PSEG Nuclear LLC
P.O. Box 236, Hancocks Bridge, NJ 08038-0236

PSEG Nuclear LLC

Order EA-12-049

LR-N16-0217

JAN 25 2017

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

Hope Creek Generating Station
Renewed Facility Operating License No. NPF-57
NRC Docket No. 50-354

Subject: Hope Creek Generating Station 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

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. NRC Letter to PSEG, "Hope Creek Generating Station – Report for the Onsite Audit Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Pool Instrumentation Related to Orders EA-12-049 and EA-12-051 (CAC NOS. MF0867 and MF1031)," dated March 25, 2016

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 Hope Creek Generating Station (HCGS) 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."

Attachment 1 provides a summary of HCGS compliance with the NRC Order EA-12-049 requirements and includes the response to the open confirmatory item identified in the NRC mitigation strategies and spent fuel pool level instrumentation audit report (Reference 2). Also, EM-HC-100-1000, Attachment 1, "Final Integrated Plan - Beyond-Design-Basis FLEX Mitigating Strategies, Hope Creek Generating Station," 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 1-25-17
(Date)

Sincerely,

Eric Carr
Site Vice President
Hope Creek Generating Station

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

Enclosure: EM-HC-100-1000, Attachment 1, "Final Integrated Plan – Beyond-Design-Basis FLEX Mitigating Strategies, Hope Creek Generating Station"

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. Justin Hawkins, NRC Senior Resident Inspector, Hope Creek
Mr. Patrick Mulligan, Chief, NJBNE
Mr. Thomas MacEwen, Hope Creek Commitment Tracking Coordinator
Mr. Lee Marabella, PSEG Commitment Coordinator – Corporate

Attachment 1

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

Hope Creek Generating Station 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 Hope Creek Generating Station (HCGS), documenting the diverse and flexible coping strategies (FLEX) in response to NRC Order EA-12-049 (Reference 2). In References 3 through 9, 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 10) to develop the HCGS FLEX strategies.

The original HCGS compliance milestone for NRC Order EA-12-049 was prior to plant startup from the nineteenth refueling outage (H1R19) in spring 2015, as reported in the OIP (Reference 1). The NRC staff subsequently issued Order EA-13-109 (Reference 11) for a severe accident capable hardened containment vent system (HCVS), with a Phase 1 (torus venting) due date of prior to plant startup from the twentieth refueling outage (H1R20) in fall 2016. As a result, the NRC granted schedule relaxation (Reference 12) to change the NRC Order EA-12-049 compliance milestone to H1R20, to allow full compliance with the FLEX order coincident with compliance with the torus vent requirements of NRC Order EA-13-109. Consistent with additional schedule relaxation (Reference 13), PSEG implemented NRC Order EA-12-049 FLEX requirements unrelated to NRC Order EA-13-109 torus vent requirements by December 18, 2015, with exceptions related to deferral of alternate mechanical FLEX connection to RHR until H1R20 as described in Reference 14.

Prior to startup from H1R20 on November 9, 2016, PSEG implemented design changes for the HCVS and alternate FLEX mechanical connection, and related activities (e.g., procedure revisions) to comply with NRC Order EA-12-049. The current HCGS FLEX strategies are described in the enclosed Final Integrated Plan (FIP).

2 NRC FLEX AUDIT ITEM RESOLUTION

NRC staff generated open and confirmatory items in the HCGS FLEX interim staff evaluation (ISE) (Reference 15), and conducted an onsite audit in February 2016. The NRC audit report (Reference 16) identified one confirmatory item requiring licensee action. This item was reported as complete in the previous six-month status report (Reference 9), and the response is provided below.

Item Ref.	Description	Status
CI 3.2.1.4.A	Additional technical basis or a supporting analysis is needed for both FLEX pumping system (one engine/pump located at the SWIS and one motor/pump located in the reactor building) capabilities considering the pressure within the RPV and the loss of pressure along with details regarding the FLEX pump supply line routes, length of runs, connecting fittings, to show that the pumps are capable of injecting water into the RPV with a sufficient rate to maintain and recover core inventory for both the primary and alternate flow paths as well as supplying water [to] the SFP. The licensee addressed these issues during the audit process and stated that this analysis will be performed as part of the design change process. Confirm that the analysis results are acceptable.	Complete – the plant-specific FLEX hydraulic analysis (Reference 17) was updated and provided to the NRC staff via the e-portal subsequent to issuance of the NRC's onsite audit report (Reference 16).

3 MILESTONE SCHEDULE STATUS

All HCGS 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	
	Aug 2016	Complete	
Develop Strategies	May 2013	Complete	

Milestone	**Original Target Completion Date**	**Activity Status**	**Revised Target Completion Date**
Modifications			
Develop Modifications	Apr 2014	Complete	Apr 2016
Implement Modifications	Apr 2015	Complete	Nov 2016
FLEX Support Guidelines (FSGs)			
Develop FSGs	Dec 2013	Complete	Apr 2015
Approve FSGs	Oct 2015	Complete	Dec 2015
Validation Walk-throughs or Demonstrations of FLEX Strategies and Procedures	May 2015	Complete	Dec 2015
Perform Staffing Analysis	Dec 2013	Complete	Dec 2014
Develop Training Plan	Jun 2014	Complete	Jan 2015
Implement Training	Dec 2014	Complete	Dec 2015
Develop Strategies / Contract with National SAFER Response Center (formerly called "Regional Response Center")	Oct 2013	Complete	Feb 2015
Procure Equipment	Dec 2013	Complete	Nov 2016
Create Maintenance Procedures	Jun 2014	Complete	Dec 2015
Emergency Preparedness (EP) Communications Improvements	Jun 2014	Complete	May 2015
HC Implementation Outage	Apr 2015	Complete	Nov 2016
Report to NRC When Full Compliance is Achieved	Aug 2015	Complete With This Report	Jan 2017

4 NRC ORDER EA-12-049 COMPLIANCE ELEMENTS SUMMARY

HCGS compliance with NRC Order EA-12-049 (Reference 2) was achieved using the guidance in NEI 12-06, Revision 0 (Reference 10), which has been endorsed by the NRC with clarifications on determining baseline coping capability and equipment quality (Reference 18). The significant compliance elements have been addressed for HCGS as described below.

Strategies - Complete

HCGS 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 HCGS 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 HCGS was procured, received, initially tested and/or performance verified. The availability of FLEX equipment and connection points is maintained via administrative controls (Reference 19) and implementation of the corrective action program. Periodic maintenance and testing is addressed via the preventive maintenance process.

Protected Storage – Complete

The storage facilities required for implementation of the HCGS 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 HCGS 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 HCGS been completed in accordance with an accepted training process, as recommended in NEI 12-06, Section 11.6.

Staffing – Complete

PSEG completed the HCGS staffing assessment (Reference 20) in response to the NRC staff 10 CFR 50.54(f) information request dated March 12, 2012 (Reference 21). 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 HCGS response strategies (Reference 22).

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 Reference 23.

Validation - Complete

PSEG performed validation (Reference 24) in accordance with industry-developed guidance to assure required tasks, manual actions, and decisions for the HCGS FLEX strategies are feasible and may be executed within the time constraints identified in the enclosed FIP.

FLEX Program Document - Established

The HCGS FLEX overall program document (Reference 25) 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-N13-0031, "PSEG Nuclear LLC's Overall Integrated Plan for the Hope Creek 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 27, 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-N13-0173, "PSEG Nuclear LLC's First Six-Month Status Report for the Hope Creek 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 22, 2013
4. PSEG Letter LR-N14-0025, "PSEG Nuclear LLC's Second Six-Month Status Report for the Hope Creek 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-N14-0184, "PSEG Nuclear LLC's Third Six-Month Status Report for the Hope Creek 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-N15-0022, "PSEG Nuclear LLC's Fourth Six-Month Status Report for the Hope Creek 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-N15-0169, "PSEG Nuclear LLC's Fifth Six-Month Status Report for the Hope Creek 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 27, 2015

8. PSEG Letter LR-N16-0042, "PSEG Nuclear LLC's Sixth Six-Month Status Report for the Hope Creek 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. PSEG Letter LR-N16-0137, "PSEG Nuclear LLC's Seventh Six-Month Status Report for the Hope Creek 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 24, 2016

10. Nuclear Energy Institute (NEI) Report NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0, dated August 2012

11. NRC Order EA-13-109, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Effective Immediately)," dated June 6, 2013

12. NRC Letter to PSEG, "Hope Creek Generating Station – Relaxation of the Schedule Requirements for Order EA-12-049 'Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events,'" dated May 20, 2014

13. NRC Letter to PSEG, "Hope Creek Generating Station – Relaxation of the Schedule Requirements for Order EA-12-049 'Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events,'" dated April 29, 2015

14. PSEG Letter LR-N15-0190, "Intermediate Implementation Milestone Change for NRC Order EA-12-049, 'Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events' – Hope Creek Generating Station," dated December 14, 2015

15. NRC Letter to PSEG, “Hope Creek Generating Station – Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Order EA-12-049 (Mitigation Strategies) (TAC NO. MF0867),” dated February 11, 2014

16. NRC Letter to PSEG, “Hope Creek Generating Station – Report for the Onsite Audit Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Pool Instrumentation Related to Orders EA-12-049 and EA-12-051 (TAC Nos. MF0867 and MF1031),” dated March 25, 2016

17. PSEG Calculation H-1-FLX-MDC-4022, “FLEX Hydraulic Model”

18. 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

19. OP-HC-108-115-1001, “Operability Assessment and Equipment Control Program”

20. PSEG Letter LR-N14-0248, “Hope Creek 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 December 9, 2014

21. NRC Letter to PSEG, "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

22. NRC Letter to PSEG, “Hope Creek Generating Station - Response Regarding Phase 2 Staffing Submittals Associated with Near-Term Task Force Recommendation 9.3 Related to the Fukushima Dai-ichi Nuclear Power Plant Accident (TAC No. MF5406)," dated September 9, 2015

23. PSEG Vendor Technical Document (VTD) 432539, Volume 1, “SAFER Response Plan for Hope Creek Generating Station”

24. PSEG Vendor Technical Document 432563, “Hope Creek Validation of FLEX Strategies”

25. EM-HC-100-1000, “Response to Beyond Design Basis External Events Program Document, Hope Creek Generating Station”

Enclosure

EM-HC-100-1000, Attachment 1, "Final Integrated Plan – Beyond Design Basis FLEX Mitigating Strategies, Hope Creek Generating Station"

Attachment 1 - Final Integrated Plan - Beyond-Design-Basis FLEX Mitigating Strategies, Hope Creek Generating Station

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Final Integrated Plan - Beyond Design Basis FLEX Mitigation Strategies
Hope Creek Generating Station

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 a Near-Term Task Force (NTTF) to advise the Commission on actions the US nuclear industry should take to preclude core damage and a release of radioactive material after a natural disaster such as that seen at Fukushima. The NTTF report (Reference 22) 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 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 spent fuel pool (SFP) cooling capabilities following a BDB external event.

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

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

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

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

The Order specifies a three-phase approach for strategies to mitigate BDB external events:

- 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 additional capability and redundancy from offsite equipment until power, water, and coolant injection systems are restored or commissioned.

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 diverse and flexible (FLEX) 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. PSEG used Revision 0 to NEI 12-06 to develop the Hope Creek Generating Station (HCGS) FLEX strategies.

NRC Order EA-12-051 (Reference 5) required licensees to install reliable SFP instrumentation with specific design features for monitoring SFP water level. This Order was prompted by NTTF Recommendation 7.1 (Reference 22).

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.

NRC Order EA-13-109 (Reference 8) required licensees to install a severe accident capable hardened containment vent system for the primary containment wetwell (torus at HCGS) to remove decay, vent the containment atmosphere, and control containment pressure to within acceptable limits.

NEI 13-02 (Reference 13) provided guidance to assist licensees with compliance with Order EA-13-109. The NRC issued Interim Staff Guidance (References 14 and 88), which endorsed NEI 13-02 with exceptions and clarifications for use in meeting the requirements of NRC Order EA-13-109.

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

2.1 GENERAL ELEMENTS

2.1.1 *Assumptions*

The assumptions used for the evaluations of a Hope Creek Generating Station (HCGS) ELAP/LUHS event and the development of FLEX strategies are stated below.

Boundary conditions consistent with NEI 12-06, Section 2, *Overview of Implementation Process,* are established to support development of FLEX strategies, as follows:

– The BDBEE occurs impacting all units at the site.

– The reactor is initially operating at full power, unless there are procedural requirements to shut down due to an impending event. The reactor has been operating at 100% power for the past 100 days.

– The reactor is successfully shut down when required (i.e., all rods inserted, no ATWS). Steam release to maintain decay heat removal upon shutdown functions 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 FLEX equipment stored in structures with designs that are robust with respect to seismic events, floods and high winds and associated missiles, remains available.

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

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

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

- For the 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.

- Offsite resources are assumed to begin arriving at hour 6 with normal site access for receipt of offsite 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 SFP cooling capabilities at all units on the 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. Emergency Operating Procedures (EOPs) and Abnormal Operating Procedures (AOPs) have been revised in accordance with established change processes, to clearly reference and identify appropriate entry and exit conditions for these pre-planned strategies. Procedures govern the operational response to a BDBEE following established command and control practices. 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 reactor, 2) maintain the containment function and 3) maintain cooling and prevent damage to fuel in the SFP using installed equipment, onsite portable and pre-staged equipment, and pre-staged offsite resources. This indefinite coping capability will address an ELAP (extended 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 condition could arise following external events that are within the existing design basis with additional failures and conditions that could arise from a Beyond-Design-Basis External Event (BDBEE).

The plant indefinite coping capability is attained through the implementation of pre-determined strategies (FLEX strategies) that are focused on maintaining or restoring key plant safety functions. The FLEX strategies are not tied to any specific damage state or mechanistic assessment of external events. Rather, the strategies are developed to maintain the key plant safety functions based on the evaluation of plant response to the coincident ELAP/LUHS event. A safety function-based approach provides consistency with, and allows coordination with, existing plant EOPs. FLEX strategies are implemented in support of EOPs using FLEX Support Guidelines (FSGs). For HCGS, FSGs are 400-series EOPs, i.e., HC.OP-EO.ZZ-04##.

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 FLEX 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 HCGS. 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 HCGS 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.

PSEG used NEI 12-06 Revision 0 (Reference 3) as the basis for the FLEX mitigation strategies. The following are HCGS alternatives to NEI 12-06 Revision 0, with reference to the FIP sections that provide additional information and justification:

- Outdoor Storage of FLEX Equipment (Section 2.6.4)
- Pre-staged vs Portable FLEX Equipment (2.3.9.1 for FLEX Alternate Header pumps and Section 2.7 for FLEX diesel generators)
- Single, Installed Motor Control Center (Section 2.3.5.5)
- Phase 3 Electrical Connection (Section 2.3.5.6)
- N+1 Cables and Hoses (Section 2.18.6)

Diagrams of the overall FLEX strategies, showing the mechanical and electrical connections, are provided in Figures 1 and 2, respectively.

2.3 REACTOR CORE COOLING

During the first six hours after shutdown caused by the BDBEE, main steam isolation valves automatically close and feedwater is lost. Safety relief valves (SRVs) are cycled to control pressure, causing reactor water level to decrease. When reactor water level reaches the low-low, level 2 setpoint, reactor core isolation cooling (RCIC) and high pressure coolant injection (HPCI) automatically start to inject makeup water to the reactor vessel. This injection recovers the reactor level to the normal band. Reactor level and pressure are maintained using SRVs, RCIC and/or HPCI. Both pump suctions are normally aligned to the condensate storage tank (CST) but will be manually swapped to the torus to ensure longer RCIC availability. If CST inventory is not available suction will automatically swap to the torus.

2.3.1 *Phase 1 Strategy*

Station Blackout (SBO) symptoms will be recognized within the first few minutes. AOP HC.OP-AB.ZZ-0135, *Station Blackout // Loss of Offsite Power // Diesel Generator Malfunction,* will be entered assuming the SBO will not extend beyond four hours in accordance with the existing SBO licensing basis for Hope Creek. In addition, this AOP provides guidance for ELAP determination and in-plant coping strategies and resultant compensatory measures required to meet the challenges and anticipated duration of an ELAP/LUHS event.

When it has been determined that RCIC and HPCI are the only available injection systems, EOP HC.OP-EO.ZZ-0105, *Reactor Pressure Vessel Control - HPCI / RCIC Only*, will be entered, providing guidance to stabilize reactor level and commence RPV depressurization within normal cooldown constraints, maintaining sufficient RPV pressure to ensure RCIC and HPCI viability. RCIC and HPCI systems are safety-related and capable of operation independent of AC power (UFSAR Sections 5.4.6 and 6.3).

Under SBO conditions, HC.OP-AB.ZZ-0135 provides direction to investigate the emergency diesel generator (EDG) start failures and to determine the anticipated duration of the loss of offsite power. An ELAP will be declared not later than one hour after the SBO event initiation if it has been determined the EDGs can not be restored to service within four hours, and offsite power will remain unavailable. FSGs will be entered as soon as practical after identification of the ELAP condition.

Initially, RPV pressure will be controlled with SRVs. HPCI and RCIC suctions will be swapped to the torus until the torus water temperature reaches 170° F for HPCI or 215° F for RCIC, or will remain aligned to the torus if the CST is unavailable. This strategy maintains HPCI and RCIC system availability and preserves the cool, high quality water supply from the CST for as long as possible. When torus water temperature reaches 170°F, core decay heat and the resulting feed demand is minimized allowing the CST volume (if available) to support the strategy for a longer duration. To minimize torus water heat up, HPCI injection will be terminated as soon as RCIC is capable of controlling RPV level alone, which is normally approximately 20 minutes after the scram.

When torus water temperature reaches 170°F, HPCI will be transferred to the CST if available. RCIC will be transferred to the CST at a torus temperature of 215° F. Once transferred to the CST, HPCI or RCIC can be placed into RPV pressure control mode to limit torus water temperature and level rise. At this point, the SRVs will be used only as necessary if the HPCI turbine or the CST are not available. If available, HPCI is capable of controlling RPV pressure within 30 minutes of the scram. The CST is considered seismically adequate (Reference 77) and is credited for use following a seismic, hot weather or cold weather event.

Torus water temperature rise will be mitigated by venting the torus using the hardened containment vent system (HCVS) . EOPs HC.OP-EO.ZZ-0102, *Containment Control*, and EOPs HC.OP-EO.ZZ-0106, *Containment Control – HPCI /RCIC Only*, intiate venting via EOP HC.OP-EO.ZZ-0318, *Containment Venting*. HC.OP-AB.ZZ-0135 directs the operators to connect the HCVS nitrogen supply using HC.OP-EO.ZZ-0318 within four hours of an SBO. MAAP analyses in HC-MISC-005 (Reference 41), show torus water temperature reaches 200º F in approximately 4.1 hours. Torus venting in this time frame limits the torus water temperature peak to approximately 250º F. Reducing torus water temperature rate of rise by venting allows the subsequent use of the RCIC system if the CST becomes unavailable. In addition, it maintains primary containment at a reduced pressure, enhancing the capabilities of injection systems external to primary containment.

DC coping calculations (References 61 and 62) document the duration of battery support associated with the deep load shedding that will be conducted in a BDBEE. The DC coping calculations are based on the NEI white paper on battery life which has been endorsed by the NRC (Reference 9). These evaluations show that the 125 VDC batteries provide the required voltage for five hours (Reference 61); and the 250 VDC batteries provide the required voltage for nine hours (Reference 62). Therefore, RCIC will remain functional for at least five hours without support from FLEX equipment.

SRV capability is dependent on availability of compressed gas, drywell pressure, and 125 VDC power. After the scram, drywell pressure begins to rise. The Primary Containment Instrument Gas (PCIG) receivers will continue to provide compressed air to the SRVs until it is depleted, at which point individual air accumulators would provide motive force for SRV operation. When continuous sources of instrument gas are unavailable,EOPs (e.g., HC.OP-EO.ZZ-0106) direct operators to limit SRV operations as much as possible to limit the use of compressed gas.

The peak drywell pressure of 40 psia used in initial FLEX strategy development based on NEDC-33771P (Reference 56) is conservative compared to plant-specific MAAP analysis results (Reference 41) which show lower peak drywell pressures. Vendor Technical Document (VTD) 430123 (Reference 72) and Technical Evaluation 80113610-0030 (Reference 73) evaluate the SRV accumulators' capacity to support valve cycling under SBO and ELAP conditions, respectively, based on a drywell pressure of 40 psia. Under ELAP conditions, each accumulator can provide at least 26 additional SRV operations with drywell pressure under 40 psia during the six hour duration after the ELAP occurs (Reference 73), for a total of 364 total cycles for the 14 SRVs.

An evaluation of 125 VDC battery life based on the deep load shed for FLEX (Reference 61) shows that the battery providing control power to the SRVs will support five hours of service based on load shedding in accordance with HC.OP-AB.ZZ-0135. The SRV accumulators will support the necessary SRV operations for over five hours. Therefore, the SRVs will be available for at least five hours without any FLEX equipment support.

The normal power source for the HCVS is Uninterruptible Power Supply (UPS) inverter 1DD481 on the "D" bus, which supplies the Remote Shutdown Panel (10C399) and thereby powers the HCVS equipment at the Primary Operating Station in the Remote Shutdown Room (Reference 40). FLEX power is supplied to the HCVS via the B channel as part of the Phase 2 strategy via HC.OP-EO.ZZ-0401, *FLEX Electrical - Phase 2*.

To ensure HPCI and RCIC continue to provide service, the equipment area high temperature system isolations are defeated for both systems per HC.OP-AB.ZZ-0135.

2.3.2 *Phase 2 Strategy*

Under SBO conditions, HC.OP-AB.ZZ-0135 provides direction to declare an ELAP condition and enter FSGs within one hour of SBO event initiation if a determination is made that the EDGs can not be restarted and offsite power will remain unavailable. FSGs will be entered as soon as practical after identification of the ELAP to effectively manage the event and maintain RPV injection and pressure control capability. Depending on the water source, RPV flow paths are established via HC.OP-EO.ZZ-0403, *FLEX Service Water Injection*, HC.OP-EO.ZZ-0404, *FLEX Injection from CST*, or HC.OP-EO.ZZ-0406, *FLEX Injection from Torus*.

RCIC is critical to the ELAP coping plan and actions necessary to keep RCIC functional will be performed on a high priority basis. In accordance with the revised EOPs, RPV pressure is maintained above 150 psig to provide the motive force for RCIC when RCIC and/or HPCI are the only systems capable of providing adequate core cooling. Electrical power for RCIC valves and small motors is supplied by the 250 VDC battery and for RCIC logic by the “B” channel 125 VDC battery. Battery sizing evaluations and implementation of load shedding strategies after the ELAP is declared will support operation of RCIC and the SRVs for a minimum of 5 hours. Station modifications (Reference 54) enable station operators to connect emergency power from the FLEX generator to the 250 VDC and 125 VDC battery chargers within five hours assuring no interruption in critical electrical power to RCIC and the SRVs.

A portable compressor will be connected to the PCIG piping system to assure continued SRV functionality during Phase 2 using HC.OP-EO.ZZ-0407, *FLEX SRV Air Compressor*. This portable compressor is powered by the 480 VAC supply provided by the FLEX generator.

Water from the Delaware River can be injected into the RPV using a portable diesel-driven FLEX pump deployed near the river. This FLEX pump will be deployed to a location near the Service Water Intake Structure (SWIS). A suction hose with strainer will be placed in the river. A hose will be run from the FLEX pump discharge to a FLEX connection on either the “A” or “B” SW header located inside the hardened SWIS. The service water side of the Safety Auxiliaries Cooling System (SACS) and Reactor Auxiliaries Cooling System (RACS) heat exchangers will be isolated, and the FLEX pump will be used to pressurize the service water system piping into the Reactor Building. The installed service water to RHR emergency makeup line will be opened to allow service water to enter the RHR piping system and then routed to the RPV. This flow path injects river water inside the shroud above the fuel consistent with BWROG recommendations to maintain adequate core cooling when using raw water (Reference 47).

Actions to deploy the FLEX pump to the SWIS will be initiated after an ELAP condition is identified. If flood conditions exist, pump deployment activity can not start until flood waters recede. Since flood conditions are predictable, the pump and engine would be fully prepped for operation and stored inside the Hope Creek Unit 2 Reactor Building prior to the flood. After flood waters recede, the pump will be towed to the deployment location and the hoses run to the river and connected to the service water piping.

Depending on the initiating event, other sources of water may be available prior to the use of river water. The CST inventory is normally maintained above a minimum of 218,000 gallons which can provide inventory for RPV injection until the FLEX pump is deployed at the river.

The torus provides the baseline coping capability during a flood event which limits access to the river. The EOPs direct station personnel to control torus water heat up by opening the torus vent at approximately 200º F. With RCIC taking suction from the torus and the HCVS open, the torus water will heat up to 215º F in approximately 6 hours and may threaten RCIC reliability. An evaluation of the acceptability of the RCIC suction and discharge piping for temperatures up to 255º F has been performed. However, prior to that point the FLEX electric motor-driven Alternate Header pump will be connected and available to take suction on the torus and inject to the RPV via the installed FLEX piping and FLEX connection (primary) at the "B" SW to RHR emergency makeup flow path. The alternate connection is located at the "A" RHR heat exchanger.

Torus level replenishment will be provided by river water from the portable diesel-driven FLEX pump near the SWIS to the torus spray header or the RHR test return valve.

To support mitigation of a beyond design basis high wind event, the portable diesel-driven FLEX pump will be deployed at the river and connected to either the "B" (primary) or "A" (secondary) SW header connections to inject water to the RPV via the SW to emergency RHR crosstie flow path. The portable diesel-driven FLEX pump will be deployed at approximately 6 hours into the event, the point at which RCIC performance could begin to degrade due to elevated torus temperatures.

AC/DC Power

FLEX power is provided by a 480 VAC FLEX diesel generator (DG) using HC.OP-EO.ZZ-0401, *FLEX Electrical – Phase 2.* Major FLEX electrical loads for core cooling include the FLEX Alternate Header pump, motor-operated valves, and 125 V and 250 V battery chargers. HC.OP-EO.ZZ-0401 includes measures to ensure the station busses are de-energized and not capable of being powered from normal sources before establishing FLEX power. Correct phase rotation of the FLEX DGs was verified during modification acceptance testing.

The FLEX Alternate Header pump will be powered from the 480 VAC FLEX MCC powered by the FLEX diesel generator to a receptacle in the "B" core spray room on the 54' elevation of the Reactor Building. A secondary receptacle wired from a breaker in the 10B222 MCC is available to provide an alternate feed for the FLEX Alternate Header pump.

2.3.3 *Phase 3 Strategy*

PSEG participates in the Strategic Alliance for FLEX Emergency Response (SAFER). The HCGS SAFER Response Plan is provided in Reference 51.

Phase 3 coping relies on four 4.16 kV generators from a National SAFER Response Center (NSRC) providing enough electrical power to start up one channel of ECCS equipment and a large diesel-driven pump providing adequate flow from the ultimate heat sink through the Safety Auxiliaries Cooling System (SACS) heat exchanger to provide effective cooling capability. Core cooling can be initiated with the "A" SACS pump and the "A" RHR pump. The generators are sized to support the core cooling loads plus have adequate margin to provide power to begin torus water and SFP cooling (Reference 87). Plant-specific guidance for connecting the 4.16 kV SAFER generators and powering loads is provided in HC.OP-EO.ZZ-0402, *FLEX Electrical –Phase 3*. HC.OP-EO.ZZ-0402 includes steps to ensure isolation of other sources prior to energizing the 4 kV bus with FLEX power.

2.3.4 *Structures, Systems, and Components*

2.3.4.1 Hardened Containment Vent System

PSEG modified the 12" Hardened Torus Vent to meet the Phase 1 requirements of NRC Order EA-13-109 (Reference 8) and associated NEI guidance (Reference 13), as described in References 36, 40, 55, and 57.

2.3.4.2 RCIC System

The RCIC system is a safety-related system consisting of a steam turbine, turbine-driven pump, piping, valves, controls and instrumentation designed to ensure that sufficient reactor water inventory is maintained in the reactor vessel to allow for adequate core cooling. On a reactor low water level signal, the RCIC system automatically starts and delivers demineralized makeup water from the CST to the reactor through the feedwater system. If the CST is not available, suppression pool (torus) water is available as an alternate source.

2.3.4.3 Safety/Relief Valves (SRVs)

During an ELAP/LUHS event with the loss of all AC power and instrument air, SRVs automatically cycle to initially control reactor pressure until the Operations crew controls RPV pressure by cycling SRVs to depressurize the RPV while maintaining a controlled cooldown.

2.3.4.4 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 5 hours of operation.

The 250 VDC batteries and chargers are at the 54’ elevation of the Auxiliary Building in the following rooms:

- 5129 - HPCI Charger
- 5104 - HPCI Battery
- 5130 - RCIC Charger
- 5126 - RCIC Battery

The 125 VDC batteries, battery chargers and inverters are located in the Auxiliary Building in the following specific locations:

Component	Room	Plant Elevation
Batteries		
AD414	5544	146’
BD414	5540	146’
CD414	5542	146’
DD414	5538	146’
Battery Chargers		
AD411	5545	146’
BD411	5541	146’
CD411	5543	146’
DD411	5539	146’
Inverters		
AD481	5501	137’
BD481	5448	124’

Component	Room	Plant Elevation
CD481	5501	137’
DD481	5448	124’

2.3.4.5 Pressure Suppression Chamber

The suppression pool (torus) is the heat sink for reactor vessel SRV discharges and RCIC turbine steam exhaust following a BDBEE. It is also the suction source for the RCIC pump and the FLEX Alternate Header pump for core cooling if the CST is not available.

2.3.5 *FLEX Strategy Connections*

2.3.5.1 Primary Core Cooling Connection

The primary connection to inject to the RPV is via the installed FLEX piping and FLEX connection at “B” service water to emergency RHR crosstie flow path. This connection is in the Reactor Auxiliary Cooling System (RACS) Pump Area in the Reactor Building and is protected from all external hazards.

2.3.5.2 Alternate Core Cooling Connection

In the event that the primary connection is not available, an alternate connection location is provided. The alternate connection to inject to the RPV is via the installed FLEX piping and FLEX connection at the “A” RHR heat exchanger. This connection is in the “A” RHR Heat Exchanger Room in the Reactor Building and is protected from all external hazards.

2.3.5.3 Water Sources

The HCGS mitigation strategies utilize various water sources such as the torus, CST or river water. The preferred source of water is the CST. Torus water is used in the baseline MAAP analysis (Reference 41) because it is protected from all external hazards and readily available. Although not credited, alternate sources of water, including water from the CST, may be available. When possible, high quality water sources will be used to maintain RPV level via the FLEX Alternate Header pump located at the FLEX header in the Reactor Building.

A motor-driven FLEX Alternate Header pump (Figure 1) can take suction from the CST if available or the torus. Torus level replenishment can be provided by river water from the portable diesel-driven FLEX pump near the SWIS to the torus spray header or the RHR test return valve. Water from the Delaware river can be injected into the RPV using the portable diesel-driven FLEX pump deployed near the river. A suction hose with strainer will be placed in the river. A hose will be run from the diesel-driven FLEX pump discharge to a FLEX connection on either the "A" or "B" SW header located inside the hardened SWIS. The service water side of the Safety Auxiliaries Cooling System (SACS) and the Reactor Auxiliaries Cooling System (RACS) heat exchangers will be isolated, and the FLEX pump will be used to pressurize the service water system piping into the Reactor Building. The installed service water to RHR emergency makeup line will be opened to allow service water to enter the RHR piping system and then routed to the RPV.

2.3.5.4 Primary Electrical Connection

The primary connection to the FLEX MCC from the 480 VAC FLEX diesel generators is located on elevation 130' of the Unit 2 Auxiliary Building Control/Diesel Area near the door for roof access to the Unit 2 Reactor Building roof. Cable in conduit is routed from the FLEX MCC to receptacles near the "A" and "B" unit substations in the Unit 1 switchgear rooms. Back-feed breakers are installed in the unit substations and wired out to nearby receptacles. Cables are provided to make the final connection between the FLEX receptacles and the unit substation back-feed breaker receptacles.

Cable in conduit is routed from the 480 VAC FLEX MCC to a receptacle in the "B" core spray room on elevation 54' of the Reactor Building to power the FLEX Alternate Header pump.

An electrical one-line diagram is provided in Figure 2.

2.3.5.5 Alternate Electrical Connection

Cable in conduit is run from the FLEX MCC to receptacles near HPCI and RCIC 250 VDC battery chargers at the 54' elevation and to receptacles near the "A" and "B" 125 VDC battery chargers at the 146' elevation of the Auxiliary Building. Cables are provided to make the final connection between the FLEX receptacles and the battery charger receptacles.

A second receptacle is wired from a breaker in the 10B222 MCC to provide an alternate feed for the FLEX Alternate Header pump.

HCGS uses a single 480 V Motor Control Center (MCC) that has been installed specifically to support the FLEX strategy. The MCC is installed in HCGS Unit 2 Auxiliary Building Corridor 5424 and is protected from all external hazards. The MCC is not safety-related but is seismically qualified and subject to augmented quality requirements to assure that it remains functional following a seismic event. The use of a single MCC is an alternative to NEI 12-06 provisions regarding the use of primary and alternate connections as diverse means of re-powering FLEX equipment, e.g., in NEI 12-06, Section 3.2.2. The use of the permanently installed MCC 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."

2.3.5.6 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. Four 4.16 kV AC portable generators will be provided by the NSRC. These 4.16 kV generators will be used to power one channel of ECCS equipment and are sized to support core cooling loads plus have adequate margin to provide power to begin torus water and SFP cooling.

HC.OP-EO.ZZ-0402, *FLEX Electrical – Phase 3,* and DCP 80112547 (Reference 69), provide direction for staging, connecting, and loading the SAFER 4.16 kV generators. The HCGS FLEX Phase 3 electrical connection design (Figure 2, Page 2) uses a single set of 4.16 kV connections as an alternative to NEI 12-06 Revision 0, Section 3.2.2 of which includes the following:

"Electrical diversity can be accomplished by providing a primary and alternate method to repower key equipment and instruments utilized in FLEX strategies. At a minimum, the primary connection point should be an installed connection suitable for both the on-site and off-site equipment. The secondary connection point may require reconfiguration (e.g., removal of valve bonnets or breaker) if it can be shown that adequate time is available and adequate resources are reasonably expected to be available to support the reconfiguration. Both the primary and alternate connection points do not need to be available for all applicable hazards, but the location of the connection points should provide reasonable assurance of at least one connection being available."

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. SAFER will provide four 4.16 kV AC portable generators and 4.16 kV switchgear for HCGS to on-site Staging Area B (Figure 3). The generators and switchgear will be deployed on the west side of the Auxiliary Building Control/Diesel area at elevation 102'-0" (near the EDG truck bay door) to allow the re-powering of Class 1E switchgear 10A401 and its existing station loads. The SAFER switchgear with an output circuit breaker is used to connect the four generators and to provide a total common output of 4.0 MW at 4.16 kV.

DCP 80110322 (Reference 54) provided a permanently installed receptacle enclosure (H1FLX-10-S-4000) in the HCGS Auxiliary Building Control/Diesel area at elevation Elev. 102'-0" (near the EDG truck bay door). The receptacle enclosure is non-safety related but it is designed to assure that it remains available following a seismic event and subject to augmented quality requirements (Reference 54). The installed Phase 3 connection points are protected from all external hazards based on their design and location within the safety-related, Seismic Class I Auxiliary Building.

The single set of connections for Phase 3, 4.16 kV power represents an alternative to NEI 12-06 Revision 0 criteria for primary and alternate connections. Based on the protection of these connections from external hazards via their seismic design and location within the safety-related Auxiliary Building, the Phase 3 electrical design provides reasonable assurance of remaining available to support the FLEX strategy.

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, proceduralized guidance is available for taking local readings.

- Reactor Level (Fuel Zone), Channels A and B
- Reactor Level
- Reactor Pressure

- Reactor Level (Post Accident Monitoring System).
- Reactor Pressure (Post Accident Monitoring System).
- Torus Level

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.

Additional guidelines for alternately obtaining the critical parameters locally are provided in HC.OP-AM.TSC-0027, *Local Monitoring of Key Plant Parameters*.

2.3.7 *Thermal Hydraulic Analyses*

MAAP analysis was performed to support the FLEX strategies discussed in subsections 2.3.1 and 2.3.2 (Reference 41). The HCGS FLEX strategies are based on MAAP analysis and existing EOP responses.

MAAP4 code benchmarking for use in support of Post-Fukushima applications is discussed in detail in Section 5 of EPRI Report 3002001785, (Reference 44). The EPRI report concludes that MAAP4 is acceptable for use in support of the industry response to NRC Order EA-12-049. The NRC accepted the use of the MAAP4 code subject to five limitations (Reference 45). Those five limitations and the associated confirmatory items in the HCGS FLEX Interim Staff Evaluation (Reference 46) have been addressed for Hope Creek in Reference 43. The MAAP analyses also account for recirculation pump seal leakage (18 gpm/pump) plus 25 gpm of identified leakage at normal operating pressure based on HCGS Technical Specification 3.4.3.2 leakage limits (References 41 and 43).

Plant-specific hydraulic analyses of the HCGS FLEX flow paths are provided in Reference 80.

2.3.8 *Shutdown Margin Analysis*

Not applicable to BWRs for FLEX.

2.3.9 *FLEX Pumps and Water Supplies*

2.3.9.1 FLEX Alternate Header Pump (Motor-Driven)

Consistent with NEI 12-06, Appendix C, RPV water injection capability is provided using a portable FLEX Alternate Header pump through a primary and alternate connection. The FLEX Alternate Header pumps have a nominal flow rate of 450 gpm and 180 psi discharge pressure. A FLEX Alternate Header pump will provide a back-up method for RPV injection in the event that the RCIC pump can no longer perform its function due to insufficient turbine inlet steam flow. Hydraulic analyses (Reference 80) have confirmed that one FLEX Alternate Header pump is sized to provide the minimum required RPV injection flowrate to support reactor core cooling and decay heat removal.

Two FLEX Alternate Header pumps are available to satisfy the N+1 criteria of NEI 12-06. They are both pre-staged as an alternative to NEI 12-06 criteria for use of portable FLEX equipment. The pre-staged pumps are in the Core Spray Pump Room (Room 4104) of the Seismic Category I Unit 1 Reactor Building and are protected from all external hazards. Analyses of the 72-hour ELAP transient temperatures demonstrate acceptable temperatures for equipment reliability and personnel access to establish the flow paths in accordance with the FLEX timelines (Reference 81). Based on the pumps' design characteristics and low likelihood of catastrophic failure, consequential failure of the N+1 pump due to failure of the N pump is not considered credible. Therefore, the pre-staged electric motor-driven pumps provide reasonable assurance of maintaining core cooling and SFP cooling during an ELAP.

The FLEX hydraulic analyses (Reference 80) include net positive suction head (NPSH) evaluations of the FLEX Alternate Header pumps. Pump curves and operating characteristics are included in HC.OP-EO.ZZ-0404, *FLEX Injection from CST* and HC.OP-EO.ZZ-0406, *FLEX Injection from Torus.*

2.3.9.2 Diesel-Driven FLEX Pump

Water from the river can be pumped through the SW system to inject water to the RPV via the SW to emergency crosstie flow paths to "B" or "A" RHR.

The FLEX hydraulic analyses (Reference 80) include net positive suction head (NPSH) evaluations of the diesel-driven FLEX pumps. Pump curves and operating characteristics are included in HC.OP-EO.ZZ-0403, *FLEX Service Water Injection.*

2.3.9.3 Makeup Water Supplies

Suppression Pool (Torus)

The suppression pool (torus) water volume is maintained between 118,000 ft^3 and 122,000 ft^3 per Hope Creek Technical Specifications and is a water supply source for the FLEX Alternate Header pump. The suppression pool (torus) is part of the primary containment system and is located in the Reactor Building. The Reactor Building is designed to withstand the maximum postulated seismic event. In addition, the Reactor Building is designed to provide protection of the torus from all postulated external hazards including tornadoes. The torus water supply is robust for all external hazards and is the credited water supply for the baseline strategy in the MAAP analyses (Reference 41).

Condensate Storage Tank (CST)

The Condensate Storage Tank (CST) is the normal source of water for the HPCI and RCIC pumps and can also provide a suction source for the FLEX Alternate Header pump. The water volume in the CST is maintained above 276,000 gallons during normal operation. The CST is designed to provide a reserve of 135,000 gallons for HPCI and RCIC use. The CST is located outdoors and is provided with freeze protection. The CST is a field erected, non-seismic tank supported on a reinforced concrete mat foundation at plant grade level near the Reactor Building. Although it is not Seismic Category I, the CST is considered to be seismically adequate to survive the design basis SSE and the ground motion response spectra (GMRS) of the re-evaluated seismic hazard. The peak ground acceleration is 0.2g for the SSE and the GMRS, compared to a high confidence of low probability of failure (HCLPF) of 0.34g for the CST (Reference 77). The CST is surrounded by a Seismic Category I dike capable of containing the total volume of water within the tank. The dike also provides some protection of the tank from external flooding and wind-borne missiles. However, the CST inventory is not assumed to be available in the baseline MAAP analyses (Reference 41), which relies on pump suction from the torus.

Delaware River

Delaware River provides an indefinite supply of water. Refer to Section 2.15 for a discussion of water quality.

2.3.9.4 Borated Water Supplies

Not applicable to BWRs for FLEX.

2.3.10 *Electrical Analysis*

The Class 1E battery duty cycle of five (5) hours for HCGS 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 and endorsed by the NRC (Reference 9).

The strategy to re-power the HCGS vital AC/DC buses requires the use of diesel-powered generators. For this purpose, three 480 VAC portable DGs are available to provide the power required during Phase 2 of the FLEX strategy. Only one DG is required. Calculation E-15.16 (Reference 87) evaluates and documents the electrical system requirements for HCGS FLEX strategies.

The 480 VAC DGs are 750 KVA, 600 kW nominal rated generators. They are mounted with a 1075 gallon diesel fuel tank built into the frame. Two DGs are on the Hope Creek Unit 2 Reactor Building roof, providing N and N+1 capability except for a tornado event that results in an ELAP and disables both pre-staged DGs. During a tornado event, an additional diesel generator is available, normally stored >1200 feet away from the two DGs on the roof.

Additional replacement 480 VAC generators and 4160 VAC generators are available from the National SAFER Response Center (NSRC) for the Phase 3 strategy. Reference 87 includes the Phase 3 loading requirements. The specific equipment from the NSRC is listed in Table 2.

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 spent fuel pool. Assuming the technical specification minimum SFP water level, uncovering fuel would not occur until approximately 37 hours after loss of SFP cooling (Reference 86). 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*

There are several methods to supply water to the SFP using the FLEX equipment (Figure 1) using either a diesel-driven FLEX pump or an electric motor-driven FLEX Alternate Header pump.

The diesel-driven FLEX pump at SWIS is capable of supplying water to the SFP via the SW header to the reactor building via either

a. the emergency fill line in RACS Room at the 77’ elevation in the Reactor Building. This is the same flow path for injection to the RPV described in Section 2.3.2, except the flow is diverted to the SFP via installed system piping; or

b. the fill path in the SW system to supply water to the SFP.

The electric motor-driven FLEX Alternate Header pump is capable of providing flow to the SFP using CST (if available) or the torus by any of the following means:

a. FLEX standpipe to the SFP in the northwest stairwell of the Reactor Building truck bay and injecting via a hose staged on the refueling floor.

b. FLEX standpipe to the 168’ elevation and a connection to the existing B.5.b SFP spray nozzle.

c. FLEX injection header to the SW emergency fill line in RACS room 77’ elevation of the Reactor Building.

The diesel-driven FLEX (SW) pump deployed to the Delaware River as described in Section 2.3.2 can be aligned to provide makeup to the SFP. Water supply options are made available through the piping configurations discussed above. The electric motor-driven FLEX Alternate Header pump can be routed to the FLEX stand-pipe in the Reactor Building stairwell from the 102’ elevation to the 201’ elevation. The standpipe includes a “T” and isolation valve at the 162’ elevation that provides a connection to the SFP spray nozzles.

2.4.3 *Phase 3 Strategy*

Phase 1 and 2 strategies will provide sufficient capability such that no additional Phase 3 strategies are required.

2.4.4 *Structures, Systems, and Components*

2.4.4.1 Spent Fuel Pool

The SFP is a reinforced concrete structure that forms an integral part of the Reactor Building. The normal SFP depth of approximately 40 feet provides about 25 feet of water above the top of stored fuel assemblies and about 9 feet of water above the active fuel in transit. The SFP is designed to Seismic Category I requirements. It is lined with stainless steel to minimize leakage and reduce corrosion product formation. The SFP is designed so that it cannot be drained to a level that uncovers the top of the stored fuel. The cooling water supply lines enter the SFP from above the normal water level and are provided with high point vent lines to prevent siphoning of water from the pool.

2.4.4.2 Fuel Building Ventilation

A vent pathway for steam and condensate from the SFP is established as recommended by NEI 12-06.

To promote circulation and ventilation inside the Reactor Building, a Filtration, Recirculation, and Ventilation System (FRVS) vent fan will be re-powered by the FLEX electrical system using . HC.OP-EO.ZZ-0401, *FLEX Electrical - Phase 2* The fan takes suction on the Reactor Building and exhausts the air out the FRVS vent stack. The large secondary containment door on 102' elevation (4302) can be opened to promote circulation and provide a source of cool air to the Reactor Building. Operation of this system will help reduce the condensation and temperatures at the SFP.

2.4.5 *FLEX Strategy Connections*

The flow paths described in 2.4.2 include hose connections and manual valves inside the Unit 1 Reactor Building that are protected from all external hazards. Depending on the water source, the SFP connections and flow paths are established via HC.OP-EO.ZZ-0403, *FLEX Service Water Injection,* HC.OP-EO.ZZ-0404*, FLEX Injection from CST,* or HC.OP-EO.ZZ-0406*, FLEX Injection from Torus.*

2.4.5.1 Primary Connection

The primary FLEX SFP makeup connection line from Service Water is a 5 inch connection to the B SW piping (Figure 1) in the Service Water Intake structure which is protected from all external hazards.

2.4.5.2 Alternate Connection

The alternate FLEX connection is a 5 inch connection to the A SW piping (Figure 1) in the Service Water Intake structure which is protected from all external hazards.

2.4.6 *Key SFP 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*)*.

2.4.7 *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 about 97.5 gpm. Assuming the technical specification minimum SFP water level, uncovering fuel would not occur for over 2.06 days without fuel pool makeup flow (Reference 75). Plant-specific hydraulic analyses of the HCGS FLEX flow paths are provided in Reference 80.

2.4.8 *FLEX Pump and Water Supplies*

2.4.8.1 FLEX Alternate Header Pump (Refer to 2.3.9.1)

The FLEX Alternate Header pumps have a nominal flow rate of 450 gpm and 180 psi discharge pressure. One pump is shared between the core cooling and SFP functions. After 44 hours when SFP makeup is anticipated to be required, the FLEX Alternate Header pump can provide make up to the SFP.

2.4.8.2 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 makeup source to the SFP.

2.4.8.3 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.

2.4.9 *Electrical Analysis*

Calculation E-15.16 (Reference 87) evaluates and documents the electrical system requirements for HCGS FLEX strategies. Also, the SFP will be monitored by instrumentation installed in response to NRC Order EA-12-051. The power for this equipment has backup battery capacity for 72 hours. Alternative power will be provided within 72 hours via 125 VDC station battery charging using HC.OP-EO.ZZ-0401, *FLEX Electrical – Phase 2.*

2.5 Containment Integrity

HCGS used NRC endorsed MAAP analysis to support the FLEX strategies and timelines for containment integrity.

2.5.1 *Phase 1*

SSCs required to maintain primary containment integrity survive the initial BDBEE event. All primary containment isolation valves that do not fail closed upon loss of power should remain open to facilitate BDBEE coping but will be closed in accordance with HC.OP-AB.ZZ-0135 if coping activities are not successful and fuel damage appears imminent.

The SRVs and HCVS are used to protect containment. Operation of these two systems are discussed in the core cooling section, Section 2.3.1.

Plant-specific MAAP analyses in HC-MISC-005 (Reference 41) show a peak drywell gas temperature less than 290º F, which is well below the short-term (three hour) design basis containment temperature of 340º F used for environmental qualification (EQ) of equipment (Reference 50). SAP Operation 80108591-0160 (Reference 58) provides reasonable assurance of qualification of critical drywell components (i.e., safety/relief valve (SRV) solenoids, drywell seals and penetrations, and Regulatory Guide 1.97 instrumentation for reactor level, reactor pressure, drywell pressure, and drywell temperature) under ELAP conditions. Reference 58 includes a comparison of ELAP drywell temperature profiles from Revision 6 of HC-MISC-005 to the design basis accident profile from Reference 50, which is used for design basis qualification of critical drywell equipment. HC-MISC-005 was subsequently revised to reflect MAAP parameter adjustments and modifications to the hardened torus vent via Design Change Package (DCP) 80115583 (Reference 55). The revised MAAP analyses include some minor increases to drywell temperature response but do not invalidate the conclusions of Reference 58. Operator action is not required to address drywell temperature.

Torus venting via the HCVS will be initiated per site procedures to maintain containment parameters below design limits and within the limits that allow continued use of RCIC. Procedures for torus venting as part of FLEX implementation (also known as anticipatory venting) are based on Boiling Water Reactor Owners Group (BWROG) Emergency Procedure Guidelines / Severe Accident Guidelines (EPG/SAG), Revision 3 (Reference 59), in accordance with the NRC letter to NEI regarding anticipatory venting (Reference 60). EOPs HC.OP-EO.ZZ-102, *Containment Control* and HC.OP-EO.ZZ-0106, *Containment Control - HPCI/RCIC Only*, direct anticipatory venting actions using HC.OP-EO.ZZ-0318, *Containment Venting,* which includes direction to manually breach the HCVS rupture disk using compressed nitrogen to allow venting.

2.5.2 *Phase 2*

The HCVS is designed to relieve pressure from the containment under accident conditions in which containment integrity is threatened by overpressure, resulting from an accident sequence (reference 48). The HCVS, enhanced by the requirements of NRC Order EA-13-109 (Reference 8), provides adequate venting to maintain primary containment pressure within design basis values.

A portable compressor will be connected to the PCIG piping system using HC.OP-EO.ZZ-0407, *FLEX SRV Air Compressor* to assure continued SRV functionality during Phase 2. This portable compressor is powered by the 480 VAC supply provided by the FLEX generator.

Operation of the HCVS removes inventory from the torus thereby mitigating torus water level rise when water sources outside of primary containment are used.

2.5.3 *Phase 3*

Phase 3 FLEX equipment to maintain containment is the same as for maintaining core cooling. Four 4.16 kV generators will provide adequate power to energize one safety channel and initiate core cooling using RHR with adequate margin remaining to begin torus water and SFP cooling.

2.5.4 *Structures, Systems, and Components*

2.5.4.1 Hardened Containment Vent System

PSEG modified the 12” Hardened Torus Vent to meet the Phase 1 requirements of NRC Order EA-13-109 (Reference 8) and associated NEI guidance (Reference 13), as described in References 36, 40, 55, and 57.

2.5.4.2 Safety/Relief Valves (SRVs)

During an ELAP/LUHS event with the loss of all AC power and instrument air, SRVs automatically cycle to initially control reactor pressure until the Operations crew controls RPV pressure by manually initiating SRV openings to depressurize the RPV while maintaining a controlled cooldown.

2.5.4.3 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 5 hours of operations.

2.5.4.4 Pressure Suppression Chamber

The suppression pool (torus) is the heat sink for reactor vessel SRV discharges and RCIC turbine steam exhaust following a BDBEE. It is also the suction source for the RCIC pump and the FLEX Alternate Header pump for core cooling if the CST is not available.

2.5.5 *Key Containment Parameters*

Instrumentation providing the following key parameters is credited for all phases of the Containment Integrity strategy:

Containment Essential Instrumentation	Safety Function
H1BJ-1BJLI-R062A-E41 Channel A	Suppression Pool Level (Narrow Range)
H1BJ-1BJLR-4805-1 Channel A	Suppression Pool Level
H1SB-1SBTR-3881B1 Channel B	Suppression Pool Water Temperature
H1GS-1GSPR-4960A1 Channel A	Suppression Chamber Pressure
H1GS-1GSTR-4967A1 Channel A	Suppression Chamber Temperature
H1GS-1GSPR-4960A3 Channel A	Drywell Pressure (Narrow Range)
H1GS-1GSPR-4960A2 Channel A	Drywell Pressure (Wide Range)
H1GS-1GSTR-4967A2 Channel A	Drywell Temperature

2.5.6 *Thermal-Hydraulic Analyses*

See discussion in Section 2.5.1 and 2.5.2.

2.5.7 *Electrical Analysis*

One (1) Class 1E 4160 VAC bus is required to repower the cooling options described above. The 4160 VAC equipment 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 calculation (Reference 87) to support the sizing of the 4160 VAC generators being provided by the NSRC. Accordingly, four (4) 1-MW 4160 VAC generators and a distribution panel (including cable and connectors) are provided from the NSRC.

2.6 Characterization of External Hazards

2.6.1 *Seismic*

As discussed in Section 3.7.1.1 of the HCGS Updated Final Safety Analysis Report (UFSAR), the design basis Safe Shutdown Earthquake (SSE) has a peak ground acceleration of 0.20 g. 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 (Reference 1). This request was prompted by NTTF Recommendation 2.1 (Reference 22).

PSEG re-valuated the seismic hazard for HCGS and submitted the results to the NRC on March 28, 2014 (Reference 23). The conclusion of the seismic re-evaluation required a high frequency confirmation, as described in Reference 23 and agreed to by the NRC in Reference 49.

PSEG submitted the HCGS Mitigating Strategies Assessment (MSA) for the re-evaluated seismic hazard (Reference 79). The re-evaluated seismic hazard is bounded by the SSE in the frequency range of 1 Hz to 10 Hz, and has an inconsequential exceedance at higher frequencies. Therefore, seismic re-evaluations do not require any changes to the HCGS FLEX strategies.

FLEX equipment required to mitigate a seismic event at HCGS is stored at its point of deployment in a Seismic Category 1 structure (i.e., HCGS Unit 1 Reactor Building, HCGS Unit 1 Auxiliary Building and the HCGS Unit 2 Reactor Building roof) or stored at locations evaluated to withstand the effects of a seismic event, including potential liquefaction (Reference 70). Large, portable FLEX equipment is secured for a seismic event or located so that it is not damaged by other items in 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. The FLEX equipment is stored adjacent to Seismic Category I buildings or away from areas where the equipment could be impacted by non-seismically robust components or structures. The required towing and debris removal equipment is located at Outdoor FLEX Storage Area 2 (OFSA2) and will withstand a seismic event. The additional set of towing and debris removal equipment stored east of the HCGS Cooling Tower has not been evaluated for a seismic event and is not credited.

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

FLEX equipment storage in Hope Creek Unit 2 addresses the seismic protection criteria of NEI 12-06 Section 5.3.1, based on the evaluations performed in DCP 80108785 (Reference 67) and DCP 80110322 (Reference 54).

As described in the HCGS UFSAR, Section 2.5.4.8.3, non-liquefiable backfill surrounds the top 30 feet of power block and intake structures up to final grade. Deployment pathways of FLEX equipment from the proposed storage location will consider the potential for debris due to failure of non-seismically designed structures. Debris removal equipment onsite will be capable of clearing pathways for deployment.

2.6.2 *External Flooding*

Current design basis flooding mechanisms at HCGS are identified in HCGS UFSAR Table 2.4-6. The maximum design still-water height is a result of the hurricane storm surge and is 113.8 ft. Public Service Datum (PSD). The maximum run-up elevation at HCGS is 124.4 ft. PSD for the power block structures and 134.4 ft. PSD for the SWIS, as shown in UFSAR Tables 2.4-10 and 2.4-10a, respectively.

The NRC requested licensees to re-evaluate all appropriate external flooding sources, including the effects from local intense precipitation on the site, probable maximum flood (PMF) on streams and rivers, storm surges, seiches, tsunami, and dam failures (Reference 1). The NRC requested that the re-evaluation apply present-day regulatory guidance and methodologies. This request was prompted by NTTF Recommendation 2.1 (Reference 22).

The external flooding hazard was re-evaluated and submitted to the NRC on March 12, 2014 (Reference 10). The re-evaluation shows that the local intense precipitation (LIP) event is the only flooding hazard not bounded by the current design basis at HCGS. The re-evaluated LIP event could produce flood levels that are above the watertight door thresholds, but significantly below the plant's minimum flood-protected elevation of 121 ft. Public Service Datum (PSD); e.g., the maximum LIP flood level at critical door locations is 102.6 ft. PSD. In Reference 78, the NRC staff concluded that the re-evaluated flood hazards information is suitable for the assessment of mitigating strategies developed in response to Order EA-12-049 for HCGS. Reference 78 describes the re-evaluated flood hazards that exceed the current design-basis for use in the mitigating strategies assessment (MSA) i.e., LIP with associated effects and flood duration parameters. PSEG submitted the flooding hazard MSA to the NRC in Reference 84, which concludes that a LIP does not challenge the HCGS design basis flood protection and it is not an event that can challenge key safety functions at HCGS. Therefore, HCGS does not consider an ELAP/LUHS to be a credible outcome of a LIP event. However, LIP flooding elevations and associated effects are considered in the protection of FLEX connections and equipment during storage.

The FLEX DGs stored or pre-staged on the HC Unit 2 roof are above LIP flood depths and are not vulnerable to any other external flooding events. Procedures have been revised to close watertight doors if a LIP is forecasted.

A hurricane storm surge 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 (Reference 76). The FLEX DGs stored and pre-staged on the HCGS Unit 2 Reactor Building roof are protected from hurricane storm surge flood depths and are not vulnerable to an external flooding event.

FLEX equipment required to mitigate a flooding event at HCGS is stored at its point of deployment in a flood protected structure (i.e., HCGS Unit 1 Reactor Building), above the flood elevation (i.e., HCGS Unit 2 Reactor Building roof) or will be stored in the flood protected HCGS Unit 2 Reactor Building.

The diesel-driven FLEX Service Water pumps, including the N+1 pump, will be moved to the flood protected HCGS Unit 2 Reactor Building from the normal outdoor storage locations within the protected area before the arrival of a hurricane and deployed after flood waters recede.

Debris removal equipment will be moved to the flood protected HCGS Unit 1 Reactor Building prior to the hurricane to support deployment of FLEX equipment in Phases 2 and 3. Towing equipment will be staged in the flood protected HCGS Unit 2 Reactor Building prior to the hurricane to support deployment of FLEX equipment in Phases 2 and 3.

OP-AA-108-111-1001, *Severe Weather and Natural Disaster Guidelines,* provides guidance for severe weather warnings, and triggers protective measures including closure of watertight doors and protection of FLEX equipment. FLEX equipment flood protection actions are performed in accordance with SH.OP-AM.FLX-0050, *Pre-Storm Storage and Protection of Outdoor FLEX Equipment*. SH.OP-AM.FLX-0051, *Salem/Hope Creek Shared FLEX Equipment Phase 2 Deployment,* includes instructions for deploying FLEX equipment, debris removal and towing vehicles after hurricane flood waters recede. HCGS does not rely on FLEX equipment for mitigation of ground water inleakage.

2.6.3 *Severe Storms with High Wind*

Per HCGS UFSAR Section 3.3, the design wind velocities are 108 mph at 30 feet above ground for Seismic Category I structures and 100 mph at 30 feet above ground for non-Seismic Category I structures. The design basis tornado has a maximum wind speed of 360 mph, a maximum rotational speed of 290 mph with a radius of 150 feet, a maximum translational speed of 70 mph, and a minimum translational speed of 5 mph. Design basis tornado missile characteristics are provided in UFSAR Table 3.5-12.

FLEX equipment required to mitigate a beyond design basis external event (BDBEE) at HCGS is stored at its point of deployment in a robust structure (e.g., new distribution equipment and pumps stored in the reactor and auxiliary buildings), or stored in locations separated by sufficient distance to minimize the probability that a single event would damage all FLEX mitigation equipment. The minimum separation distance of 1200 feet for tornado missile protection of outdoor FLEX equipment is consistent with NEI 12-06 and supported by site-specific evaluation of tornado characteristics in Attachment A of Reference 83.

The primary FLEX equipment stored outdoors includes the diesel-driven FLEX pumps and FLEX DGs. This equipment will not be missile protected, but is separated by 1200 feet or greater to ensure a single event does not damage all FLEX mitigating equipment such that at least N sets of FLEX equipment would remain deployable in accordance with NEI 12-06, Section 7.3.1(c). Therefore, at least one FLEX diesel generator and one diesel-driven FLEX Pump will be available for deployment following a tornado event.

The two FLEX DG stored at the deployment location on the HCGS Unit 2 Reactor Building roof are not missile protected. 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. The location on the HCGS Unit 2 Reactor Building roof is considered a protected location since it is elevated 30 feet above grade and protected to the south and east by much taller buildings. Section 3.1 of NUREG/CR-7004, “Technical Basis for Regulatory Guidance on Design-Basis Hurricane-Borne Missile Speeds for Nuclear Power Plants” 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 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 and unlikely to be elevated to over 30 feet above grade.

High winds may delay deployment of FLEX equipment. Consequently, the FLEX strategy includes consideration for deployment of equipment prior to the high wind event, since typically, for a high wind event (such as a hurricane), significant warning time would be available. It is noted that for tornados there may not be significant warning time available. Since tornados are typically short term events, deployment of equipment during a tornado would not be anticipated. Towing and debris removal equipment is diversely located, separated by 1200 feet or greater to ensure a single tornado does not impact more than one set of towing and debris removal equipment, and therefore available to support deployment of FLEX equipment.

The HCVS piping and components located less than 30 feet above grade are protected from all missiles by the walls of the Reactor Building. The Reactor Building is a Seismic Category I structure and is designed to provide protection from the design basis tornado wind and missiles. Technical Evaluation 80115583-0860 (Reference 57) documents the basis for reasonable protection of the HCVS piping external to the Reactor Building from wind-borne missile hazards.

2.6.4 *Ice, Snow and Extreme Cold*

HCGS 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. A comparable level of protection is being provided by outdoor storage locations which consist of the following:

- HCGS Unit 2 Reactor Building roof
- Outdoor FLEX Storage Area (OFSA) 1 - east of the SGS oil water separator area - outside the protected area and within the vehicle barrier system
- OFSA2 - west of Salem Generating Station (SGS) - inside the protected area
- OFSA3 - the northwest corner of the HCGS Unit 2 reactor building - inside the protected area

An additional set of debris removal and towing equipment is stored at a separate on-site location.

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 74) considered a low temperature of -4 °F based on Hope Creek UFSAR Table 2.3-11, which is bounding for the site. HCGS is located at latitude 39° 27 min 53 sec north and longitude 75° 32 min 12 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.”

Severe weather conditions such as snow or ice may delay deployment of 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. PSEG revised OP-AA-108-111-1001, *Severe Weather and Natural Disaster Guidelines*, and MA-AA-716-002-1002, *Facilities Maintenance Guidelines,* to address FLEX equipment as part of site the preparation and response to severe cold weather.

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 generators and FLEX diesel-driven pumps are stored outside and thus are subject to extreme cold and snow conditions. The equipment is provided with keep warm systems whose operation is checked during routine operator rounds via HC.OP-DL.ZZ-0006-F1, *Auxiliary Building* and HC.OP-DL.ZZ-0007-F1, *Yard*.

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 is performed as required to maintain FLEX equipment deployment paths. Debris removal equipment can move through moderate snow accumulations and can also be used to move FLEX equipment. PSEG revised MA-AA-716-002-1002 to identify the Outdoor FLEX Storage Areas (OFSAs) and deployment pathways in the snow removal plan.

The potential effect of frazil ice is addressed by having more than one strainer assembly for each diesel driven FLEX pump. If there is a clogging issue from Ice or debris, the strainer can be pulled from the river and exchanged and cleaned as necessary. If surface ice on the river prevents normal access for the FLEX diesel-driven SW pump, the pump suction hose will be routed to inside the icebreakers in front of the SWIS, using HC.OP-EO.ZZ-0403, *FLEX Service Water Injection*.

2.6.5 *High Temperatures*

Technical Evaluation 80112074-0025 (Reference 74) considers Salem Generating Station (SGS) and HCGS extreme temperature conditions for evaluation of outdoor FLEX equipment storage. Reference 74 uses a high temperature of 100 °F as a bounding value based on SGS UFSAR Table 2.3-5.

The HCGS plan for storage locations includes storage at the point of deployment and storage in outdoor locations within the owner controlled area. These locations have adequate ventilation to maintain reasonable storage temperatures. Backup ventilation cooling is not expected to be required if power is lost because the equipment is expected to be deployed shortly after the initiation of the ELAP.

High temperature does not impact the deployment of FLEX equipment. All FLEX equipment has been procured to be suitable for use in peak temperature for the region.

2.7 Protection of FLEX Equipment

Protection of FLEX Equipment is addressed in Section 2.6 for each of the applicable external hazards.

The HCGS FLEX strategy includes equipment pre-staged at its point of deployment as an alternative to portable Phase 2 equipment as suggested by NEI 12-06. Protection of pre-staged equipment from external hazards combined with diversely located portable equipment provides flexibility to prevent a single event from defeating the FLEX strategy. Section 2.3.9.1 provides details regarding the pre-stage FLEX Alternate Header Pumps as an alternative to NEI 12-06.

The basis for pre-staging two (N and N+1) FLEX DGs on the Hope Creek Unit 2 Reactor Building roof as an alternative to NEI 12-06 is provided in Reference 71. The two pre-staged FLEX DGs are reasonably protected to provide N and N+1 capability during BDBEE scenarios other than a tornado missile event that causes a beyond-design-basis ELAP and affects both DGs. A spare FLEX DG sufficiently separated from the Unit 2 Reactor Building would be deployed to support the FLEX strategy in the event that both DGs on the roof are lost. FLEX timelines and staffing resources account for the time to deploy the spare DG in a tornado scenario if needed. The HCGS FLEX DG storage and deployment strategy considers the external hazards applicable to the site and provides reasonable assurance that no single event will defeat the FLEX strategy.

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 3 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 "Staging Area" locations 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 HELB. These doors and gates are typically administratively controlled to maintain their function as barriers during normal operations. Following a BDB external event 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. For this reason, certain barriers (gates and doors) will be opened and remain open. This deviation from normal administrative controls is acknowledged and is acceptable during the implementation of FLEX coping strategies. The watertight doors required for flood protection during a flooding event have pneumatic seals which do not require power to operate.

The ability to open doors for ingress and egress, ventilation, or temporary cables/hoses routing is necessary to implement the FLEX coping strategies. During an ELAP, personnel and vehicle 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 ELAP and may be accessed via keys controlled by the Operations Shift Manager in accordance with administrative controls in OP-HC-108-101-1002, *Key Control - Hope Creek.*

2.9 Deployment of Strategies

2.9.1 *Fueling of Equipment*

Portable equipment used in Phase 2 are equipped with fuel storage tanks sufficient for at least 12 hours of operation without refueling to minimize actions required to keep equipment running (Reference 85). The existing diesel fuel oil pumps will be repowered via the unit substations. Fuel oil will be pumped to the EDG day tanks, where a portable FLEX hose can be connected to drain valves. The fuel will be supplied by a FLEX fuel oil transfer pump, powered by the FLEX MCC, and pumped via installed piping to a connection on elevation 136’, near the door that leads to the FLEX diesel generators on the roof. A fill hose is staged near the door for filling the FLEX DGs. The pump will also be used to fill portable fuel transfer tanks (Transcubes) that will be used to supply remote diesel-driven equipment (e.g. debris removal equipment, diesel-driven FLEX pumps, etc).

The EDG fuel oil is subject to testing in accordance with surveillance requirements in HCGS Technical Specification 4.8.1.1.2.

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. PSEG 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 assembly area established by the SAFER response team. From there, equipment can be taken to the HCGS site and staged at the SAFER onsite Staging Area “B” by helicopter if ground transportation is unavailable. Communications will be established between the HCGS plant site and the SAFER team via satellite phones 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 HCGS *SAFER Response Plan* (Reference 51).

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 HCGS is listed in Table 2. Table 2 identifies the equipment that is specifically credited in the FLEX strategies for HCGS, but also lists the equipment that will be available for backup/replacement if needed. Since all the equipment will be located at the local assembly 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 BDB external event and subsequent ELAP/LUHS event at HCGS, 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 ventilation is the heat buildup which occurs when forced ventilation is lost in areas that continue to have heat loads. Loss of ventilation analyses were performed and summarized in References 81 and 82, 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.

Existing SBO actions direct the bypass of HPCI and RCIC room temperature isolation and trip to ensure availability of HPCI and RCIC.

The key areas identified for all phases of execution of the FLEX strategy activities are the Main Control Room (MCR), Reactor Building, RCIC room, and the Battery rooms. These areas have been evaluated to determine the temperature profiles following an ELAP/LUHS event. With the exception of the MCR, results of the calculation have concluded that temperatures remain within acceptable limits based on conservative input heat load assumptions for all areas consistent with implementation of SBO and ELAP response actions using HC.OP-AB.ZZ-0135.

The MCR is the only area for which portable ventilation is used as a compensatory measure. Other compensatory measures include restoration of installed ventilation equipment. During Phase 2, a 3700 scfm fan will be placed in the Shift Manager’s office and discharge to the control room using HC.OP-AB.ZZ-0135. The fan will be powered by the FLEX DG. The suction of the fan will be the stairwell leading to the HC Unit 2 roof opening, which will be opened to supply outside air to the building. This fan will help maintain the control room temperatures below 102ºF. In addition, the Filtration, Recirculation, and Ventilation System (FRVS) vent fan will be repowered for the Reactor Building.

Although not required for temperature considerations, the Phase 2 strategy includes opening the battery room doors at approximately 4 hours after the event to control hydrogen buildup in the battery rooms.

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 emergency lighting will be available for eight hours from internal batteries (Appendix R lighting).

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 1), 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 22).

NEI 12-01 (Reference 15) provides guidelines for addressing BDBEE accident response communication capabilities.

PSEG Nuclear submitted the communications assessment to the NRC on October 31, 2012 (Reference 29) based on the guidance of NEI 12-01. In response to NRC generic technical issues for resolution (Reference 30), PSEG Nuclear provided a follow-up response with planned enhancements for communications to the NRC on February 21, 2013 (Reference 31). These enhancements include installing satellite phones and a tone remote desk set for Hope Creek. The NRC issued their staff assessment of the communications assessment for HCGS on June 3, 2013 (Reference 32).

Since it is a beyond design basis event, the existing on-site radio systems and equipment were assumed to be unavailable if they would be subject to, and not protected from, seismic, wind or flooding effects during a BDBEE.

DCP 80110947 (Reference 66) installed new iridium satellite phones for Hope Creek to provide a means of maintaining offsite communications during and following a BDBEE when other primary and back-up means of communication have been lost. The new satellite phones will not require the user to be located outdoors and will maintain connectivity with the satellite through the iridium system. Components are credited provided they are reasonably protected from seismic, wind, and flooding events, maintained through programmatic controls, or have a power source consistent with the other mitigating strategy schemes. The satellite phones operate using standard desktop phone sets connected to remote satellite terminals using externally mounted antennas. Power for the new satellite phones is from the 1E B Vital Inverters. Backup antennae are available if the existing antennae are affected by the BDBEE conditions.

New iridium satellite phones were installed at the Emergency Operations Facility (EOF) located in Salem City approximately 8 miles from the Hope Creek site. These satellite phones provide a means of maintaining offsite and onsite communications during and following a BDBEE when other primary and back-up means of communication have been lost. The new satellite phones will not require the user to be located outdoors and will maintain connectivity with the satellite through the iridium system. The satellite phones operate using standard desktop phone sets connected to remote satellite terminals using externally mounted antennas. Power for the new satellite phones is from the normal EOF power and backed up by the EOF Emergency Generator. Portable satellite phones are available in the EOF for field teams as needed.

Additionally, since the Central Electronics Bank (CEB) is assumed to be unavailable during and following a BDB event, a new DC remote control deskset unit is installed in the Main Control Room (MCR) providing connectivity directly to the radio repeater and bypassing the CEB. This configuration allows the MCR to communicate with other responders within the power block of the respective unit but not between units or between Salem and Hope Creek.

2.15 Water Sources

Section 2.3.9.3 provides a list of potential water sources that may be used to provide cooling water to the RPV and the SFP, their capacities, and an assessment of availability following the applicable hazards identified in Section 2.6. For RCIC and the motor-driven FLEX Alternate Header pumps, the normal suction sources are the CST and the suppression pool. Both of these sources provide RPV grade high-quality water for injection into the RPV.

The Delaware River provides an indefinite supply of water but is of lower quality. HCGS has incorporated BWROG guidance into the mitigation strategies to maintain core cooling with raw water. HC.OP-EO.ZZ-0105, *Reactor Pressure Vessel Control-HPCI / RCIC Only*, and its associated bases document, reflect the recommendations of BWROG TP-14-006 (Reference 47) and EPG/SAG Revision 3 (Reference 59) to maintain adequate core cooling if raw water must be used (e.g., by raising RPV water level to increase thermal mass and enhance circulation). In addition Phase 3 equipment provided by SAFER includes water treatment equipment as shown on Table 2.

2.16 Shutdown and Refueling Modes Analysis

HCGS 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 11). This position paper has been endorsed by the NRC staff (Reference 12).

<u>During Mode 5 with full core offload and SFP to reactor cavity gates in place</u>

The minimum time to boil after loss of cooling is just under 7 hours. The boil off rate is about 97.5 gpm and the time to uncover the fuel is 2.06 days (Reference 75). Since the fuel handling floor will become uninhabitable shortly after boiling starts, all preparations to secure a FLEX hose or pipe to the SFP will be complete before six hours after loss of cooling. Water should be added to the SFP when boiling begins but must start before the fuel is uncovered.

During Mode 5, the torus water will be at normal temperatures. Since the torus is immune from all BDBEE hazards and RPV injection is not required, torus water will be used for SFP replenishment. The same two piping options described above for using the stairwell stand-pipe will be available during Mode 5.

<u>During Mode 5 with full core offload and SFP to reactor cavity gates removed</u>

Station procedures allow the torus to be drained when the reactor cavity is flooded with the SFP to reactor cavity gates removed. When the torus is filled to its normal level, the coping strategy for the gates removed will be the same as for the gates in place because natural circulation between the SFP and the reactor cavity results in a lower SFP heat up rate with ultimately the same boil off rate. When the torus is drained, an alternate source of water is used to replenish SFP level, e.g., via HC.OP-EO.ZZ-0404, *FLEX Injection from CST,* or HC.OP-EO.ZZ-0403, *FLEX Service Water Injection*.

2.17 Sequence of Events

The Table 3 presents a Sequence of Events (SOE) Timeline for an ELAP/LUHS event at HCGS. Validation of each of the FLEX time constraint actions has been completed (Reference 28) in accordance with the FLEX Validation Process document issued by NEI (Reference 18) and includes consideration for staffing.

2.18 Programmatic Elements

2.18.1 *Overall Program Document*

A description of the Diverse and Flexible Coping Strategies (FLEX) Program for HCGS is provided in Section 1 of this program document (EM-HC-100-1000). 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 lower tier documents.

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 specific procedural guidance impractical. 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 Operating Procedures (AOPs) strategies, the EOP or AOP directs the entry into and exit from the appropriate FSG.

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.

FSG maintenance is performed by Operations as described in EM-AA-100-1002. FSGs have been reviewed and validated by the involved groups 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 are 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 15). 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 SGS or HCGS or a combination of two operators between the stations. Reference 16 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 both units (all units 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 communication equipment determined available post-BDB external event and the staff deemed available per the staffing studies. The validation process was performed and documented 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 19), 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 are outlined in EM-AA-100-1004*, Performance Enhancing Activities Guideline*. 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 HCGS storage locations necessary for the implementation of the FLEX strategies in response to a BDB external event is listed in Table 1. Table 1 identifies the quantity, and applicable strategy for the major BDB equipment components only, as well as various clarifying notes. Specific details regarding fittings, tools, hose lengths, consumable supplies, etc. are not provided in Table 1. HC.OP-PM.FLX-0002*, Hope Creek FLEX Equipment Inventory*, is used to ensure equipment inventories are maintained.

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. Sufficient equipment has been purchased 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. Therefore, where a single resource is sized to support the required function of both units a second resource has been purchased to meet the +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.

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.

The N+1 capability applies to the FLEX equipment that directly supports maintenance of the key safety functions identified in Table 3-1 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.

For the cables associated with FLEX equipment required for FLEX strategies, PSEG uses Method 1 as described in Reference 33 and endorsed by the NRC (Reference 34) as an acceptable alternative to NEI 12-06. As documented in Technical Evaluation 80113610-0150 (Reference 53), the +1 capability is accomplished by each cable having an N+1 cable of sufficient length to replace any damaged cable of that same configuration.

For the hoses associated with FLEX equipment required for FLEX strategies, PSEG uses Method 1 and Method 2 as described in Reference 33 and endorsed by the NRC (Reference 34) as an acceptable alternative to NEI 12-06. For each hose type, the hose runs were sorted by FLEX strategies and hose configurations. The amount of hose required for each strategy and hose configuration was then determined. Technical Evaluation 80113610-0140 (Reference 52) demonstrates that the hose inventory is sufficient using a combination of Method 1 and Method 2 depending on the application. After completing the evaluation in Reference 52, PSEG installed the alternate mechanical FLEX connection to “A” RHR via DCP 80110321 (Reference 63). This connection requires eight 4” stainless steel braided hoses, 20 feet long with cam lock fittings. Nine sections of this type hose are provided to meet the N+1 requirement using Method 1.

The N+1 requirement does not apply to the BDB FLEX support equipment 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 PM program which defines periodic testing and maintenance and follows EPRI template requirements (Reference 21). The preventive maintenance requirements as defined by MA-AA-716-210, *Preventive Maintenance (PM) Process* are entered into SAP to document the required information. The PM procedures for the FLEX pumps and 480V generator are based on the EPRI templates for FLEX equipment described in Reference 21.

FLEX and SFP Level Instrumentation allowable outage times and required actions are maintained in OP-HC-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 an ELAP, Beyond Design Basis Event 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-HC-108-115-1001.

The exception to this tracking requirement is the debris removal 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 their procedures (MA-AA-716-002-1002, *Facilities Maintenance Guidelines*).

3. References

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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. NRC Order Number EA-13-109, *Issuance of Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions*, dated June 6, 2013.

9. 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).

10. LR-N14-0041, *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 - Hope Creek Generating Station Flood Hazard Reevaluation*, dated March 12, 2014.

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

12. 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).

13. NEI 13-02, *Industry Guidance for Compliance with Order EA-13-109*, Revision 1, dated April 2015.

14. NRC Interim Staff Guidance JLD-ISG-2013-02, *Compliance with Order EA-13-109 Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions*, Revision 0, dated November 14, 2013.

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

16. PSEG Letter LR-N14-0248, *Hope Creek 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 December 9, 2014.

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

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

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

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

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

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

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

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27. 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).

28. *VTD 432563, Hope Creek Validation of FLEX Strategies.*

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

30. 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).

31. LR-N13-0026, *PSEG Nuclear LLC's Response to NRC Follow-up Letter on Technical Issues for Resolution Regarding Licensee Communication Submittals Associated with Fukushima Near-Term Task Force Recommendation 9.3,* dated February 21, 2013.

32. 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).

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

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36. DCP 80113941, Hardened Containment Vent Mechanical.

37. LR-N14-0258, *Hope Creek Generating Station's First Six-Month Status Report in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)*, dated December 19, 2014.

38. NRC Letter, *Hope Creek Generating Station - Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Phase 1 of Order EA-13-109 (Severe Accident Capable Hardened Vents) (TAC No. MF4458),* dated February 12, 2015 (ADAMS Accession No. ML14332A154).

39. LR-N15-0129, *Hope Creek Generating Station's Second Six-Month Status Report in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109),* dated June 18, 2015.

40. DCP 80113942, *Hardened Containment Vent Electrical*.

41. HC-MISC-005, *MAAP Analysis to Support FLEX Initial Strategy*.

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47. BWROG-TP-14-006, *Fukushima Response Committee - Raw Water Issue: Fuel Inlet Blockage from Debris*, Revision 0 (Contains Proprietary Information).

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55. DCP 80115583, Hope Creek Hardened Torus Vent Modification.

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58. SAP Operation 80108591-0160, ISE CI 3.2.3.A - Temperatures During Venting, Critical Components.

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62. PSEG Calculation E-5.2, *Hope Creek 250 VDC Beyond Design Basis Event Battery Sizing Calculation*.

63. DCP 80110321, *Hope Creek FLEX Mechanical Connection Modifications*.

64. DCP 80112012, *Hope Creek FLEX Specific Mechanical Modifications*.

65. DCP 80109771, *Hope Creek Spent Fuel Pool Level Instrumentation Modification*.

66. DCP 80110947, *Hope Creek Communications Upgrade*.

67. DCP 80108785, *Hope Creek U2 Upgrades for FLEX Equipment Storage*.

68. DCP 80112074, *Outdoor FLEX Storage Areas.*

69. DCP 80112547, *Hope Creek FLEX Electrical Modification Phase 3*.

70. VTD 432393, *Outdoor FLEX Storage Area Liquefaction Analysis*.

71. SAP Operation 80108591- 0090, *Pre-Staged DGs*.

72. VTD 430123 Volume 1, *PSEG Nuclear LLC Hope Creek Generating Station Extended Power Uprate SRV Actuations Under Station Blackout Conditions*.

73. Technical Evaluation 80113610-0030, *Technical Evaluation of SRV Actuation at 6 Hours Past ELAP*.

74. Technical Evaluation 80112074-0025, *Outdoor Storage of FLEX Equipment in Extreme Cold and Hot Weather*.

75. PSEG Calcualtion EC-0010, *SFP Evaporation Rates, Heat-Up Rates and Fuel Uncover Times - EPU*.

76. VTD 432358 Volume 003, *Wave Run-up, Loads, and Total Water Level Calculation for Salem and Hope Creek Generating Stations*.

77. Technical Evlauation 80113610-0080, *Technical Evaluation of Seismic Adequacy for Hope Creek CST*.

78. NRC Letter, *Hope Creek Generating Station - Interim Staff Response to Reevaluated Flood Hazards Submitted in Response to 10 CFR 50.54(f) Information Request - Flood-Causing Mechanism Reevaluation (TAC No. MF3789)*, dated September 10, 2015 (ADAMS Accession No. ML15238B655).

79. PSEG Letter LR-N16-0121, *PSEG Nuclear LLC's NEI 12-06, Appendix H, Revision 2, H.4.2 Path 2: GMRS < SSE with High Frequency Exceedances, Mitigating Strategies Assessment (MSA) Report for the New Seismic Hazard Information*, dated December 12, 2016 (ADAMS Accession No. ML16348A305).

80. PSEG Calculation H-1-FLX-MDC-4022, *FLEX Hydraulic Model*.

81. Technical Evaluation 80113610-0200, *Evaluation of Hope Creek Gothic Results for Reactor Building FLEX Response*.

82. Technical Evaluation 80113610-0210, *Evaluation of Hope Creek Gothic Results for Auxiliary Building FLEX Response*.

83. VTD 903078, *FLEX Water Storage Tornado Wind Hazard Evaluation*.

84. PSEG Letter LR-N16-0112, *Hope Creek Generating Station's Flood Hazards Mitigating Strategies Assessment (MSA) Report Submittal*, dated December 29, 2016 (ADAMS Accession No. ML16364A217).

85. Technical Evaluation 80113610-0070, *Evaluation of FLEX Portable Equipment Fuel Usage Against NEI 12-06 Requirements*.

86. Technical Evaluation 70127346-0230, *Hope Creek Spent Fuel Pool Time to Boil and Level Depletion Rate*.

87. PSEG Calculation E-15.16, *Hope Creek FLEX Electrical System Loading Analysis*.

88. NRC Interim Staff Guidance JLD-ISG-2015-01, *Compliance with Phase 2 of Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions*, Revision 0, dated April 2015.

Table 1- FLEX Equipment Stored On-Site

Table 1- FLEX Equipment Stored On-Site						
Equipment	Use and (Potential/Flexibility) Diverse Uses					Performance Criteria
	Core	Containment	SFP	Instrumentation	Accessibility	
480 VAC Diesel-Driven Generators N=3 for both SGS units; N=1 for HCGS; (6) DGs are on site.	X	X	X	X		600 kW
480 VAC MCC	X	X	X	X		-
Diesel-Driven FLEX SW pumps N=1 for both SGS units; N=1 for HCGS; (3) are on site.	X	X	X			1500 GPM @ 350' Total Dynamic Head
460 VAC FLEX Alternate Header pumps	X	X	X			450 gpm 180 psi
FLEX Compressors	X	X				36.7 cfm 125 psi
FLEX Fuel Oil Pumps	X	X	X			43 gpm, maximum pressure of 500 psi
Caterpillar Wheel Loader					X	Site debris removal and equipment hauling

Table 1- FLEX Equipment Stored On-Site						
Equipment	Use and (Potential/Flexibility) Diverse Uses					Performance Criteria
	Core	Containment	SFP	Instrumentation	Accessibility	
Komatsu Wheel Loader					X	Site debris removal and equipment hauling
Kalmar Ottawa Terminal Tractors					X	Site debris removal and equipment hauling
Forklifts					X	Site debris removal and equipment hauling

Table 2- FLEX Equipment from NSRC

Table 2 - FLEX Equipment From NSRC (Reference 51)						
Equipment	Use and (Potential/Flexibility) Diverse Uses					Performance Criteria
	Core	Containment	SFP	Instrumentation	Accessibility	
(4) 4160 VAC Generators	X	X	X	X	X	1 MW
(1) 4160 Distribution System	X	X	X	X	X	4160 VAC, 1200 AMP
(1) 480 VAC Diesel-Driven Generator	X		X	X		1 MW
(1) High Pressure Injection Pump						60 gpm, 2000 psi
(1) Reactor Vessel Makeup Pump						500 gpm, 500 psi, 12 ft lift
(1) LP/Med Flow Diesel-Driven Pump	X	X	X			2500 gpm, 300 psi, 12 ft lift

Table 2 - FLEX Equipment From NSRC (Reference 51)						
Equipment	Use and (Potential/Flexibility) Diverse Uses					Performance Criteria
	Core	Containment	SFP	Instrumentation	Accessibility	
(1) LP/High Flow Diesel-Driven Pump	X	X	X			5000 gpm, 150 psi, 12 ft. lift
(1) On-Site Diesel Fuel Transfer Pump	X	X	X	X	X	60 gpm
(1)Portable Diesel Fuel Tank and attached pump	X	X	X	X	X	264 gal, 35 gpm AC pump, 25 gpm DC pump
(1) Mobile Water Treatment	X	X	X			250 gpm
(1) 20,000 gallon Water Storage	X	X	X			20,000 gal
(2) Suction Booster Lift Pump (One Hydraulic Unit / Two pods)	X	X	X			5000 gpm, 26 ft. lift
(2) Mobile Lighting Towers					X	440,000 Lumens, 30' Height

Table 3 - Sequence of Events Timeline

Table 3 - Sequence of Events Timeline (see Reference 28)				
Action Item	**Elapsed Time**	**Action**	**Time Constraint (Y/N)**	**Discussion**
0	0	Event Starts	N/A	
1	60 sec	HPCI and RCIC auto start with suction normally aligned to CST. If CST inventory is not available due to damage from BDBEE, HPCI and RCIC will be manually aligned to torus.	N	Current SBO event response.
2	5 min	Use EOPs, to restore and maintain level and pressure. Verify reactor shut-down.	N	Current SBO event response.
3	15 min	Control Room instruments indicate all EDGs fail to start. Enter HC.OP-AB.ZZ-0135; includes direction to dispatch operator to EDG rooms to investigate.	Y, A	Current SBO event response.
4	15 min	Control RPV level with HPCI and RCIC. Approximately 20 minutes after scram, RCIC has adequate capacity to control RPV level. RPV pressure will be controlled with SRVs.	N	Current SBO event response.
5	30 min	In accordance with HC.OP-AB.ZZ-0135 • Block open doors to facilitate area cooling. • Perform initial load shedding on the non-Class 1E 125 VDC system to reduce heat loads in the MCR and the control equipment room. • Bypass the HPCI and RCIC high temperature isolation trips. • Swap RCIC suction from the CST to the Torus	Y,A	Current SBO event response. Enhances long-term operation of RCIC.
6	1 hour	Block open doors to additional critical area rooms to facilitate cooling.	Y, A	NEI 12-06, 3.2.1.7

Table 3 - Sequence of Events Timeline (see Reference 28)				
Action Item	**Elapsed Time**	**Action**	**Time Constraint (Y/N)**	**Discussion**
7	1 hour	Continue EDG start attempt per HC.OP-AB.ZZ-0135. If EDG start attempt is not successful 1 hour after scram, declare ELAP and enter FSGs. At ELAP declaration, the Shift Manager will contact the NSRC and request SAFER equipment.	Y, A	NEI 12-06, 3.2.1.7
8	1.5 hours	ELAP Load Shed: All unnecessary loads from the Class 1E 125 VDC panels and 120 VAC battery backed panels removed to conserve Class 1E batteries in accordance with HC.OP-AB.ZZ-0135.	Y, A	NEI 12-06, 3.2.1.7
9	~ 4 hour	Torus water temperature has reached approximately 200° F. Station operators open the torus vent to limit torus temperature rise.	Y, A	NEI 12-06, 3.2.1.7
10	5 hours	Deployment of 480 VAC FLEX generator and associated electrical power distribution is complete. • Electrical connections from FLEX generator to FLEX MCC are installed. • FLEX generator is on line and 10B410 and 10B420 Unit Substations are energized. • Two 125 VDC and two 250 VDC battery chargers are energized to support RCIC and HPCI. • Power is available for the FLEX Alternate Header pump.	Y, A	NEI 12-06, 3.2.1.7

Table 3 - Sequence of Events Timeline (see Reference 28)				
Action Item	**Elapsed Time**	**Action**	**Time Constraint (Y/N)**	**Discussion**

11	5 hours	Complete deployment of FLEX Alternate Header pump and piping
		• Connect hose jumpers to complete the following FLEX piping connections:
		  ○ FLEX header to FLEX pump suction
		  ○ FLEX pump discharge to FLEX piping
		If water from the CST is not available:
		• Complete evaluation of other sources of water; torus or river water.
		• Complete FLEX piping and valve line-up.
		• Complete isolation of RCIC suction from torus.
		• New source of water can be supplied from the FLEX header to the RPV.
			Y, A	NEI 12-06, 3.2.1.7

12	13 hours	FLEX hose jumper installed to complete FLEX piping to the SFP. Transfer water to the SFP as necessary to maintain level. The FLEX diesel pump can be aligned to the supply from the SWIS and can maintain level with river water using the normal FLEX flow path.	Y, B	NEI 12-06, 3.2.1.7

Table 3 - Sequence of Events Timeline (see Reference 28)				
Action Item	**Elapsed Time**	**Action**	**Time Constraint (Y/N)**	**Discussion**
13	18.4 hrs	The diesel-driven FLEX pump at the SWIS structure is deployed and ready for operation. • Transport the diesel-driven FLEX pump to the SWIS. • Install FLEX suction piping from the FLEX pump to the Delaware River. • Install FLEX discharge hose from the FLEX pump to the service water discharge pipe connection inside the SWIS.	Y, B	NEI 12-06, 3.2.1.7

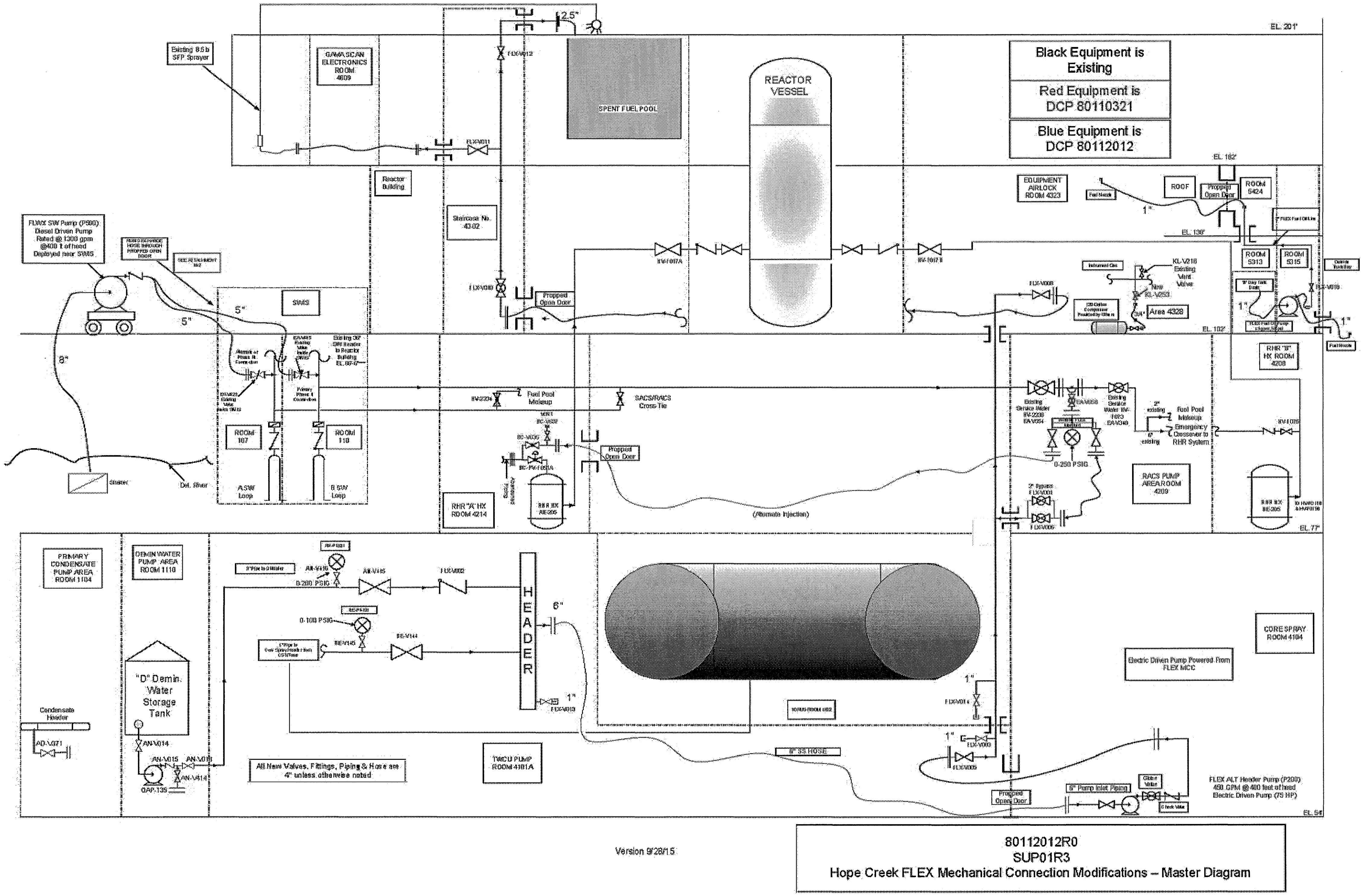

Figure 1 - FLEX Mechanical and Piping

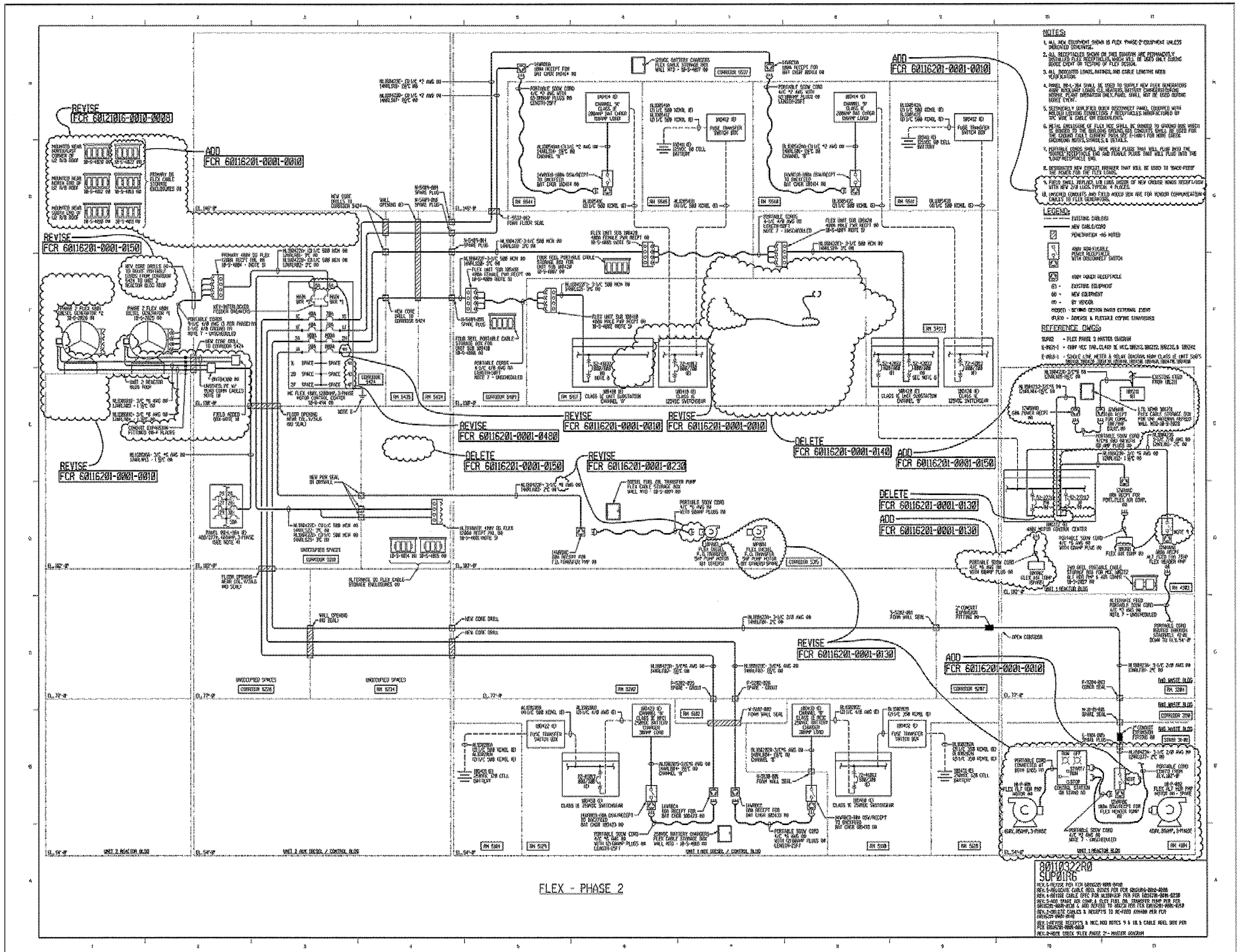

Figure 2: FLEX Electrical Strategy (Page 1 of 2)

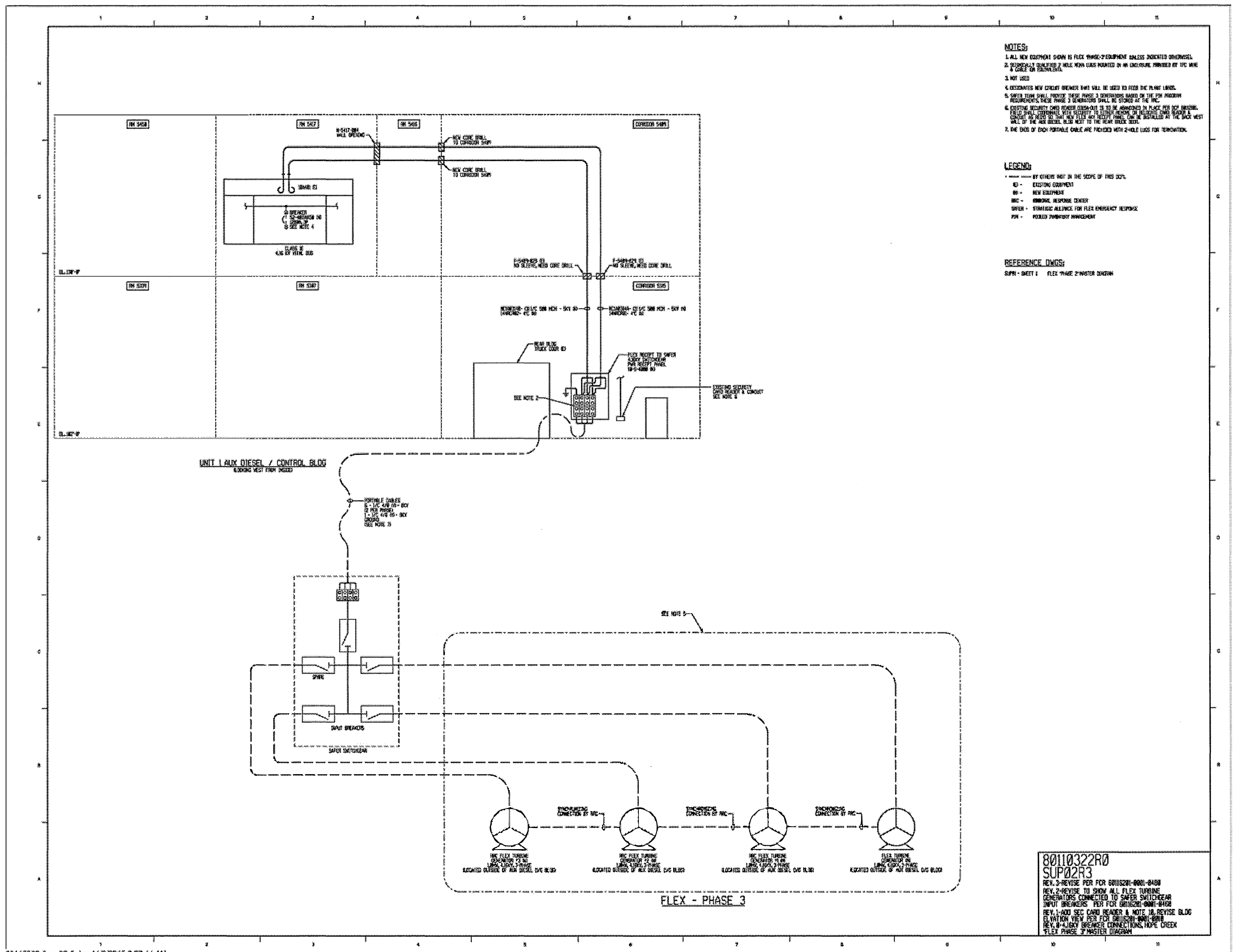

Figure 2: FLEX Electrical Strategy (Page 2 of 2)

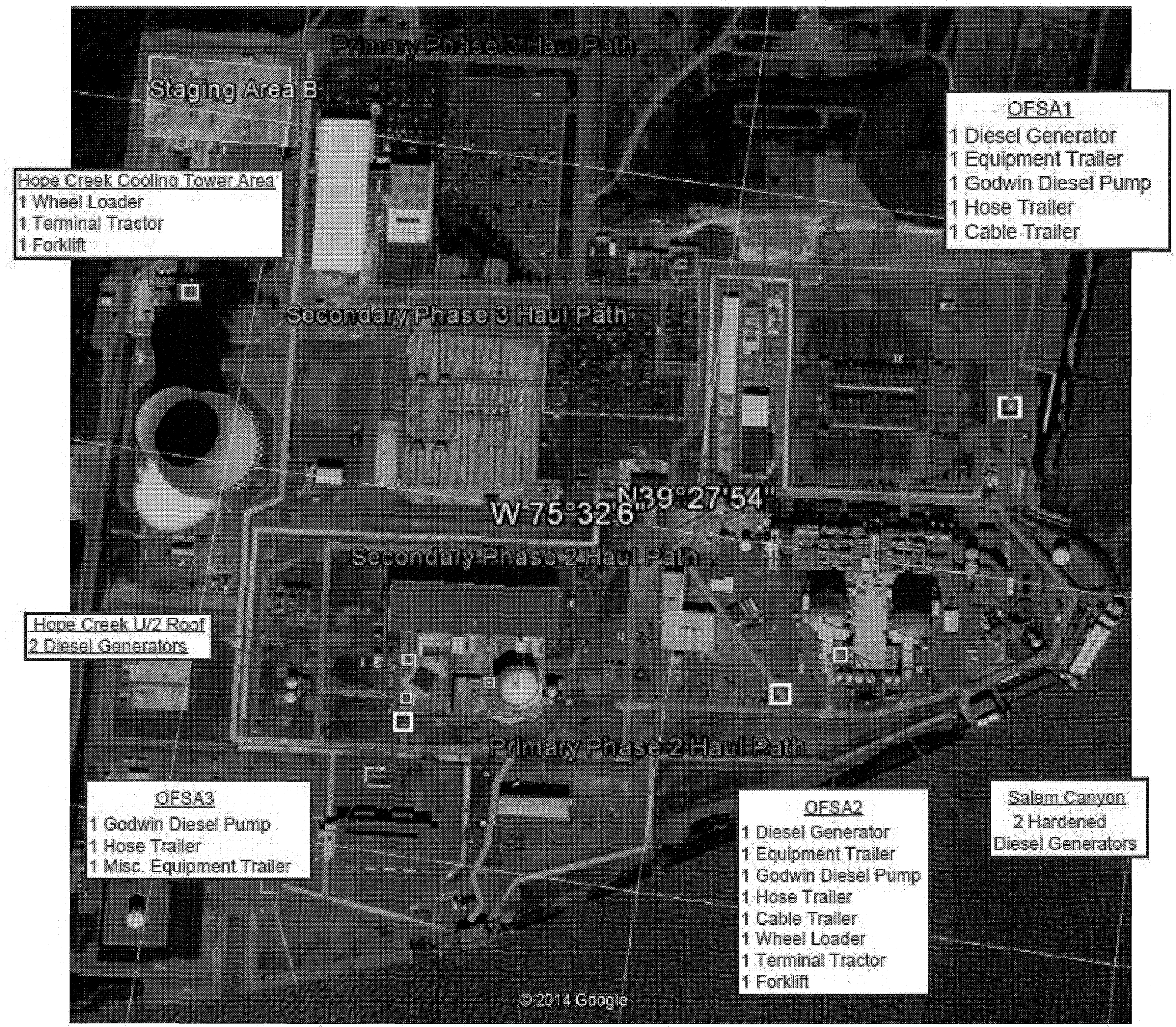

Figure 3: BDB FLEX Storage Location