, *Salem Generating Station Unit 2 Compliance with March 12, 2012 NRC Order to Modify Licenses with Regard to Reliable Spent Fuel*

Pool Instrumentation (Order Number EA-12-051) and Responses to Requests for Additional Information for Salem Units 1 and 2, dated January 25, 2016

Table 1 - FLEX Equipment Stored On-Site						
Equipment (quantities are for both Units)	**Use and (Potential/Flexibility) Diverse Uses**					**Performance Criteria**
	Core	**Containment**	**SFP**	**Instrumentation**	**Accessibility**	
(4) 480 VAC Diesel Driven Generators N=3 for both SGS units; N=1 for HCGS; (6) DGs are on site.	X	X	X	X	X	600 kW
(1) 240 VAC MCC	X	X	X	X	X	-
(2) 480 VAC MCCs	X		X			-
(2) Diesel Driven FLEX SW pumps N=1 for both SGS units; N=1 for HCGS. 3 are on site.	X		X			nominal 1,500 gpm - provides minimum total flow rate of: 700 gpm to AFW, 112 gpm for RCS inventory makeup and 500 gpm for Spent Fuel spray, split between SGS Units 1 and 2
(4) 460 VAC submersible pumps	X		X			350 gpm at 43.3 psig
(3) FLEX Charging Pumps	X					56 gpm at a discharge pressure of 1600 psig
(3) FLEX AFW Pumps	X		X			350 gpm, 380 psid

Table 1 - FLEX Equipment Stored On-Site						
Equipment (quantities are for both Units)	**Use and (Potential/Flexibility) Diverse Uses**					**Performance Criteria**
	Core	**Containment**	**SFP**	**Instrumentation**	**Accessibility**	
(6) Portable Fans	X				X	TDAFW Pump Room HVAC Compensatory Measures
(10) Canyon Dewatering Pumps	X	X	X	X	X	3.5 hp
(1) Caterpillar Wheel Loader					X	Site debris removal and equipment hauling-
(1) Komatsu Wheel Loader					X	Site debris removal and equipment hauling -
(2) Kalmar Ottawa Terminal Tractors					X	Site debris removal and equipment hauling -
(2) Forklifts					X	Site debris removal and equipment hauling -
(2) Portable Boration Skids	X					One skid supports boration for SGS Units 1 and 2. See Section 2.3.8- -

Table 2 - FLEX Equipment From NSRC (Reference 20)						
Equipment (quantities are for both Units)	**Use and (Potential/Flexibility) Diverse Uses**					**Performance Criteria**
	Core	**Containment**	**SFP**	**Instrumentation**	**Accessibility**	
(4) 4160 VAC Diesel Driven Generators	**X**	**X**	**X**	**X**	**X**	1 MW
(2) 4160 Distribution Systems	**X**	**X**	**X**		**X**	4160 VAC, 1200 AMP
(2) 480 VAC Diesel Driven Generators	**X**		**X**	**X**		1 MW
(2) High Pressure Injection Pumps	**X**					60 gpm, 2000 psi
(2) SG/Reactor Vessel Makeup Pumps	**X**		**X**			500 gpm, 500 psi, 12 ft lift

Table 2 - FLEX Equipment From NSRC (Reference 20)						
Equipment (quantities are for both Units)	**Use and (Potential/Flexibility) Diverse Uses**					**Performance Criteria**
	Core	**Containment**	**SFP**	**Instrumentation**	**Accessibility**	
(2) 2500 gpm Diesel Driven Pumps	**X**	**X**	**X**			2500 gpm, 300 psi, 12 ft lift
(2) 5000 gpm Diesel Driven Pumps	**X**	**X**	**X**			5000 gpm, 150 psi, 12 ft. lift
(2) On-Site Diesel Fuel Transfer Pumps	**X**	**X**	**X**	**X**	**X**	60 gpm
Portable Diesel Fuel Tank and attached pumps	**X**	**X**	**X**	**X**	**X**	264 gal, 35 gpm AC pump, 25 gpm DC pump
(2) Mobile Water Treatment	**X**		**X**			250 gpm
(1) 20,000 gallon Water Storage	**X**		**X**			20,000 gal
(2) Suction Booster Lift Pump (One Hydraulic Unit / Two pods)	**X**		**X**			5000 gpm, 26 ft. lift

Table 3 - Sequence of Events Timeline (See Reference 46)

Action Item	Elapsed Time	Action	Time Constraint (Y/N)	Discussion
1	-48 hrs	Tropical Storm/Hurricane Warning issued OR P-Surge indicates >9 ft. NAVD (98.8 ft. PSD) (water predicted to breach site grade, begin actions to move FLEX equipment to Canyon	Y Level B	OP-AA-108-111-1001, Att 1
2	-36 hrs	P-Surge indicates >13 ft. NAVD (>4 ft. of water predicted above site grade, begin actions to build Canyon (HESCO) Wall.	Y Level B	OP-AA-108-111-1001, Att 1
3	-30 hrs	Complete FLEX equipment deployment to Canyon	Y Level B	Begin building the HESCO Wall
4	-24 hrs	Begin FLEX equipment deployment to HCGS	Y Level B	
5	-6 hrs	FLEX equipment deployed to HCGS	Y Level B	
6	-6 hrs	Complete building HESCO Wall		
	0	Event Starts	N/A	Plant @ 100% power

Table 3 - Sequence of Events Timeline (See Reference 46)

Action Item	Elapsed Time	Action	Time Constraint (Y/N)	Discussion
7	15 sec	TDAFW Pump Start Initiation	N	Standard station trip response.
8	1 min	EDGs failed to start. Enter 1/2-EOP-LOPA-1, Loss of all AC Power.	N	Current SBO event response.
9	10 min	Begin DC load shedding on 125 VDC vital busses IAW S1/S2.OP-AB.LOOP-0001.	Y Level A	Current LOOP event response.
10	15 min	Control SG levels with TDAFW pump.	N	Current SBO event response.
11	15 min	Loss of AFST Inventory Identified. Initiate action to provide suction from HC Fire Protection System, or pre-staged turbine building submersible FLEX pump.	Y Level A	NEI 12-06, 3.2.1.7 WCAP 17601 (SG Dryout) DMST and FP/FW tanks validation not required (existing design)
12	30 min	SBO DG failed to start.	N	Current SBO event response.

Table 3 - Sequence of Events Timeline (See Reference 46)

Action Item	Elapsed Time	Action	Time Constraint (Y/N)	Discussion
13	30 min	Complete DC load shedding on 125 VDC vital busses IAW S1/S2.OP-AB.LOOP-0001.	Y	NEI 12-06, 3.2.1.7
14	30 min	IAW S1/S2.OP-AB.LOOP-0001, block open doors in the MCR and the TDAFW pump rooms.	Y	NEI 12-06, 3.2.1.7 Current SBO event response - reformatted the procedure
15	1 hr	ELAP Declared Attempts to start EDGs are unsuccessful, determination made that it will take > 4 hours to restore power via "normal" means. Begin deep load shed activities.	Y Level A	EOP-LOPA-0004 S1/S2.OP-FS.FLX-0004 (FSG-4)
16	1 hr	Begin Main Generator hydrogen venting	Y Level A	S1/S2.OP-FS.FLX-0005 (FSG-5)

Table 3 - Sequence of Events Timeline (See Reference 46)

Action Item	Elapsed Time	Action	Time Constraint (Y/N)	Discussion
17	70 min	Alternate suction source aligned to TDAFW pump and supplying AFW to SGs	Y Level A	NEI 12-06, 3.2.1.7 WCAP 17601 (SG Dryout 55 min from loss of AFW flow)
18	~1.5 hr	Install SFP Spray Nozzles and connect hoses	Y Level A	NEI 12-06, 3.2.2 (11), Table 3-2 GOTHIC temperature analysis
19	2 hrs	Initiate RCS cooldown	Y Level A	WCAP 17601
20	2 hrs	Complete Main Generator hydrogen venting	Y Level A	S1/S2.OP-FS.FLX-0005 (FSG-5)
21	2.5 hrs	Complete DC load shedding on 125 and 28 VDC vital busses IAW FSG-0004	Y Level A	Battery Sizing Calcs NEI 12-06, 3.2.2 (6)

Table 3 - Sequence of Events Timeline (See Reference 46)

Action Item	Elapsed Time	Action	Time Constraint (Y/N)	Discussion
22	3 hrs	Complete SFP spray nozzles and hose installation	Y Level A	NEI 12-06 3.2.2 (11), Table 3-2 GOTHIC analysis PSEG Technical Evaluation 80111831 0020
23	4 hrs	Target SG pressure reached for RCS cooldown	Y Level A	WCAP 17601
24	6 hrs	480 VAC FLEX DG deployed and providing power to FLEX 480 VAC FLEX MCC.	Y Level A	NEI 12-06, 3.2.1.7
25	6 hrs	480 VAC FLEX DG deployed and providing power to 240 VAC FLEX MCC, and associated battery charger loads.	Y Level A	NEI 12-06, 3.2.1.7 Battery Sizing Calcs
26	~ 6 hrs	Begin 12/22WR41 bonnet/adapter change-out.	Y Level B	NEI 12-06, 3.2.2 (5), Table 3.2 S1/S2.OP-FS.FLX-0006 (FSG-6) Att 1, performed by augmented staff

Table 3 - Sequence of Events Timeline (See Reference 46)

Action Item	Elapsed Time	Action	Time Constraint (Y/N)	Discussion
27	7 hrs	Prepare portable boron mixing tank. Includes tank fill, heat-up, boron mixing and transfer. Repeat as needed.	Y Level A	NEI 12-06, Table D-1 Technical Evaluation 80111831-0210 Activity could begin <6 hours after the event
28	7 hrs	“A” 460 VAC Vital Bus powered from FLEX MCC.	Y Level B	NEI 12-06, 3.2.1.7 S1/S2.OP-FS.FLX-0005 (FSG-5) Att 2
29	7 hrs	Assess borated water inventory and prepare FLEX charging pump for RCS injection.	Y Level B	WCAP 17601 NEI 12-06, 3.2.1.7 S1/S2.OP-FS.FLX-0008 (FSG-8)

Table 3 - Sequence of Events Timeline (See Reference 46)

Action Item	Elapsed Time	Action	Time Constraint (Y/N)	Discussion
30	8 hrs	Begin RCS makeup to restore inventory and ensure sub-criticality using FLEX charging pump.	Y Level B	WCAP 17601 Site specific SDM calculation. Revised Westinghouse calculation based on RCP seal leak-off line orifice installation S1/S2.OP-FS.FLX-0001 (FSG-1) or S1/S2.OP-FS.FLX-0008 (FSG-8)
31	9 hrs	Transfer boron mixture from portable boron mixing tank to BASTs. (Note: First transfer occurs at 9 hours then every 2 hours as required)	Y Level B	NEI 12-06, Table D-1, Technical Evaluation 80111831-0210

Table 3 - Sequence of Events Timeline (See Reference 46)

Action Item	Elapsed Time	Action	Time Constraint (Y/N)	Discussion
32	9 hrs	Complete 12/22WR41 bonnet/adapter change-out and PWST water available for SG make-up.	Y Level B	NEI 12-06, 3.2.2 (5), Table 3.2 Technical Evaluation 80111831-0100
33	10 hrs	Portable fan placed in TDAFW pump room door.	Y Level B	Technical Evaluation 80111831-0020 S1/S2.OP-FS.FLX-0005 (FSG-5) Att 4
34	<11 hrs	Diesel driven FLEX SW pump deployed at river, SW header pressurized and aligned to AFW pump (Non-Flood).	Y Level B	NEI 12-06, 3.2.1.7
35	16 hrs	Prepare FLEX AFW pump as backup to TDAFW if required.	N	Backup strategy

Table 3 - Sequence of Events Timeline (See Reference 46)

Action Item	Elapsed Time	Action	Time Constraint (Y/N)	Discussion
36	~ 20 hrs	Diesel driven FLEX SW pump deployed at river and SW header pressurized (Flood).	Y Level B	NEI 12-06, 3.2.1.7 S1/S2.OP-FS.FLX-0005 (FSG-5) Att 3
37	24 hrs	Preferred water source for SFP makeup identified and aligned for refill using FLEX pump.	Y Level B	NEI 12-06, 3.2.1.7 S1/S2.OP-FS.FLX-0011 (FSG-11)
38	>72 hrs	Phase 3 coping equipment (e.g., 4.16 KV DG, diesel driven pumps, water treatment equipment, etc.) from the NSRC is deployed and functional. Phase 3 coping strategies are initiated to maintain containment integrity and establish indefinite coping capability.	Y Level C	NEI 12-06, 3.2.1.7

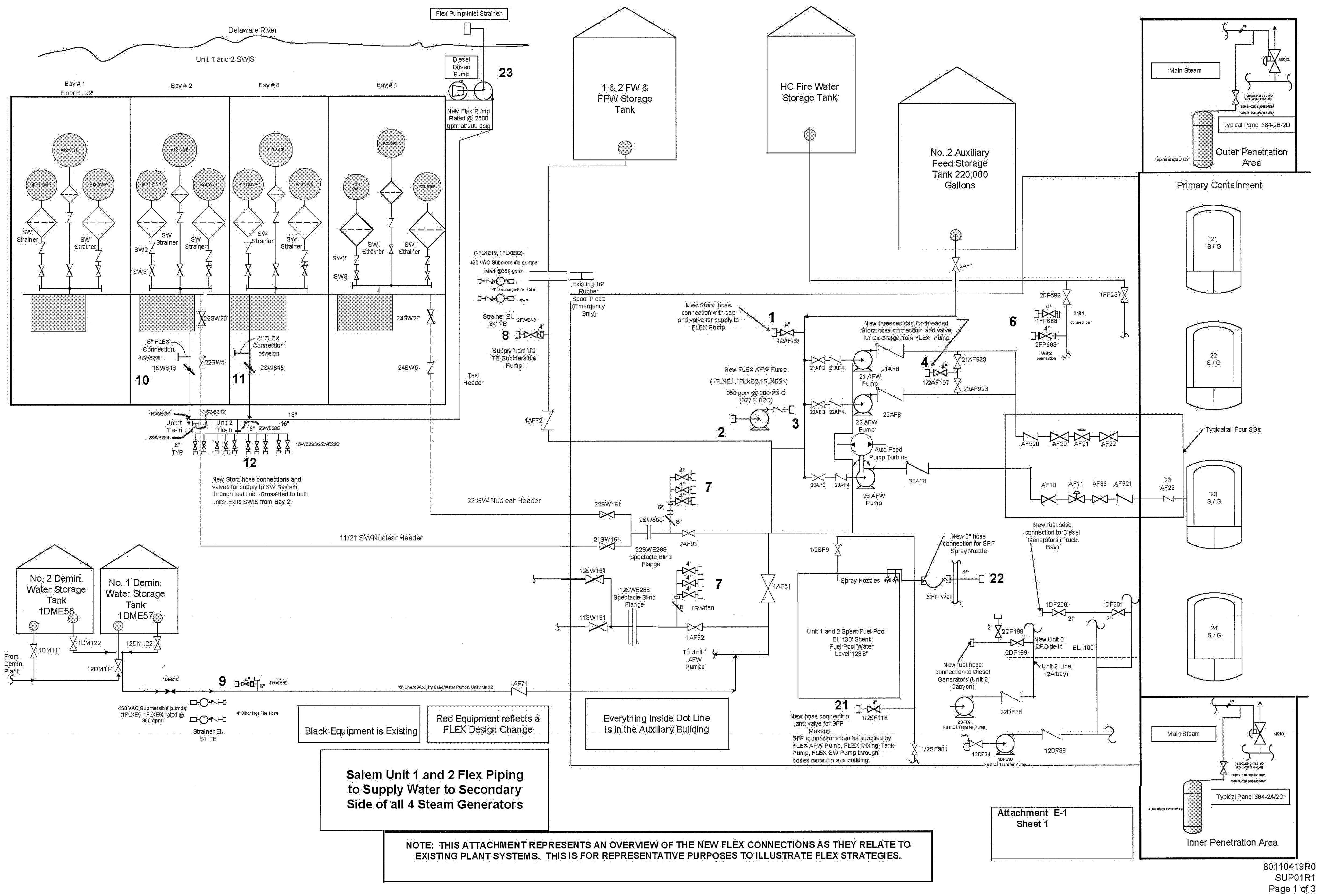

Figure 1: BDB FLEX Strategy Piping and Equipment (Page 1 of 3)

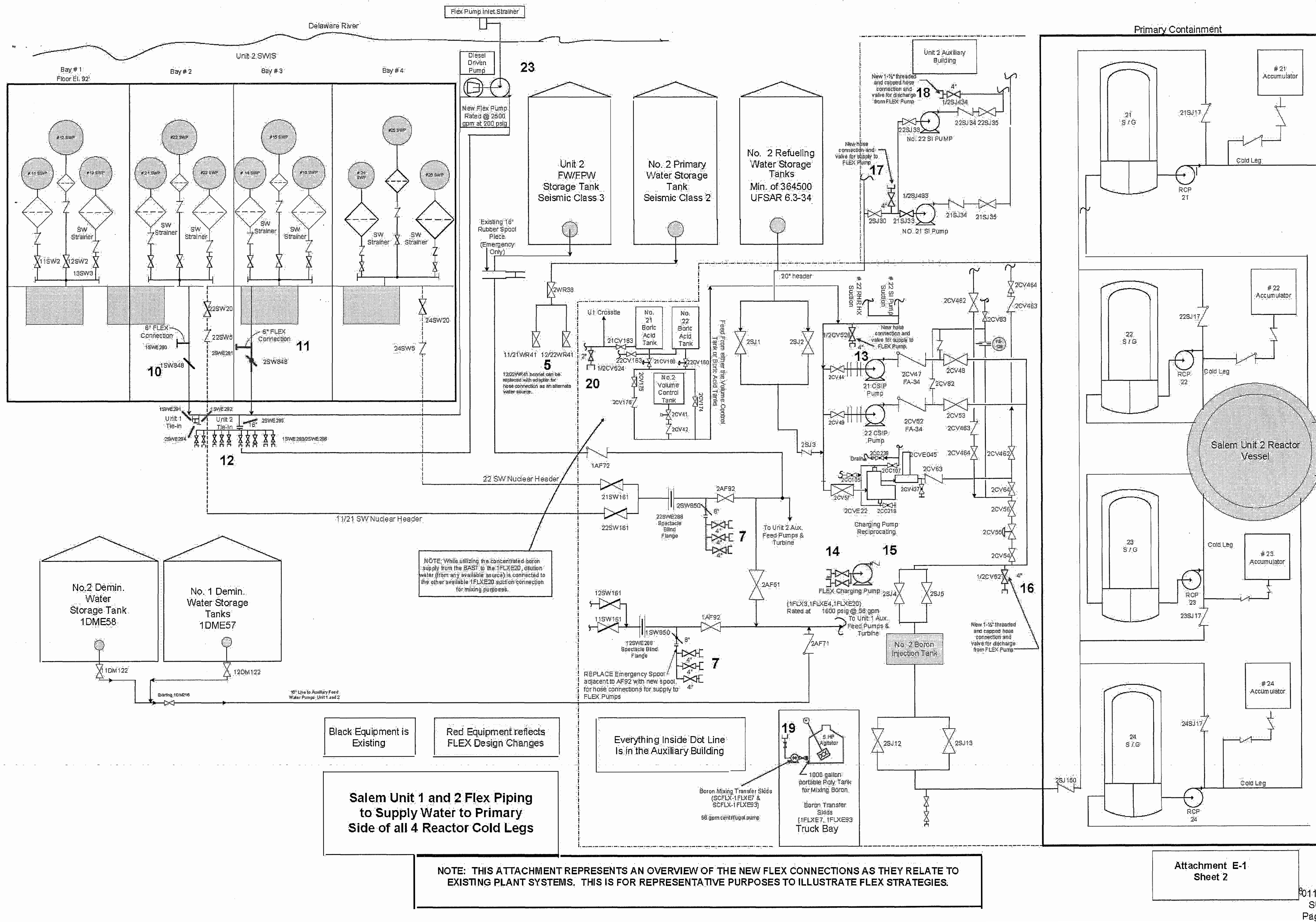

Figure 1: BDB FLEX Strategy Piping and Equipment (Page 2 of 3)

FLEX Connections

Connection Points are numbered on sheets 1 and 2, the description of the use of the connection point is described in the program document section listed below.

Connection Point	Description	Program Document Section
1 (Sheet 1)	1/2AF196 - FLEX AFW PUMP SUCTION CONNECTION ISOLATION	2.1.2, 2.4.2
2 (Sheet 1)	1FLXE1, 1FLXE2, 1FLXE21 - FLEX AFW PUMP SUCTION	2.1.2, 2.2.2, 2.4.2
3 (Sheet 1)	1FLXE1, 1FLXE2, 1FLXE21 - FLEX AFW PUMP DISCHARGE	2.1.2, 2.2.2, 2.4.2
4 (Sheet 1)	1/2AF197 -FLEX AFW PUMP DISCHARGE CONNECTION ISOLATION	2.1.2
5 (Sheet 2)	12/22WR41 - PRIMARY WATER MAKEUP PUMP INLET VALVE	2.1.2, 2.2.2, 2.4.2
6 (Sheet 1)	1/2FP683 - FIRE PROTECTION HEADER FLEX CONNECTION ISOLATION	2.1.2, 2.2.2, 2.4.2
7 (Sheet 1, 2)	1/2SW850 - FLEX AFW/CHARGING PUMP SUCTION CONNECTION ISOLATION	2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.4.2
8 (Sheet 1)	2FWE43 - UNIT 2 FLEX TGA CONNECTION (SUBMERSIBLE PUMPS CONNECTION)	2.1.2, 2.2.2, 2.4.2
9 (Sheet 1)	1DME89 - UNIT 1 FLEX TGA CONNECTION (SUBMERSIBLE PUMPS CONNECTION)	2.1.2, 2.2.2, 2.4.2
10 (Sheet 1,2)	1SWE290 - UNIT 1 FLEX SW CONNECTION (SWIS Bay 2)	2.1.2, 2.2.2, 2.3.3, 2.4.2
11 (Sheet 1, 2)	2SWE291 - UNIT 2 FLEX SW CONNECTION (SWIS Bay 3)	2.1.2, 2.2.2, 2.3.3, 2.4.2
12 (Sheet 1, 2)	1SWE291 - UNIT 1 FLEX SW 6 INCH CONNECTION (TEST HEADER)	2.1.2, 2.2.2, 2.3.3, 2.4.2
12 (Sheet 1, 2)	1SWE292 - UNIT 1 FLEX SW 16 INCH CONNECTION (TEST HEADER)	2.1.3, 2.2.3, 2.3.3, 2.4.3
12 (Sheet 1, 2)	1SWE293 - UNIT 1 FLEX 12 VALVE MANIFOLD (TEST HEADER)	2.1.3, 2.2.3, 2.3.3, 2.4.3
12 (Sheet 1, 2)	2SWE294 - UNIT 2 FLEX SW 6 INCH CONNECTION (TEST HEADER)	2.1.2, 2.2.2, 2.3.3, 2.4.2
12 (Sheet 1, 2)	2SWE295 - UNIT 2 FLEX SW 16 INCH CONNECTION (TEST HEADER)	2.1.3, 2.2.3, 2.3.3, 2.4.3
12 (Sheet 1, 2)	2SWE296 - UNIT 2 FLEX 12 VALVE MANIFOLD (TEST HEADER)	2.1.3, 2.2.3, 2.3.3, 2.4.3
13 (Sheet 2)	1/2CV526 - FLEX CHARGING PUMP SUCTION CONNECTION ISOLATION	2.2.2, 2.2.3
14 (Sheet 2)	1FLXE3, 1FLXE4, 1FLXE20 - FLEX CHARGING PUMP SUCTION	2.2.2, 2.2.3
15 (Sheet 2)	1FLXE3, 1FLXE4, 1FLXE20 - FLEX CHARGING PUMP DISCHARGE	2.2.2, 2.2.3
16 (Sheet 2)	1/2CV527 - FLEX CHARGING PUMP DISCHARGE CONNECTION ISOLATION	2.2.2, 2.2.3
17 (Sheet 2)	1/2SJ433 - FLEX AFW PUMP SJ SUCTION CONNECTION ISOLATION	2.2.2, 2.2.3
18 (Sheet 2)	1/2SJ434 - FLEX AFW PUMP DISCHARGE SJ CONNECTION ISOLATION	2.2.2, 2.2.3
19 (Sheet 2)	1FLXE7, 1FLXE93 - FLEX BORIC ACID TRANSFER SKID (PORTABLE MIXING TANK)	2.2.2, 2.2.3
20 (Sheet 2)	1/2CV524 -FLEX CHARGING PUMP SUCTION CONNECTION ISOLATION	2.2.2, 2.2.3
21 (Sheet 1)	1/2SF116 - FLEX PUMP DISCHARGE SFP CONNECTION ISOLATION	2.4.2
22 (Sheet 1)	SFP SPRAY RIG CONNECTION	2.4.2
23 (Sheet 1, 2)	1FLXE42, 1FLXE18 - FLEX STRATEGY PORTABLE DIESEL PUMP	2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.3, 2.4.2, 2.4.3

Figure 1: BDB FLEX Strategy Piping and Equipment (Page 3 of 3)

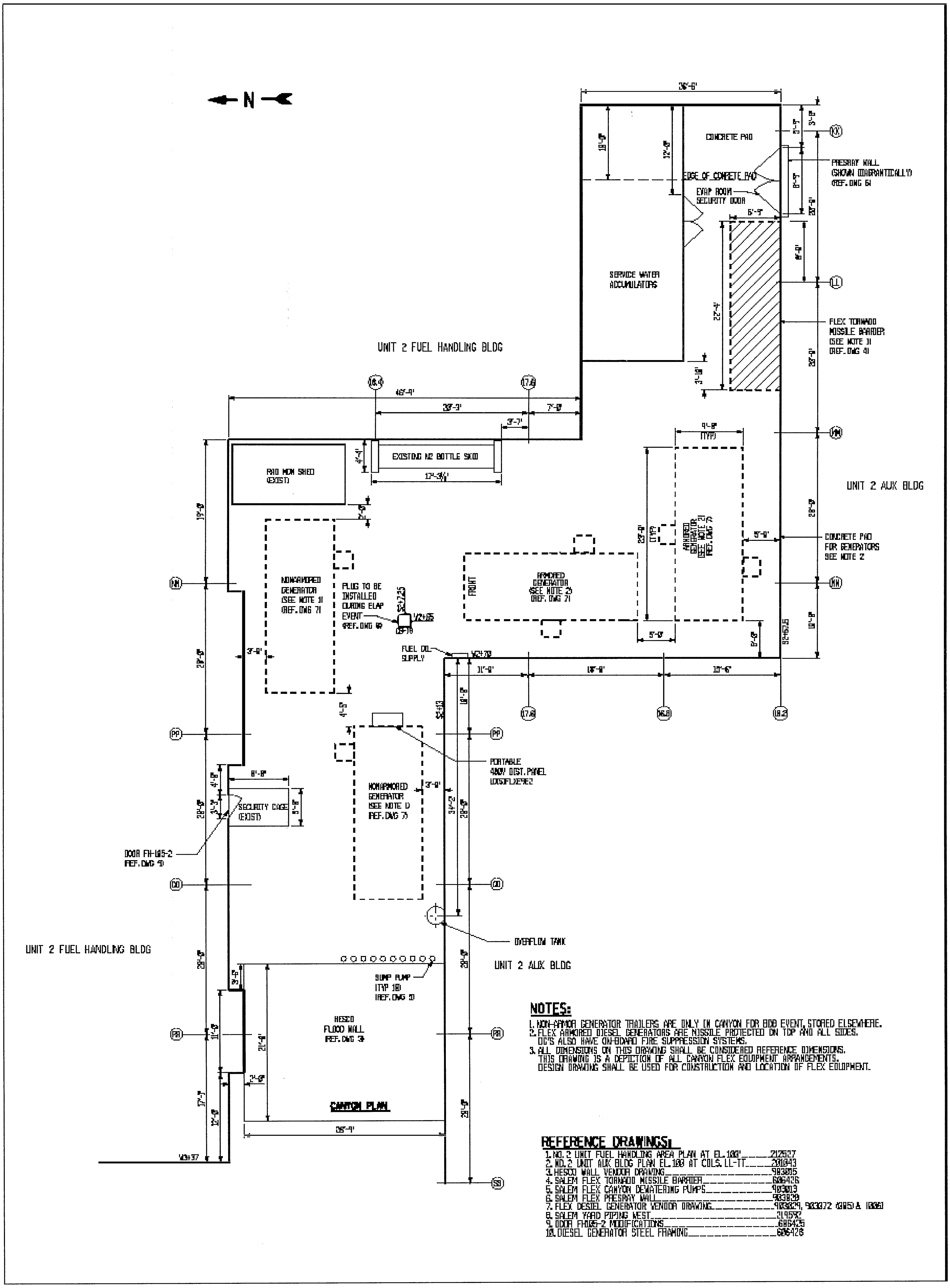

Figure 2: FLEX Canyon Layout (PSEG Drawing 606424, sh.1)

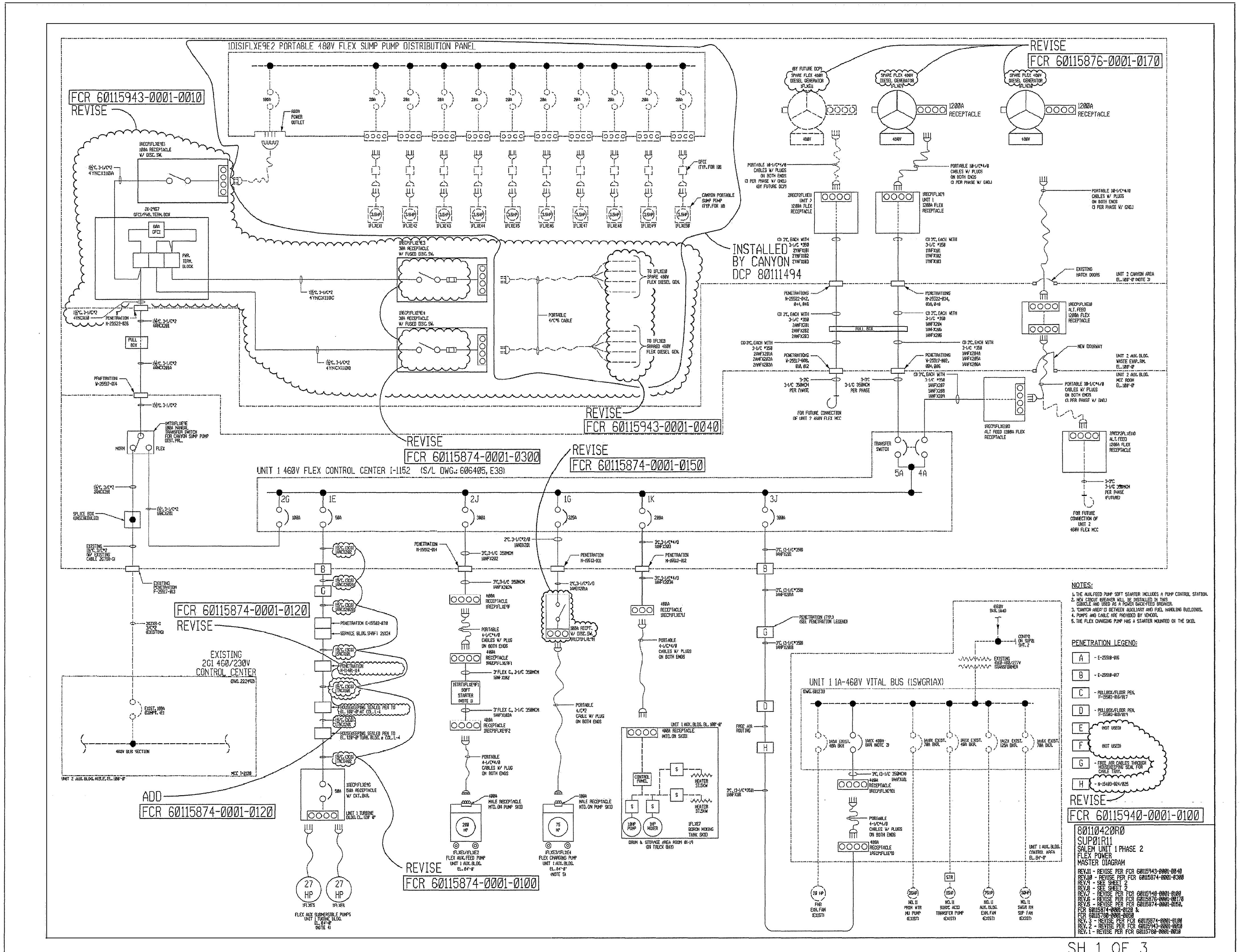

Figure 3: BDB FLEX Electrical Strategy (Page 1 of 3)

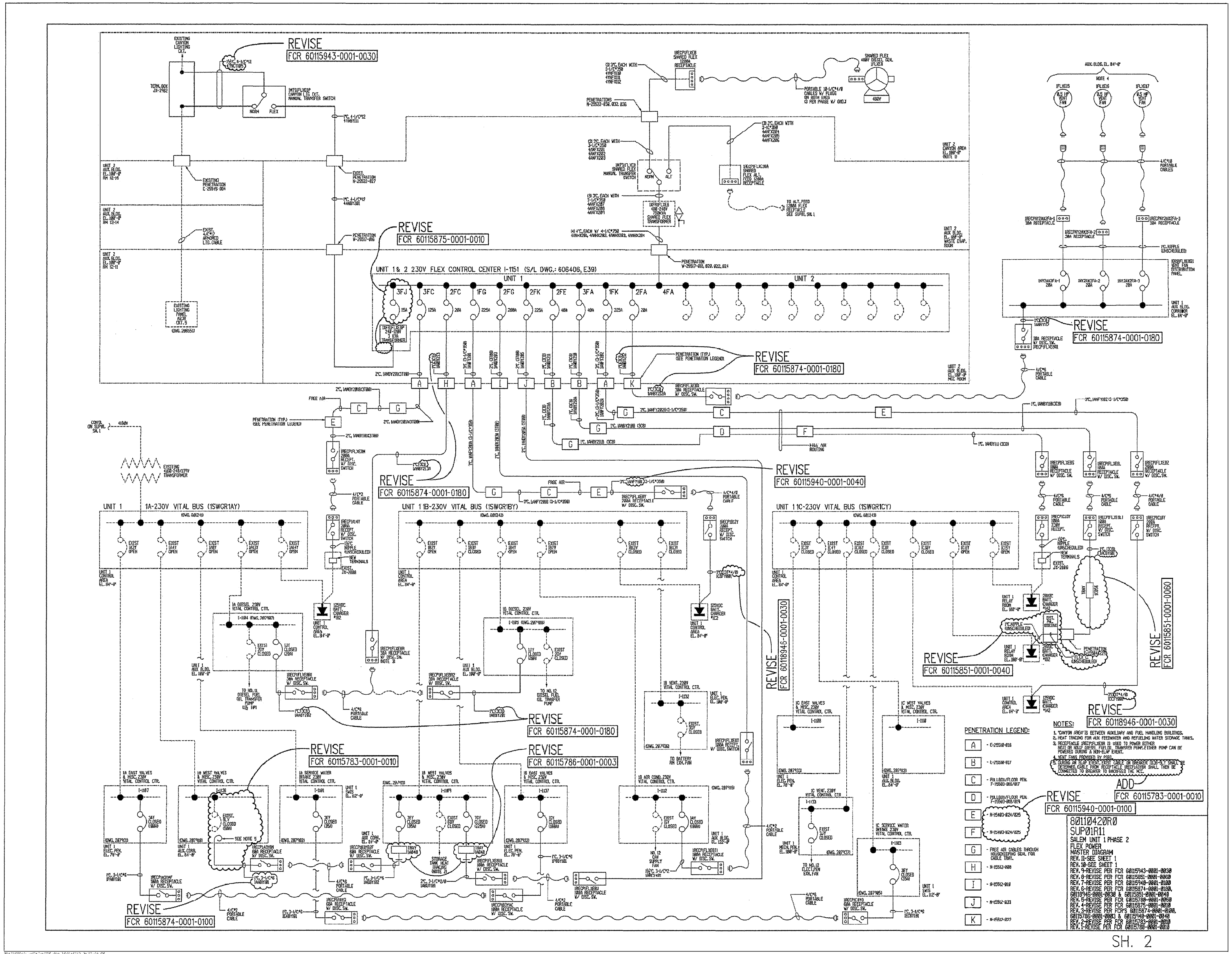

Figure 3: BDB FLEX Electrical Strategy (Page 2 of 3)

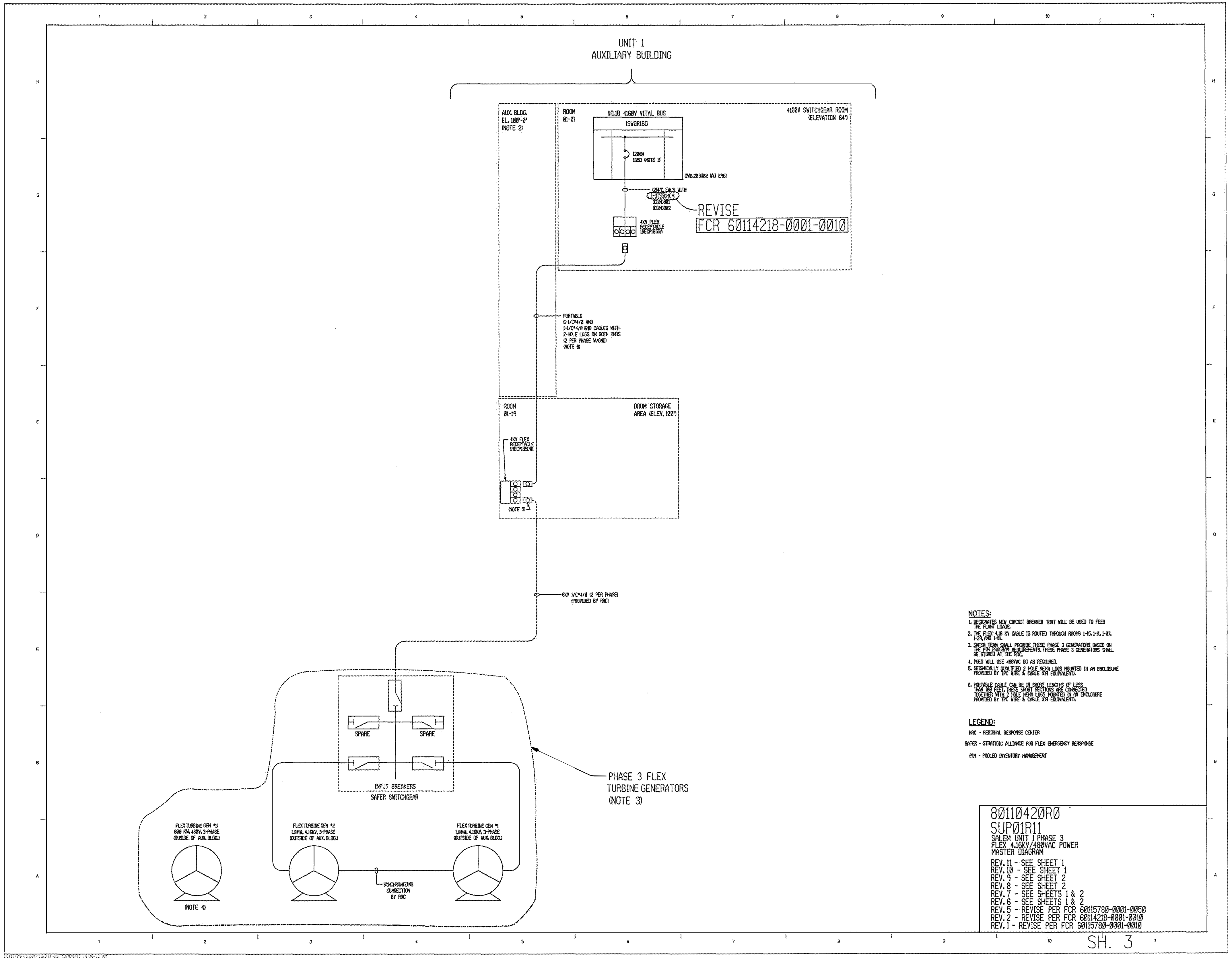

Figure 3: BDB FLEX Electrical Strategy (Page 3 of 3)

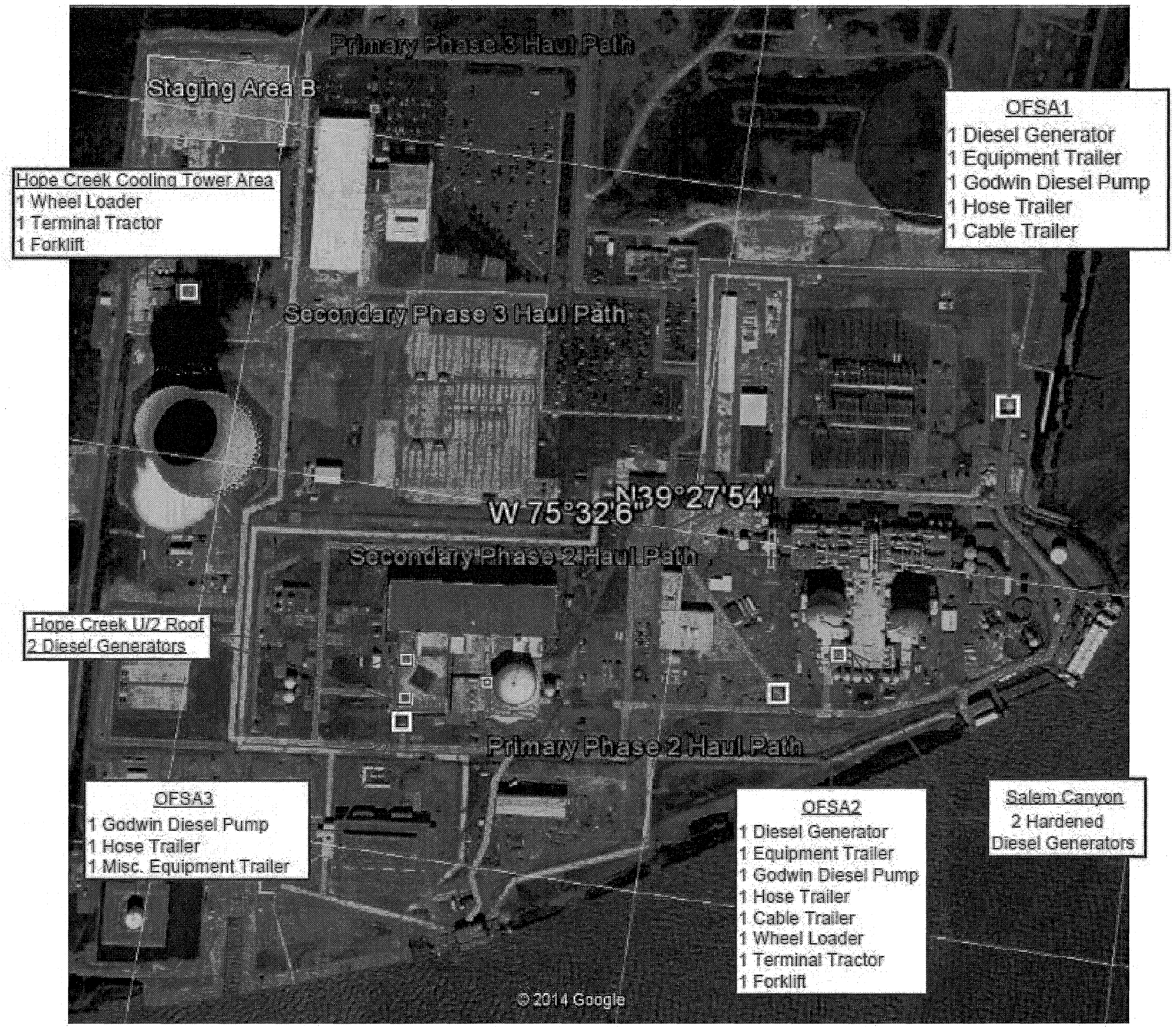

Figure 4: BDB FLEX Storage Locations