Exelon Generation.

RS-16-063

Order No. EA-12-049

May 4, 2016

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

Calvert Cliffs Nuclear Power Plant, Unit 1
Renewed Facility Operating License No. DPR-53
NRC Docket No. 50-317

Subject: Report of Full Compliance with 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)

References:

1. NRC Order Number EA-12-049, "Issuance of Order to Modify Licenses with Regard to Requirements For Mitigation Strategies For Beyond-Design-Basis External Events," dated March 12, 2012
2. 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 1, dated January 22, 2016
3. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 2, dated December 2015
4. Letter from M. G. Korsnick (CENG) to Document Control Desk (NRC), Initial Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated October 26, 2012
5. Letter from M. G. Korsnick (CENG) to Document Control Desk (NRC), Overall Integrated Plan in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated February 28, 2013
6. Letter from M. G. Korsnick (CENG) to Document Control Desk (NRC), Supplement to Overall Integrated Plan in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated March 8, 2013
7. Letter from E. D. Dean (CENG) to Document Control Desk (NRC), Calvert Cliffs Nuclear Power Plant, Units 1 and 2 - Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated August 27, 2013

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8. Letter from M. G. Korsnick (CENG) to Document Control Desk (NRC) – February 2014 Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated February 27, 2014
9. Letter from M. G. Korsnick (CENG) to Document Control Desk (NRC) – August 2014 Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated August 26, 2014
10. Letter from M. G. Korsnick (CENG) to Document Control Desk (NRC) – February 2015 Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated February 20, 2015 (RS-15-054)
11. Exelon Generation Company, LLC letter to NRC – Fifth Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated August 28, 2015 (RS-15-217)
12. Exelon Generation Company, LLC letter to NRC – Sixth Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049), dated February 26, 2016 (RS-16-028)
13. Letter from J. S. Bowen (NRC) to J. A. Spina (CENG), Calvert Cliffs Nuclear Power Plant, Units 1 and 2 – Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Order EA-12-049, (Mitigation Strategies) (TAC Nos. MF1142 and MF1143), dated December 17, 2013
14. NRC Letter, Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3, of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, dated March 12, 2012
15. Letter from M. G. Korsnick (CENG) to Document Control Desk (NRC), 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 October 13, 2014
16. Letter from J. Paige (NRC) to M. G. Korsnick (CENG), Calvert Cliffs Nuclear Power Plant, Units 1 and 2 – Report for the Audit Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Pool Instrumentation Related to Orders EA-12-049 and EA-12-051 (TAC Nos. MF1142, MF1143, MF1140, and MF1141), dated February 20, 2015
17. Exelon Generation Company, LLC letter to NRC, Calvert Cliffs Nuclear Power Plant, Unit 2 – Report of Full Compliance with 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 July 2, 2015 (RS-15-099)

On March 12, 2012, the Nuclear Regulatory Commission ("NRC" or "Commission") issued Order EA-12-049, "Order Modifying Licenses with Regard to Requirements For Mitigation Strategies For Beyond-Design-Basis External Events," (Reference 1) to Exelon Generation Company, LLC

(EGC), previously Constellation Energy Nuclear Group, LLC (Exelon, the licensee) for Calvert Cliffs Nuclear Power Plant, LLC (CCNPP), Unit 1. Reference 1 was immediately effective and directed Constellation Energy Nuclear Group, LLC (CENG) 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. Specific requirements are outlined in Attachment 2 of Reference 1.

Reference 1 required submission of an initial status report 60 days following issuance of the final interim staff guidance and an Overall Integrated Plan (OIP) pursuant to Section IV, Condition C. Reference 2 endorsed industry guidance document NEI 12-06, Revision 2 (Reference 3) with clarifications and exceptions identified in Reference 2. Reference 4 provided the CENG initial status report regarding mitigation strategies. References 5 and 6 provided the Calvert Cliffs Nuclear Power Plant, Unit 1 OIP and its supplement, respectively.

Reference 1 required submission of a status report at six-month intervals following submittal of the OIP. References 7, 8, 9, 10, 11, and 12 provided the first, second, third, fourth, fifth and sixth six-month status reports, respectively, pursuant to Section IV, Condition C.2, of Reference 1 for Calvert Cliffs Nuclear Power Plant, Unit 1.

The purpose of this letter is to provide the report of full compliance with the 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) (Reference 1) pursuant to Section IV, Condition C.3 of the Order for Calvert Cliffs Nuclear Power Plant, Unit 1.

Calvert Cliffs Nuclear Power Plant, Unit 1 has developed, implemented, and will maintain the 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 response to Order EA-12-049. The information provided herein documents full compliance for Calvert Cliffs Nuclear Power Plant, Unit 1 with Reference 1.

OIP open items have been addressed and closed as documented in References 7, 8, 9, 10, 11, 12, and 17, and below, and are considered complete pending NRC closure. EGC's response to the NRC Interim Staff Evaluation (ISE) open items identified in Reference 13 have been addressed and closed as documented in References 9 and 10, and are considered complete pending NRC closure. EGC's response to the NRC ISE confirmatory items identified in Reference 13 have been addressed and closed as documented in References 8, 9, 10, and 17, and are considered complete pending NRC closure. EGC's response to the NRC audit questions and additional audit open items as documented in Reference 16 have been addressed and closed as documented in References 10, 16, and 17 and are considered complete pending NRC closure. The following table provides completion references for each OIP open item, NRC ISE open or confirmatory item, and NRC Audit Report open item.

Overall Integrated Plan Open Items

OIP Open Item	Completion Response Reference
OIP Open Item No. 1	Reference 10
OIP Open Item No. 2	Reference 8 and updated with this submittal as provided below

OIP Open Item	Completion Response Reference
OIP Open Item No. 3	Reference 10
OIP Open Item No. 4	Reference 10
OIP Open Item No. 5	Reference 17
OIP Open Item No. 6	Reference 10
OIP Open Item No. 7	Reference 17
OIP Open Item No. 8	Reference 10
OIP Open Item No. 9	Reference 17
OIP Open Item No. 10	Reference 8
OIP Open Item No. 11	Reference 7
OIP Open Item No. 12	Reference 8
OIP Open Item No. 13	Reference 10
OIP Open Item No. 14	Reference 17
OIP Open Item No. 15	References 8 and 10 and updated with this submittal as provided below
OIP Open Item No. 16	Deleted – Addressed in Reference 7
OIP Open Item No. 17	Reference 10 and updated with this submittal as provided below
OIP Open Item No. 18	Reference 8
OIP Open Item No. 19	Reference 8 and updated with this submittal as provided below
OIP Open Item No. 20	Deleted – Addressed in Reference 7
OIP Open Item No. 21	Reference 8 and updated with this submittal as provided below
OIP Open Item No. 22	Deleted – Addressed in Reference 8
OIP Open Item No. 23	Reference 10
OIP Open Item No. 24	Reference 17
OIP Open Item No. 25	Reference 17
OIP Open Item No. 26	Reference 10
OIP Open Item No. 27	Reference 10
OIP Open Item No. 28	Reference 10
OIP Open Item No. 29	Reference 8
OIP Open Item No. 30	Reference 8 and updated with this submittal as provided below
OIP Open Item No. 31	Reference 7 and updated with this submittal as provided below
OIP Open Item No. 32	Deleted- Addressed in Reference 8

OIP Open Item	Completion Response Reference
OIP Open Item No. 33	Deleted – Addressed in Reference 7
OIP Open Item No. 34	References 8 and 12
OIP Open Item No. 35	Deleted – Addressed in Reference 8
OIP Open Item No. 36	Reference 10
OIP Open Item No. 37	Reference 10
OIP Open Item No. 38	Reference 17
OIP Open Item No. 39	Reference 10
OIP Open Item No. 40	Reference 10 and updated with this submittal as provided below
OIP Open Item No. 41	Reference 9
OIP Open Item No. 42	References 8 and 12
OIP Open Item No. 43	References 8 and 12
OIP Open Item No. 44	Deleted – Addressed in Reference 7
OIP Open Item No. 45	Reference 10
OIP Open Item No. 46	Reference 17
OIP Open Item No. 47	Reference 17
OIP Open Item No. 48	Deleted – Addressed in Reference 8
OIP Open Item No. 49	Reference 8 and updated with this submittal as provided below
OIP Open Item No. 50	Reference 10
OIP Open Item No. 51	Deleted – Addressed in Reference 7
OIP Open Item No. 52	Deleted - Addressed in Reference 9
OIP Open Item No. 53	Reference 10
OIP Open Item No. 54	Deleted – Addressed in Reference 8
OIP Open Item No. 55	Reference 10
OIP Open Item No. 56	References 8 and 12
OIP Open Item No. 57	Reference 17
OIP Open Item No. 58	Reference 17
OIP Open Item No. 59	Reference 17
OIP Open Item No. 60	Duplicate to OIP Open Item No. 55 – Addressed in Reference 10
OIP Open Item No. 61	Reference 9
OIP Open Item No. 62	Reference 9
OIP Open Item No. 63	Reference 7

OIP Open Item	Completion Response Reference
OIP Open Item No. 64	Reference 7
OIP Open Item No. 65	Reference 9
OIP Open Item No. 66	Reference 9
OIP Open Item No. 67	Reference 9
OIP Open Item No. 68	Reference 9
OIP Open Item No. 69	Deleted – Addressed in Reference 8
OIP Open Item No. 70	Reference 10
OIP Open Item No. 71	Reference 10
OIP Open Item No. 72	Reference 8
OIP Open Item No. 73	Deleted – Addressed in Reference 8
OIP Open Item No. 74	Deleted – Addressed in Reference 10
OIP Open Item No. 75	Reference 10
OIP Open Item No. 76	Reference 17
OIP Open Item No. 77	Reference 8
OIP Open Item No. 78	Deleted – Addressed in Reference 7
OIP Open Item No. 79	Reference 10
OIP Open Item No. 80	Deleted – Addressed in Reference 9
OIP Open Item No. 81	Reference 9
OIP Open Item No. 82	Reference 9
OIP Open Item No. 83	Reference 9
OIP Open Item No. 84	Deleted – Addressed in Reference 10
OIP Open Item No. 85	Deleted – Addressed in Reference 10
OIP Open Item No. 86	Deleted – Addressed in Reference 9
OIP Open Item No. 87	Reference 10
OIP Open Item No. 88	Reference 10
OIP Open Item No. 89	Reference 10
OIP Open Item No. 90	Reference 17
OIP Open Item No. 91	Reference 17
OIP Open Item No. 92	Reference 17
OIP Open Item No. 93	Deleted – Addressed in Reference 8
OIP Open Item No. 94	References 11 and 12

Interim Staff Evaluation Open Items

ISE Open Item	Completion Response Reference
Item No. 3.2.1.1.A	Reference 10
Item No. 3.2.1.1.B	Reference 9
Item No. 3.2.1.8.A	Reference 10

Interim Staff Evaluation Confirmatory Items

ISE Confirmatory Item	Completion Response Reference
Item No. 3.1.1.1.A	Reference 10
Item No. 3.1.1.1.B	Reference 10
Item No. 3.1.1.4.A	References 10 and 17
Item No. 3.1.2.2.A	References 10 and 17
Item No. 3.1.2.2.B	References 10 and 17
Item No. 3.1.2.2.C	Reference 10
Item No. 3.1.3.2.A	References 9 and 17
Item No. 3.1.4.2.A	References 9 and 17
Item No. 3.1.4.2.B	Reference 9
Item No. 3.2.1.2.A	Reference 9
Item No. 3.2.1.5.A	Reference 9
Item No. 3.2.1.6.A	References 9 and 17
Item No. 3.2.1.6.B	Reference 17
Item No. 3.2.1.7.A	References 9 and 17
Item No. 3.2.1.9.C	References 9 and 17
Item No. 3.2.1.9.D	Reference 8
Item No. 3.2.2.A	Reference 9
Item No. 3.2.2.B	Reference 10
Item No. 3.2.3.A	Reference 10
Item No. 3.2.4.1.A	Reference 9
Item No. 3.2.4.2.A	Reference 9
Item No. 3.2.4.2.B	Reference 9
Item No. 3.2.4.2.C	Reference 9
Item No. 3.2.4.2.D	Reference 9

ISE Confirmatory Item	Completion Response Reference
Item No. 3.2.4.2.E	Reference 9
Item No. 3.2.4.4.A	Reference 9
Item No. 3.2.4.4.B	Reference 9
Item No. 3.2.4.5.A	References 10 and 17
Item No. 3.2.4.6.A	Reference 9
Item No. 3.2.4.6.B	Reference 9
Item No. 3.2.4.6.C	Reference 9
Item No. 3.2.4.8.A	Reference 10
Item No. 3.2.4.8.B	Reference 10
Item No. 3.2.4.9.A	Reference 10
Item No. 3.2.4.10.A	Reference 17
Item No. 3.2.4.10.B	Reference 9
Item No. 3.4.A	Reference 10

NRC Audit Report Open Items

Audit Open Item	Completion Response Reference
AQ 3 (AQ 4)	Reference 16
AQ 16 (AQ 18)	Reference 16
AQ 37 (AQ 47)	Reference 16
SE Review Item 1	Reference 16
ISE CIs 3.1.1.4.A, 3.1.2.2.A, 3.1.2.2.B, and 3.2.4.5.A, Staging Areas	Reference 17
ISE CI 3.1.3.2.A, Debris Removal	Reference 17
ISE CI 3.1.4.2.A, Impact of Extreme Temperature Environments	Reference 17
ISE CIs 3.2.1.6.A, 3.2.1.6.B, and AQ 23 (AQ27), Sequence of Events	Reference 17
ISE CI 3.2.1.7.A and AQ 38 (AQ 48), Shutdown and Refueling Modes	Reference 17
ISE CI 3.2.1.9.C, Engineering Evaluations of Phase 3 Equipment	Reference 17
ISE CI 3.2.4.9.A and AQ 43 (AQ54), Fuel Oil Consumption	Reference 10

Audit Open Item	Completion Response Reference
ISE CI 3.2.4.10.A and AQ 34 (AQ 39), DC Load Shedding	Reference 17
ISE CI 3.4.A, Off-Site Resources	Reference 10
AQ 1 (AQ2), Power Supply	Reference 17
AQ 21 (AQ 25), DG Sizing Calculations	Reference 16
AQ 32 (AQ 37), Electrical Isolation	Reference 17
SE Review Item 4, Safety Injection Tanks (SITs)	Reference 17
SE Review Items 5 and 6, RCS Pump Hydraulic Analysis	Reference 17

The following table documents the completion of the final remaining open items. As previously stated, EGC provides the response for the following items and considers them to be complete for Calvert Cliffs Nuclear Power Plant, Unit 1.

Item	Description	Status
OIP Open Item No. 2 Implement a design change to install permanent protected Unit 1 FLEX equipment connection points	Various Engineering Change Packages (ECP) have been prepared to install permanent protected FLEX equipment connection points. These ECPs are summarized below: 1. ECP-14-000025 was prepared to reconfigure the following instrument loops to receive safety-related 120VAC vital power from safety-related instrument buses 1Y01 and 1Y02: • Reactor cavity temperature • Safety injection tank level • Safety injection tank pressure • Containment dome temperature 2. ECP-14-000118 provides the necessary electrical modifications to connect: • FLEX 480VAC 500kW/625kVA portable diesel generators to Unit 1 480 VAC Load Centers 11B and 14A. This provides the means to restore 480 VAC distribution power essential to the CCNPP Unit 1 FLEX transitional phase (Phase 2) coping strategies to provide power to the battery	Complete

Item	Description	Status
	chargers and other critical AC equipment. • FLEX 100 kW portable diesel generator to Reactor Motor Control Centers 104 (cross-connected with MCC 114). This provides the means to restore 480 VAC distribution power essential to the CCNPP Unit 1 FLEX transitional phase (Phase 2) coping strategies by providing power to the inverter backup bus (which can power the 120VAC vital instrument bus), the SIT Outlet Motor Operated Valves (MOVs), the AFW Pump Room Vent Fans, and other critical AC equipment. 3. ECP-14-000087 was prepared to install a new, permanent branch tee with a hose connection and an isolation valve in the safety related portion of 6" Auxiliary Feedwater motor-driven pump, cross-connect pipe. This new connection provides an additional means of supplying makeup water to the steam generators. 4. ECP-14-000100 was prepared to allow a portable FLEX pump to take suction from Refueling Water Tank (RWT) 1TKRWT11 to supply water to the Reactor Coolant System (RCS) using a portable FLEX pump and temporary hose that enters via newly-installed HPSI header connection valves. 5. ECP-14-000375 was prepared to add instrument air connections for connecting a portable air compressor to the instrument air system for each unit.	
OIP Open Item No. 15 Original open item text: Implement a design change to replace the 1 ft. diameter wheel with a 3 ft. wheel on each Atmosphere Dump Valve (ADV) chain operator. Modified open item text:	ECP 14-000377 implemented a modification which consisted of installing both a larger hand wheel and an enhanced gear assembly which result in the capability to operate the system in a single operator evolution. Work Order C92672329, which implements	Complete

Item	Description	Status
Implement a design change to improve mechanical advantage on each Unit 1 Atomspheric Dump Valve (ADV) chain operator.	ECP-14-000377 for Unit 1, has been completed.	
OIP Open Item No. 17 Develop a procedure or FSG to perform an early Unit 1 cooldown and depressurization as recommended by WCAP-17601-P.	CCNPP Emergency Operating Procedure, EOP-7, Station Blackout, has been revised to include the early cooldown and depressurization in accordance with the PWROG FLEX Support Guidelines and WCAP-17601-P.	Complete
OIP Open Item No. 19 Implement a design change to re-power the Unit 1 [Safety Injection Tank] SIT level and pressure indicators from a vital 120 VAC instrument bus.	Engineering Change Package, ECP-14-000025, was prepared to re-power the Safety Injection Tank (SIT) level and pressure indicators from vital 120 VAC instrument buses 1Y01 and 1Y02 to ensure the SIT wide range level and pressure indication loops are operational during extended loss of AC power (ELAP) events. Work Order C92681898, which implements ECP-14-000025 for Unit 1, has been completed.	Complete
OIP Open Item No. 21 Original open item text: Implement design changes to install "plug and play" protected hose connections for the portable alternate [Auxiliary Feedwater] AFW pump to AFW on the exterior of the Auxiliary Building west wall with piping run to the 27 ft. East penetration Rooms to connect to the AFW to S/G headers. Modified open item text: Utilize flexible hose to connect a FLEX pump to a newly installed, dedicated Unit 1 hose connection located on the motor driven AFW pump cross-connect line on the 5 ft. elevation of the Auxiliary Building.	Engineering Change Package, ECP-14-000087, was prepared to install a new, permanent branch tee with a hose connection and an isolation valve in the safety-related portion of a 6" Auxiliary Feedwater motor-driven pump, cross-connect pipe. This new connection provides an additional means of supplying makeup water to the steam generators. Work Order C92672324, which implements ECP-14-000087 for Unit 1, has been completed.	Complete

Item	Description	Status
OIP Open Item No. 30 Implement a design change to provide dedicated hose connections and piping to the Unit 1 Safety Injection System.	Engineering Change Package, ECP-14-000100, was prepared to provide dedicated hose connections via HPSI header connection by installing two (2) new valves and a hose connection to the Safety Injection System. Work Order C92672376, which implements this portion of ECP-14-000100 for Unit 1, has been completed.	Complete
OIP Open Item No. 31 Develop a Unit 1 procedure or FSG to mimic the AFW makeup strategy described in ERPIP-611, Attachment 1.	FSG-3, Alternate Low Pressure Feedwater, provides the necessary actions to utilize the FLEX equipment at CCNPP to provide a feedwater source to the steam generators when the steam driven auxiliary feedwater pumps are no longer available. This FSG includes a description of the alternate strategy for AFW makeup, as described in ERPIP-611, Attachment 1.	Complete
OIP Open Item No. 40 Develop and implement Unit 1 procedures to supply power to critical instrumentation using primary and alternate methods.	FSG-7, Loss of Vital Instrument and Control Power, has been approved and implemented.	Complete
OIP Open Item No. 49 Implement a design change to power Unit 1 containment dome and reactor cavity temperatures instrumentation from a vital 120 VAC instrument bus.	Engineering Change Package, ECP-14-000025, was prepared to repower the Containment Dome and Reactor Cavity temperature instrumentation loops from a vital 120 VAC instrument bus to maintain their functionality during ELAP events. Work Orders C92681901 and C92681903, which implement ECP-14-000025 for Unit 1, have been completed.	Complete

MILESTONE SCHEDULE – ITEMS COMPLETE

Milestone	Completion Date
Submit 60 Day Status Report	October 26, 2012
Submit Overall Integrated Plan	February 28, 2013
Submit Supplement to Overall Integrated Plan	March 8, 2013
Contract with National SAFER Response Center	January 17, 2013
Submit 6 Month Updates:	
Update 1	August 27, 2013
Update 2	February 27, 2014
Update 3	August 26, 2014
Update 4	February 20, 2015
Update 5	August 28, 2015
Update 6	February 26, 2016
Modification Development:	
Phase 2 modifications	October 6, 2014
National SAFER Response Center Operational	February 26, 2015
Procedure Development:	
Strategy procedures	March 2, 2016
Validate Procedures (NEI 12-06, Sect. 11.4.3)	March 27, 2015
Staffing analysis	October 13, 2014
Modification Implementation	
Phase 2 modifications	February 29, 2016
Storage plan and construction	January 29, 2016
FLEX equipment acquisition	August 21, 2015
Training completion	February 5, 2016
Unit 1 implementation date	March 9, 2016

ORDER EA-12-049 COMPLIANCE ELEMENTS SUMMARY

The elements identified below for Calvert Cliffs Nuclear Power Plant, Unit 1 as well as the site OIP response submittal (References 5 and 6), the 6-Month Status Reports (References 7, 8, 9, 10, 11, and 12), and any additional docketed correspondence, demonstrate compliance with Order EA-12-049.

Strategies - Complete

Calvert Cliffs Nuclear Power Plant, Unit 1 strategies are in compliance with Order EA-12-049. There are no strategy related Open Items, Confirmatory Items, or Audit Questions/Audit Report Open Items. The Calvert Cliffs Nuclear Power Plant, Units 1 and 2, Final Integrated Plan for mitigating strategies is provided in the enclosure to this letter.

Modifications - Complete

The modifications required to support the FLEX strategies for Calvert Cliffs Nuclear Power Plant, Unit 1 have been fully implemented in accordance with the station design control process.

Equipment – Procured and Maintenance & Testing – Complete

The equipment required to implement the FLEX strategies for Calvert Cliffs Nuclear Power Plant, Unit 1 has been procured in accordance with NEI 12-06, Sections 11.1 and 11.2, received at Calvert Cliffs Nuclear Power Plant, Unit 1, initially tested/performance verified as identified in NEI 12-06, Section 11.5, and is available for use.

Maintenance and testing will be conducted through the use of the Calvert Cliffs Nuclear Power Plant, Unit 1 Preventative Maintenance program such that equipment reliability is achieved.

Protected Storage – Complete

The storage facilities required to implement the FLEX strategies for Calvert Cliffs Nuclear Power Plant, Unit 1 have been completed and provide protection from the applicable site hazards. The equipment required to implement the FLEX strategies for Calvert Cliffs Nuclear Power Plant, Unit 1 is stored in its protected configuration.

Procedures – Complete

FLEX Support Guidelines (FSG), for Calvert Cliffs Nuclear Power Plant, Unit 1 have been developed, and integrated with existing procedures. The FSGs and affected existing procedures have been verified and are available for use in accordance with the site procedure control program.

Training – Complete

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

Staffing – Complete

The Phase 2 Staffing Assessment (Reference 15) for Calvert Cliffs Nuclear Power Plant has been completed as required by 10CFR50.54(f), "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," Recommendation 9.3, dated March 12, 2012 (Reference 14). The Phase 2 Staffing Assessment was conducted using NEI 12-01, Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities; an approach endorsed by the NRC.

National SAFER Response Center – Complete

EGC has established a contract with Pooled Equipment Inventory Company (PEICo) and has joined the Strategic Alliance for FLEX Emergency Response (SAFER) Team Equipment

Committee for off-site facility coordination. It has been confirmed that PEICo is ready to support Calvert Cliffs Nuclear Power Plant, Unit 1 with Phase 3 equipment stored in the National SAFER Response Centers in accordance with the site-specific SAFER Response Plan.

Validation – Complete

EGC validated FLEX strategies in accordance with the NEI FLEX Validation Process. This consisted of validating the feasibility of individual strategies identified in the Overall Integrated Plan (OIP) for Order EA-12-049 using the graded approach described in the NEI guidance document and an integrated review to ensure that adequate resources (personnel, equipment, materials) are available to implement the individual strategies to achieve the intended results.

FLEX Program Document - Established

The Calvert Cliffs Nuclear Power Plant, FLEX Program Document (CC-CA-118, Revision 001) has been developed in accordance with the requirements of NEI 12-06.

This letter contains no new regulatory commitments. If you have any questions regarding this report, please contact David P. Helker at 610-765-5525.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 4th day of May 2016.

Respectfully submitted,

James Barstow
Director - Licensing & Regulatory Affairs
Exelon Generation Company, LLC

Enclosure: Calvert Cliffs Nuclear Power Plant, Units 1 and 2 Final Integrated Plan – Mitigation Strategies for a Beyond-Design-Basis External Event (NRC Order EA-12-049), May 2016

cc: Director, Office of Nuclear Reactor Regulation
NRC Regional Administrator - Region I
NRC Senior Resident Inspector – Calvert Cliffs Nuclear Power Plant
NRC Project Manager, NRR – Calvert Cliffs Nuclear Power Plant
Mr. Jeremy S. Bowen, NRR/JLD/JOMB, NRC
Mr. Jason C. Paige, NRR/JLD/JOMB, NRC
S. Gray, MD-DNR

Enclosure

Calvert Cliffs Nuclear Power Plant, Units 1 and 2

Final Integrated Plan

Mitigation Strategies for a Beyond-Design-Basis External Event

(NRC Order EA-12-049)

May 2016

(134 Pages)

Exelon Generation®

Calvert Cliffs Nuclear Power Plant

Final Integrated Plan

Mitigation Strategies for a Beyond-Design-Basis External Event

(NRC Order EA-12-049)

May 2016

Table of Contents

1. Introduction 1
1.1. Implementation Capability Requirements Overview 2
2. General Elements 4
2.1. Characterization of External Hazards 4
2.1.1. Seismic 4
2.1.2. External Flooding 5
Table 2.1.2 Comparison Design Basis Flood Evaluations at CCNPP 5
2.1.3. High Wind Hazard Assessment 7
2.1.4. Snow and Extreme Cold Assessment 8
2.1.5. Ice Hazard Assessment 9
2.1.6. Extreme High Temperature Assessment 10
2.2. Key Assumptions 10
2.3. Reactor Coolant Pump Seals 13
3. Maintain Core Cooling (Mode 1 Power Operation and Mode 2 Startup) 15
3.1. Objectives 15
3.2. Acceptance Criteria 15
3.3. Strategies 15
3.4. Key Reactor Parameters 18
Table 3.4: Key Reactor and Plant Parameters, Modes 1 and 2, S/G Available 18
3.5. Phase 1 20
3.5.1. Vital 480 VAC Load Center and 480 VAC Reactor MCC Repower 22
3.5.2. 12 CST Makeup 27
3.6. Phase 2 28
3.6.1. Initial RCS Makeup and Boration 29
3.6.2. Long-term RCS Makeup and Boration 30
3.6.3. Vital 480 VAC Load Center and 480 VAC Reactor MCC Repower 31
3.6.4. 12 CST Makeup 32
3.7. Phase 3 33
3.7.1. Long-Term RCS Cooling 34
3.7.2. Long-term RCS Makeup and Boration 34

3.7.3. Vital 480 VAC Load Center and 480 VAC Reactor MCC Repower 35
3.7.4. 12 CST Makeup 36
4. Maintain Core Cooling (Hot Standby, Hot Shutdown, Cold Shutdown – S/Gs Available, Modes 3 - 5) 38
4.1. Objectives 38
4.2. Acceptance Criteria 38
4.3. Strategies 38
4.4. Key Reactor Parameters 41
Table 4.4: Key Reactor and Plant Parameters, Modes 3 – 5, S/G Available 41
4.5. Phase 1 42
4.6. Phase 2 44
4.6.1. RCS Makeup and Boration 44
4.7. Phase 3 45
5. Maintain Core Cooling (Cold Shutdown – No S/Gs Available, and Refueling, Modes 5 and 6) 46
5.1. Objectives 46
5.2. Acceptance Criteria 46
5.3. Strategies 46
5.4. Key Reactor Parameters 48
Table 5.4: Key Reactor and Plant Parameters, Modes 5 and 6, No S/G Available 48
5.5. Phase 1 50
5.5.1. Decay Heat Removal Via RCS Boil Off 52
5.5.2. Decay Heat Removal Via RFP 53
5.6. Phase 2 54
5.7. Phase 3 54
6. Maintain Containment 56
6.1. Objectives 56
6.2. Acceptance Criteria 56
6.3. Strategies 56
6.4. Key Containment Parameters 56
Table 6.4: Key Containment Parameters 56
6.5. Phase 1 57

6.6. Phase 2 58
6.7. Phase 3 59
6.7.1. Primary Strategy 59
6.7.2. Alternate Strategy 60
7. Maintain Spent Fuel Pool Cooling 61
7.1. Objectives 61
7.2. Acceptance Criteria 61
7.3. Strategies 61
7.4. Key Spent Fuel Pool Parameters 62
Table 7.4: Key Spent Fuel Pool Parameters 62
7.5. Phase 1 62
7.5.1. SFP Area Ventilation 62
7.6. Phase 2 63
7.6.1. Full Core Offload Unit 2 2013 Refueling Outage 64
7.6.2. SFP Reactivity 64
7.6.3. Primary Strategy 64
7.6.4. SFP Makeup Routing 65
7.6.5. SFP Direct Injection 65
7.6.6. SFP Surface Makeup 66
7.7. Phase 3 66
8. Safety Function Support 67
8.1. Objectives 67
8.2. Phase 1 67
8.2.1. Vital 125 VDC power for Key Parameter Instrumentation 67
8.2.2. Emergency Lighting 69
8.2.3. Ventilation 70
8.2.4. Debris Removal 73
8.2.5. Communications 74
8.3. Phase 2 75
8.3.1. Vital 125 VDC power for Key Parameter Instrumentation 75
8.3.2. Emergency Lighting 75
8.3.3. Ventilation 75

8.3.4. Debris Removal ... 77
8.3.5. Communications ... 77
8.3.6. Fuel Oil ... 77
8.3.7. Ultimate Heat Sink (UHS) ... 78
8.4. Phase 3 ... 78
8.4.1. Ultimate Heat Sink (UHS) ... 79
8.5. Protection of Equipment ... 79
8.6. Personnel Habitability ... 80
8.7. Lighting ... 81
8.8. Communications ... 81
8.9. Deployment Routes ... 83
8.10. Offsite Support ... 84
8.10.1. National SAFER Response Center ... 84
8.10.2. Equipment List ... 85
9. Sequence of Events ... 86
Table 9.1: Sequence of Events Timeline ... 86
10. Programmatic Elements ... 92
10.1. Overall Program Document ... 92
10.2. Procedural Guidance ... 92
10.3. Staffing ... 93
10.4. Training ... 94
11. FLEX Equipment ... 96
11.1. Equipment List ... 96
11.2. Equipment Maintenance and Testing ... 96
Table 11.1: Onsite Phase 2 and 3 Equipment List ... 98
Table 11.2: Offsite Phase 3 Equipment List ... 100
Table 11.3 CCNPP FLEX Equipment Test and Maintenance Overview ... 103
12. References ... 105
13. Acronyms ... 110
14. Figures ... 113

1. Introduction

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

Nuclear Regulatory Commission (NRC) Order EA-12-049, Issuance of Order to Modify Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, (Reference 1) requires a three-phase approach for mitigating beyond-design-basis external events. The initial phase requires the use of installed equipment and resources to maintain or restore core cooling, containment and spent fuel pool (SFP) cooling capabilities. The transition phase requires providing sufficient, portable, onsite equipment and consumables to maintain or restore these functions until they can be accomplished with resources brought from off site. The final phase requires obtaining sufficient offsite resources to sustain those functions indefinitely.

These strategies must be capable of mitigating a simultaneous loss of all 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 following a beyond-design-basis external event. Reasonable protection must be provided 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. The strategies must be implementable in all modes.

NRC Interim Staff Guidance (ISG) 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, (Reference 2) provides guidance to assist nuclear power reactor applicants and licensees with the identification of measures needed to comply with the requirements to mitigate challenges to key safety functions contained in Order EA-12-049. This ISG endorses, with clarifications, the methodologies described in NEI 12-06, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide. (Reference 3)

NEI 12-06 outlines the process to be used by individual licensees to define and implement site-specific diverse and flexible mitigation strategies that reduce the risks associated with beyond-design-basis conditions. NEI 12-06 requires that each plant establish the ability to cope with the baseline conditions for a simultaneous ELAP and loss of normal access to the UHS (LUHS) event and then evaluate the FLEX protection and deployment strategies in consideration of the challenges of the external hazards applicable to the site.

This final integrated plan provides the Calvert Cliffs Nuclear Power Plant (CCNPP) approach to comply with Order EA-12-049 using the methods described in NRC JLD-ISG-2012-01. The CCNPP Final Integrated Plan is based on our design information and engineering analyses, completed modifications, developed guidelines and procurement of material.

1.1. Implementation Capability Requirements Overview

The primary FLEX objective is to develop the capability for coping with a simultaneous ELAP and LUHS event for an indefinite period through a combination of installed plant equipment, portable on-site equipment, and off-site resources. The baseline assumptions have been established on the presumption that other than the loss of normal and alternate AC power sources, and normal access to the UHS, installed equipment that is designed to be robust with respect to design basis external events is assumed to be fully available. Installed equipment that is not robust is assumed to be unavailable. Permanent plant equipment, cooling and makeup water inventories, and fuel for FLEX equipment contained in systems or structures with designs that are robust with respect to seismic events, floods, high winds and associated missiles are available. Other equipment, such as portable ac power sources, portable back up dc power supplies, spare batteries, and equipment for Title 10 of the Code of Federal Regulations (10 CFR) Section 50.54(hh)(2), may be used provided it is reasonably protected from the applicable external hazards and has predetermined hookup strategies with appropriate procedures/guidance and the equipment is stored in a relative close vicinity of the site. Installed electrical distribution system, including inverters and battery chargers, remain available provided they are protected consistent with current station design.

The FLEX strategy relies upon the following principles:

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

- Response actions will be prioritized based on available equipment, resources, and time constraints. The initial coping response actions can be performed by available site personnel post-event.
- Transition from installed plant equipment to on-site FLEX equipment may involve on-site, off-site, or recalled personnel as justified by evaluation.
- Strategies that have a time constraint to be successful are identified and a basis provided that the time can reasonably be met.

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

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

NRC Order EA-12-051 (Reference 4) required licensees to install reliable SFP instrumentation with specific design features for monitoring SFP water level.

NEI 12-02 (Reference 5) 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 6), conformance with the guidance in NEI 12-02 is an acceptable method for satisfying the requirements in Order EA-12-051.

2. General Elements

2.1. Characterization of External Hazards

The applicable extreme external hazards for CCNPP are seismic, external flooding, high winds, snow and extreme cold, ice and extreme high temperatures.

2.1.1. Seismic

The original investigation of historical seismic activity in the CCNPP region determined a design safe shutdown earthquake (SSE) which is defined as the occurrence of a Modified Mercalli Intensity of VII originating in the basement rock near the site. Per Section 2.6 of the Updated Final Safety Analysis Report (UFSAR) CCNPP determined this corresponds to horizontal and vertical design ground accelerations of 0.15 g and 0.10 g, respectively, at foundation level (Reference 7).

In accordance with the NRC Request for Information Pursuant to 10 CFR 50.54(f) Regarding Recommendation 2.1 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident, CCNPP developed a Seismic Hazard and Screening Report utilizing the guidance in NRC endorsed EPRI Report 1025287, "Seismic Evaluation Guidance, Screening, Prioritization and Implementation Details (SPID) for the Resolution of Fukushima Near-Term Task Force Recommendation 2.1: Seismic (ML12333A170) (Reference 8). CCNPP submitted to the NRC the Seismic Hazard and Screening Report on March 31, 2014. (Reference 9)

The Ground Motion Response Spectrum (GMRS) was developed solely for the purpose of screening for additional evaluation requirements in accordance with the SPID. The CCNPP GMRS exceeds the SSE in the frequency range beyond 10 Hz. However, the GMRS does not exceed the CCNPP Individual Plant Examination of External Events (IPEEE) high-confidence-of-low-probability-of-failure (HCLPF) Spectra (IHS) in the frequency range beyond 10 Hz and therefore, additional high frequency confirmations were not required. The maximum exceedance occurred at 10 Hz with a GMRS/SSE ratio of 1.17. This ratio represents the factor used to increase the horizontal SSE to determine the Review Level Ground Motion (RLGM) (Reference 10).

In response to the NRC's Screening and Prioritization letter (Reference 11) CCNPP performed the Expedited Seismic Evaluation Process (ESEP) review of the FLEX connected structures, systems and components (SSCs). The review showed that all equipment evaluated were adequate in resisting the seismic loads expected to result from the site RLGM. No plant modifications were required to support FLEX implementation at CCNPP (Reference 10).

The NRC concluded additional analysis is not warranted given the minimal level of exceedance, low peak of the spectral acceleration, and the general estimation that the plant's seismic core damage frequency is not significant. Thus CCNPP is not required to perform additional seismic probabilistic risk assessment (Reference 12).

Additional evaluation was performed to evaluate for soil liquefaction potential at CCNPP along the FLEX Deployment Routes and at the FLEX Storage Robust Building (FSRB). The evaluation concluded that based upon the original site borings, the extensive borings conducted for the installation of the Independent Spent Fuel Storage Installation (ISFSI) and the associate Heavy Haul Path, and the recent soil borings for the design of the new FLEX Storage Building, the soil liquefaction potential for the Primary and Alternate Deployment Paths is considered minimal (Reference 13).

2.1.2. External Flooding

CCNPP is located on the western shore of the Chesapeake Bay, approximately 110 miles north from the Chesapeake Bay entrance. The CCNPP Units 1 & 2 safety-related and important-to-safety SSCs were constructed across three nearly level terraces: (1) the safety-related intake structure is located at a deck elevation of 10 ft NGVD 29, (2) safety-related and important-to-safety SSCs in the main plant area are located at a grade elevation of about 45 ft NGVD 29, and (3) plant substation (switchyard) and administrative buildings are located at a grade elevation of about 70 ft NGVD 29. All open slopes between the intake level and the main plant level are riprap protected, while the open slope between the switchyard level and the main plant level are protected with ripraps and gabion mattresses. (Reference 14)

The CCNPP UFSAR identified eight separate flood mechanisms, with five evaluated as bounded by plant SSCs. Table 2.1.2 compares the design basis flood level (where applicable) against the current flood protection elevation against the reevaluated flood level for each of the individual flood mechanisms (Reference 15).

Table 2.1.2 Comparison Design Basis Flood Evaluations at CCNPP

Flooding Mechanism	Flood Critical Structure	Current Flood Protection Elevation	UFSAR Design Basis Flood Level	Reevaluated Flood Level
Local Intense Precipitation	Auxiliary Building	45.0	Not discussed	44.86
	EDG Building	45.5	44.8	43.64

Flooding Mechanism	Flood Critical Structure	Current Flood Protection Elevation	UFSAR Design Basis Flood Level	Reevaluated Flood Level
Flooding in Rivers and Streams	No Flooding Expected	No Flooding Expected	No Flooding Expected	No Flooding Expected
Upstream Dam Failures	No Flooding Expected	No Flooding Expected	Not Evaluated	No Flooding Expected
Storm Surge (including wave runup)	Intake Structure	28.5	27.5	26.17
Seiche	Not Evaluated	Not Evaluated	Not Evaluated	No Flooding Expected
Tsunami	Intake Structure	28.5	No Flooding Expected	11.5
Ice Induced Flooding	Not Evaluated	No Flooding Expected	Not Evaluated	No Flooding Expected
Channel Migration or Diversion	Intake Structure	28.5	No Flooding Expected	No Flooding Expected

Note: All elevations in ft Mean Sea Level

To determine the reevaluated flood level, CCNPP used the Hierarchal Hazard Assessment (HHA) methodology also used by the NRC staff in their evaluations. The methodology is described as a progressively refined, stepwise estimation of the site-specific hazards that evaluates the safety of the site with the most conservative plausible assumptions consistent with the available data.

CCNPP submitted the initial Flood Hazard Reevaluation Report (FHRR) (Reference 14) on March 12, 2013 utilizing conservative assumptions and approaches in evaluating the flood hazards. The FHRR indicated that two reevaluated flood causing mechanisms, Local Intense Precipitation (LIP) and Probable Maximum Storm Surge (PMSS) exceeded the current design basis flood for CCNPP Units 1 and 2. The FHRR also indicates that flooding due to the LIP and the PMSS events do not cause immediate flooding at CCNPP. Interim measures to mitigate flooding from LIP and PMSS events were completed and are procedurally governed.

In line with the HHA methodology and NUREG/CR-7046 guidance, Exelon Generation conducted additional iterations and analyses of the LIP and PMSS. An amended FHRR describing the updated LIP and PMSS was submitted in September 2015 (Reference 15). The Reevaluated Flood Levels in Table 2.1.2 above for LIP and PMSS reflect the amended FHRR report; all others are from the initial FHRR.

The table demonstrates that all current design basis and reevaluated flood levels are bounded by the existing SSCs.

CCNPP also assessed the impact of the LIP and PMSS on implementing the FLEX Strategies. The LIP flood on West Road peaks at 44.86 ft MSL, below door sill height to Emergency Diesel Generators and doors into Auxiliary Building. The flood duration was not determined since flood water stays below design basis. Due to the site topography and natural drainage north and south of the power block, LIP flood waters are expected to recede prior to time when operators begin to deploy FLEX equipment on West Road. Upon ELAP, operators spend their first 3 hours performing plant cooldown activities; deep battery load shed; damage assessment; debris removal along deployment pathways and commence FLEX equipment deployment. Therefore there is no expected impact on implementing the FLEX Strategies due to LIP.

The PMSS flood height due to wave run up is 26.17 ft MSL, below the design basis height of 27.5 ft MSL. Thus there is no impact to the Intake Structure roof, located at 28.5 ft MSL. With PMSS duration conservatively established at 72 hours minimum that water is above the height of the water tight door on the north side of the Intake Structure, entry into the Intake Structure is limited through the North Service Building while the PMSS is present. CCNPP FLEX Strategies place equipment on the waterfront or at a location to obtain necessary pump suction if the waterfront is flooded if cooling water is needed from the Chesapeake Bay. Therefore there is no expected impact on implementing the FLEX strategies due to PMSS.

2.1.3. <u>High Wind Hazard Assessment</u>

Per NEI 12-06, Figure 7-1, Contours of Peak-Gust Wind Speeds at 10-m Height in Flat Open Terrain, Annual Exceedance Probability of 10^{-6}, CCNPP has a 1 in 1 million chance per year of a hurricane induced peak-gust wind speed of 150 – 160 miles per hour. Hurricane force winds are also a hazard, as approximately one hurricane per year poses a threat to the area, and about one hurricane every 10 years produces a significant effect (Reference 7).

Per NEI 12-06, Figure 7-2, Recommended Tornado Design Wind Speeds for the 10^{-6}/yr Probability Level, CCNPP has a 1 in 1 million chance of tornado wind speeds of 166 miles per hour. As this is greater than the NEI 12-06 threshold of 130 mph, CCNPP evaluated tornado hazards, including tornado missiles, impacting FLEX deployment.

CCNPP may have some warning time prior to the event in which a significant tornado event could occur within the vicinity of the site. The most probable approach direction is from the west.

Site debris would most likely include all types of building material (metal siding, roofing, lumber, etc.), power lines and poles, Sea-vans, vehicles, light poles, trees and stored material. Minimal debris impacting deployment routes would be generated from offsite sources. FLEX portable N equipment is stored in the tornado and tornado missile proof FSRB. The N+1 equipment is stored in the FSCB, more than 2100' away.

Four alternate travel routes for FLEX deployment exist to provide a drivable path even with debris. FLEX trucks and trailers should be able to travel over small debris such as sheet metal, vegetation and other similar objects. Some FLEX hoses, cables, and connection points for FLEX pumps and generators are located in designated areas of CCNPP structures that maintain safe shutdown capability in the event of a tornado (Reference 7). Deployment pathways blocked by tornado debris can be cleared using the FLEX Bobcats, Big Red Forklift and other debris removal tools such as chainsaw, disaster saw, tow chains, etc., which are stored in the FSRB.

2.1.4. Snow and Extreme Cold Assessment

For CCNPP as documented in the UFSAR Section 2.3.9.2, Snow Storms, the snowfall total of 59 inches for the combined months of January and February, was chosen to represent the 100-year snow pack on the ground (Reference 7). Per Section 5A.4, Loadings Common to All Structures, for ice or snow loading, a uniformly distributed live load of 30 psf on all roofs provides for any anticipated snow and/or ice loading. The historical low temperature recorded at Lusby, MD, located approximately 3 miles to the south of the site was (-) 9°F in February 1996.

The FSRB will house the dedicated FLEX equipment, for the entire life of the FLEX equipment, until a BDBEE occurs. The FSRB was designed such that the interior temperature of the FSRB ranges from 40° to 100° F. The FSRB is also designed for a snow loading of 105 psf snow load (Reference 16).

Per the CCNPP Program Document, CC-CA-118, Calvert Cliffs Implementation of Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program, Revision 1, FSRB and FSCB installed heaters will be inspected as part of the seasonal readiness program. Any deficiencies identified will be documented in the corrective action program with a priority for repair before freezing weather occurs and compensatory actions put in place to keep the building temperature at or above 40°F until the heaters are repaired (Reference 17).

If significant snow fall were to occur, the CCNPP Ice and Snow Action Plan gives priority to FLEX Deployment Paths and Storage Areas. FLEX vehicles for towing and debris removal have snow plow blades already installed and ready for deployment.

An evaluation was conducted to qualify the FLEX Portable equipment above (-)9°F to demonstrate compliance with NEI 12-06, Section 8.3.2 (Reference 18). Any required compensatory actions when below 10°F were identified and incorporated into FSGs.

The purchase specification for diesel fuel to be used for FLEX equipment requires a fuel additive to prevent gelling during cold weather conditions.

2.1.5. <u>Ice Hazard Assessment</u>

In addition to the snow loading described in Section 2.1.4, CCNPP is not impacted by the formation of frazil ice in the Chesapeake Bay. CCNPP withdraws Chesapeake Bay water from two locations. The initial location is the manway access to the discharge outfall, where plant discharge water would be at elevated temperatures due to the heat loads generated by the plant. The second location is the intake structure.

If site conditions drop below 35°F, plant operators backflow Circulating Water System flow per AOP-7L, Circulating Water / Intake Malfunctions. This results in twice heated water flowing into the Intake Structure, significantly reducing the buildup of ice in the Intake Structure. Although the backflow would not continue in ELAP conditions, the initially warmer water would limit the formation of ice. An analysis for Significant Operating Experience Review 2007-02, Intake Cooling Water Blockage, found that CCNPP is not susceptible to frazil ice formation (Reference 19). In the NRC's Staff Assessment of the Calvert Cliffs' Response to 50.54(f) Information Request-Flood-Causing Mechanism Reevaluation (Reference 20) it is concluded ice-induced flooding does not inundate the plant site.

CCNPP is located within the region characterized by EPRI as ice severity level 4 (Reference 3, Figure 8-2, Maximum Ice Storm Severity). Per CCNPP Units 1 and 2 UFSAR Section 2.3.2.3, Freezing Precipitation, the Patuxent Naval Air Training Center records (1949-1964) list 910 hours of snow and 265 hours of frozen or freezing precipitation, other than snow, for a total of 1175 hours (or 70,500 minutes) in 15 years. Interpolating for a 10-year span yields 47,000 minutes of freezing precipitation (Reference 7). As such, CCNPP is subject to severe icing conditions that could also cause catastrophic destruction to electrical transmission lines.

2.1.6. Extreme High Temperature Assessment

The local maximum temperature observed was 103°F in Lusby, Maryland, approximately 3 miles south of CCNPP in July 1980. Extreme high temperatures are not expected to impact the utilization of off-site resources or the ability of personnel to implement the required FLEX strategies.

Portable diesel equipment and portable static battery charger will be operated in areas outdoors, where the temperature will effectively be ambient. Vendor information has been reviewed to verify the equipment is expected to operate at high temperatures.

An evaluation was conducted to qualify the FLEX Portable equipment to 110°F to demonstrate compliance with NEI 12-06, Section 8.3.2 (Reference 18). Any required compensatory actions were identified and incorporated into FSGs.

2.2. Key Assumptions

The assumptions used for the evaluations of a CCNPP ELAP/LUHS event and the development of FLEX strategies are stated below.

Boundary conditions consistent with NEI 12-06 (Reference 3) Section 3.2.1, *General Criteria and Baseline Assumptions* are established to support development of FLEX strategies, as follows:

- The BDB external event occurs impacting both units at the site.
- Both reactors are initially operating at power, unless there are procedural requirements to shut down due to the impending event. The reactors have been operating at 100% power for the past 100 days.
- Each reactor is successfully shut down when required (i.e., all control 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. The emergency cooling system initiates and operates normally, providing decay heat removal, thus obviating the need for further overpressure protection valve operation.
- On-site staff is at site administrative minimum shift staffing levels.

- No independent, concurrent events, e.g., no active security threat.
- All personnel on-site are available to support site response.
- The reactor and supporting plant equipment are either operating within normal ranges for pressure, temperature and water level, or available to operate, at the time of the event consistent with the design and licensing basis.

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*, for CCNPP:

- No specific initiating event is used. The initial condition is assumed to be a loss of off-site power (LOOP) with installed sources of emergency on-site AC power 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 UHS is lost, but the water inventory in the 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 and identified leakage at the upper limit of Technical Specifications (11 gpm) and reactor coolant pump seal leakage of 15 gpm for four pumps for a total of 71 gpm leakage at rated pressure (pressure dependent).

- 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 10CFR50.54(x) and/or 10 CFR 73.55(p) may be required.

- Site access is impeded for the first 6 hours, consistent with NEI 12-01 (Reference 3). Additional resources are assumed to begin arriving at hour 6 with limited site access up to 24 hours. By 24 hours and beyond, near-normal site access is restored allowing augmented resources to deliver supplies and personnel to 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. These pre-planned FLEX strategies developed to protect the public health and safety have been incorporated into the unit emergency operating procedures in accordance with established emergency operating procedure (EOP) change processes, and their impact to the design and license bases capabilities of the unit evaluated under 10 CFR 50.59. Specific FSGs have been developed for the execution of the Phase 1 and Phase 2 Strategies.

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 BDB event 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). This position is consistent with the previously documented Task Interface Agreement (TIA) 2004-04, “Acceptability of Proceduralized Departures from Technical Specification (TSs) Requirements at the Surry Power Station”, (TAC Nos. MC42331 and MC4332), dated September 12, 2006 (Reference 21).

2.3. Reactor Coolant Pump Seals

Calvert Cliffs Nuclear Power Plant Units 1 and 2 are Combustion Engineering (CE) pre-System 80 2-loop plants with four Byron Jackson Type DFSS reactor coolant pumps (RCP) per unit. The RCP seals are Sulzer Bingham model RCR875B-3V 3-stage plus vapor stage balanced stator design seals.

Per Westinghouse letter LTR-FSE-13-45, Westinghouse Response to NRC Generic Request for Additional Information (RAI) on Reactor Coolant Pump (RCP) Seal Leakage in Support of the Pressurized Water Reactor Owners Group (PWROG), Rev. 0 dated August 16, 2013 (Reference 22), determined that the loss of all RCP seal cooling condition is most effectively mitigated during the ELAP event by cooldown/depressurization of the RCS to ensure reduced temperature conditions at the RCP seal package which improves long term survivability of the seals. The leakage through the seals is conservatively accounted for by the assumed seal leakages identified in Westinghouse Topical Report WCAP-17601-P, Revision 1, "Reactor Coolant System Response to the Extended Loss of AC Power Event for Westinghouse, Combustion Engineering and Babcock & Wilcox NSSS Designs," January 2013 (Reference 23)

For Combustion Engineering Nuclear Steam Supply System (CE-NSSS) plants, current procedure guidance recommends maintaining sub-cooling between 20°F and 50°F (30°F to 50°F for per CCNPP procedures) based on representative core exit thermocouple (CET) temperature during a Licensing Basis Station Blackout (SBO) event. Maintaining this sub-cooling range prevents the RCP seal pop-open failure. The higher performance material properties of the seals utilized in the CE fleet are less impacted by the other potential failure modes described in the supporting Brookhaven National Laboratory (BNL) report on RCP Seal Failures. (Reference 24).

The PWROG recommended ELAP coping strategy for the CE fleet is to commence a rapid RCS cooldown and depressurization within 2 hours of event initiation to limit seal degradation by minimizing the duration of seal material contact with hot RCS fluid and reducing RCS inventory loss by lowering the differential pressure across the RCP seal.

CCNPP mitigating strategies implement the above Westinghouse recommendations by performing an extensive RCS cooldown to 340°F commencing at two hours into the event at an initial rate of 75°F per hour.

Additionally, in a letter from Sulzer Pumps (US) Inc. (herein referred to as "Sulzer") to CCNPP dated August 28, 2014, (reference 25) Sulzer engineering provided the results of their review of Westinghouse letter LTR-FSE-13-45. Their review included review of WCAP-16175-P-A and WCAP-17601-P, Rev. 1 as referenced by the Westinghouse letter.

In summary, Sulzer agreed with the Westinghouse letter LTR-FSE-13-45 content and conclusions with clarification that Sulzer has never seen seal face pop opening or evidence of it during their 1985, 1003 hour, high temperature loss of seal cooling test done for Southern California Edison Company's San Onofre Nuclear Generating Station Units 2 and 3 RCP RCR950B-3V 3-stage plus vapor stage balanced stator seal, nor any other test they have conducted. The CCNPP RCP 3V 3-stage plus vapor stage balanced stator seal compares well to the San Onofre Nuclear Generating Station RCP seal except for balance diameter at 8.75 inches for CCNPP and 9.5 inches for San Onofre Nuclear Generating Station.

3. Maintain Core Cooling (Mode 1 Power Operation and Mode 2 Startup)

3.1. Objectives

Heat removal provided via the steam generators (S/Gs) and sufficient makeup to restore and maintain S/G level to provide core cooling. Baseline capabilities include the use of installed plant and FLEX equipment for Phase 1, 2, and 3 coping strategies. Also in Phase 3, CCNPP ERO Technical Support Center (TSC) staff and operations shift management will determine and coordinate the use and alignment of the National SAFER Response Center (NSRC) provided equipment.

Core inventory coping time is increased by performing an early and extensive Reactor Coolant System (RCS) cooldown.

FLEX guidance includes, if needed to back-up the installed Turbine Driven Auxiliary Feedwater (TDAFW) pumps, depressurizing the S/Gs for makeup with FLEX Auxiliary Feedwater (AFW) pump utilizing primary and alternate injection points. Analyses demonstrate that the guidance and equipment for combined S/G depressurization and makeup capability supports continued core cooling. Sustained, diversely located, sources of water are available and sufficient to supply S/G makeup water indefinitely.

3.2. Acceptance Criteria

No core damage will occur. Coping times have been determined such that they preclude core damage. Analysis has determined no core damage occurs including maintaining saturation conditions in the core region, keeping peak clad temperature below core melt limits, preventing clad rupture and maintaining two-phase water level above the top of the active fuel.

3.3. Strategies

NOTE: The core cooling strategy descriptions below are the same for Calvert Cliffs Nuclear Power Plant Unit 1 and Unit 2. Any differences and/or unit specific information is included where appropriate.

Maintain Core Cooling Modes 1 and 2 encompass the following strategies:

- TDAFW and Atmospheric Dump Valves (ADVs) operated for core and RCS heat removal

- Deep DC load shed to extend station vital 125 VDC battery coping time for plant control and key reactor parameter monitoring
- Early RCS cooldown to extend RCS inventory coping and boration via Safety Injection Tank (SIT) discharge
- Vital 480 VAC load center repower via FLEX diesel generators (DGs) for:
    - Vital instrument bus power and station battery recharging
    - RCS makeup and boration using installed charging pump
    - Reactor Motor Control Center (MCC) repower for SIT isolation to prevent nitrogen (N_2) injection into the RCS
- 12 Condensate Storage Tank (CST) makeup via FLEX equipment from any of the following water sources:
    - 11 and 21 CSTs
    - 11 Demineralized Water Storage Tank (DWST)
    - 11 and 12 Pretreated Water Storage Tanks (PWST)
    - Well Water
    - Chesapeake Bay (Ultimate Heat Sink)
- FLEX AFW pump deployed and connected ready to backup installed TDAFW system for S/G makeup
- FLEX RCS Makeup pump deployed and connected ready to backup installed Charging system pump for RCS makeup and boration

The strategy for Maintain Core Cooling from initial operation in Modes 1 or 2 is to maintain heat removal using the S/Gs via TDAFW and steaming to atmosphere via the ADVs. The suction source for TDAFW is from the fully protected 12 CST.

Installed TDAFW pump defense-in-depth is afforded by each unit having two TDAFW pumps. One TDAFW pump is aligned for automatic start and the second pump is in manual standby.

The TDAFW pumps can operate reliably provided there is >50 psig steam pressure in one of the S/Gs. Operators will use the local manual function of the turbine governor for controlling TDAFW pump turbine speed.

TDAFW pumps take suction from the 350,000 gallon 12 CST which is protected against tornadoes and tornado generated missiles. Tornado protection for the tank consists of a seismic Category 1 concrete structure of sufficient thickness to stop tornado-generated missiles and to resist tornado wind pressures. Bursting pressure is relieved by baffled, missile-proof vents. In addition to the enclosure for 12 CST, there is an enclosure for the piping header from the CSTs to the AFW pump suctions. This Category 1 reinforced concrete enclosure is located in the Tank Farm adjacent to 11 and 21 CSTs. This enclosure protects the Category 1 AFW header, connecting piping, and associated valves from the same natural phenomenon.

12 CST has a normal volume of approximately 327,000 gallons. At the low level alarm point, 12 CST provides 300,000 usable gallons (Technical Specification minimum level for both units) of water for decay heat removal and cooldown of both units. The contained water volume limit includes an allowance for water not useable because of tank discharge line location or other physical differences. By adjusting AFW flow for the prescribed early RCS cooldown rate, decay heat removal and cooldown of both units can be accomplished in approximately four hours with sufficient remaining volume to maintain hot standby conditions for >6 hours. 12 CST level is monitored in the Control Room via redundant level indication channels.

AFW flow control valve (FCV) air accumulators provide a sufficient volume of pressurized air for regulating AFW flow to the S/Gs for at least two hours following a complete loss of AC power. The control air system also has nitrogen (N_2) backup capability that can provide pressurized N_2 for several days. Operators would then manually regulate the system.

Per EOP-7, Station Blackout (Reference 26), TDAFW suction can be shifted to either 11 or 21 CSTs prior to the depletion of 12 CST. 11 and 21 CSTs are not protected from tornado missile hazards. However, 11 Well Water pump connection and pump motor lead connections are protected from wind-driven missile hazards due to the installed enclosure under ECP-14-000376 (Reference 27).

Additionally, as directed from EOP-7, FSG-2, Alternate AFW Suction Source (Reference 28) provides actions to realign the TDAFW pump to an alternate source of water when 12 CST becomes unavailable to provide pump suction.

For core inventory, per the WCAP-17601-P (Reference 23) recommendations, an early and extensive RCS cooldown will be initiated at approximately two (2) hours into the event. The cooldown significantly increases coping time by reducing the probability of RCP seal failure. The depressurization of the RCS which accompanies the cooldown, reduces the RCS inventory loss from any leak and measurably increases the coping time. CENTS analysis performed demonstrated that the onset of core uncovery can be extended from about 67 hours out to approximately 10.6 days by performing an early RCS cooldown. Additionally, plant depressurization also allows SIT injection to add borated water volume to the RCS, helping to maintain shutdown margin (SDM).

In addition, considering the effect on SDM, the RCS cooldown is completed within the first 24 hours of the ELAP to capitalize on the negative reactivity added by xenon buildup during this time frame. The added negative xenon reactivity complements the rod insertion reactivity such that the core remains subcritical during the cooldown and out to approximately 32 hours based on site specific analysis (Reference 29).

Key reactor parameter instrumentation will be maintained by the 125 VDC station batteries. Station battery coping will be extended by performing deep DC load shedding.

3.4. Key Reactor Parameters

Table 3.4 identifies the Key Reactor and Plant Parameters, the specific instrument identifier, and location available to operators in an ELAP event.

Table 3.4: Key Reactor and Plant Parameters, Modes 1 and 2, S/G Available

Key Parameter	Instrument	Location
S/G Pressure	PI-1013/1023A - D	Control Room
S/G Level	LI-1114/1124A - D	Control Room
RCS Subcooled Margin	PAMS A & B	Control Room
Core Exit Temperature	PAMS A& B	Control Room
RCS Hot Leg Temperature	TI-112H/122H	Control Room
RCS Hot Leg Temperature	TI-112C/T122C	Control Room

Key Parameter	Instrument	Location
Pressurizer Level	LI-110X-1/110Y-1	Control Room
Pressurizer Wide Range Pressure	PI-105 and PI-105A	Control Room
Reactor Vessel Level	Reactor Vessel Level Monitoring System (RVLMS) PAMS A & B	Control Room
SIT Wide Range Level	LI-311, 321, 331, 341	Control Room
SIT Wide Range Pressure	PI-311, 321, 331, 341	Control Room
Wide Range Log Power	JI-001, 002, 003, 004	Control Room
AFW Steam Train Flow	FIC-4511A and FIC-4512A	Control Room
AFW Motor Train Flow	FIC-4525A and FIC-4535A	Control Room
12 CST Level	LIA-5610/LI-5611	Control Room
Refueling Water Tank Level	LIA-4143	Control Room
Boric Acid Storage Tank Level	LIA-206/LIA-208	Control Room
11, 12, 21, 22 Vital DC Bus Voltage	EI-211, 212, 221, 222	Control Room
11. 12, 13, 14 Vital AC Instrument Bus Voltage	EI-1911, 1912, 1913, 1914	Control Room
21. 22, 23, 24 Vital AC Instrument Bus Voltage	EI-1921, 1922, 1923, 1924	Control Room
11, 12, 21, 22 Vital Battery Amps	II-201, 202, 204, 205	Control Room
TDAFW Pump Steam Supply Pressure	PI-3986, PI-3988	Local at TDAFW Pump
TDAFW Pump Discharge Pressure	PI-4501, PI-4502	Local at TDAFW Pump
11 and 21 CST Level	Thermography gun or portable instrument	Local at tank
11 DWST Level	Thermography gun or portable instrument	Local at tank
11 and 21 PWST Level	Thermography gun or portable instrument	Local at tank

3.5. Phase 1

At event time "0", the LOOP will initiate an automatic turbine trip on loss of electrical load which will then result in a Reactor Protective System (RPS) Loss of Load trip of the reactor.

At the initiation of the turbine/reactor trip the control room operators will enter EOP-0 "Post Trip Immediate Actions" (Reference 30). During EOP-0 control room operators will stabilize the units in hot standby by directing local manual operation of the ADVs to lower S/G pressure and RCS temperature to establish natural circulation reactor coolant flow, and either manual or automatic initiation of AFW to provide feedwater to the S/Gs. One of two TDAFW pumps will be operated from the control room, taking suction from the fully protected 12 CST and provide AFW flow to the S/Gs.

EOP-7, Station Blackout procedure (Reference 26) will be entered as determined via the EOP-0 Diagnostic Flow Chart for single event diagnosis – Station Blackout, when the station's emergency diesel generators are confirmed unavailable and off-site power cannot be promptly restored. Per EOP-7, operators will continue to maintain hot standby conditions until ELAP is determined. EOP-7 directed actions will be taken to protect the main condenser from over pressurization and minimize S/G inventory loss, minimize RCS inventory loss, and establish an RCS heat sink using TDAFW and ADVs.

Per EOP-7, following determination of ELAP by time one hour, operators initiate actions for ELAP response, including deep DC bus load shed, FLEX equipment staging and connection for vital 480 VAC load center repower and 12 CST makeup, while concurrently transitioning into EOP-7, Appendix 1, Initial ELAP RCS Cooldown (Reference 26).

Following ELAP determination, operators immediately initiate deep DC load shedding of loads supplied from the four vital 125 VDC buses and their associated DC power panels per FSG-4, ELAP DC Bus Load Shed and Management (Reference 31). FSG-4 provides actions to remove loads from the 125 VDC batteries, as well as the associated 120 VAC buses, to extend battery life during an ELAP up to 12 hours depending on the particular station battery. For additional details, see Section 8.2.1.

When operators are prepared, but no later than two hours into the ELAP event, plant cooldown is initiated by directing local manual operation of the ADVs to lower S/G pressure and RCS temperature to establish a natural circulation flow RCS cooldown to approximately 350°F and 250 psia. A modification to the ADV Handwheel and turning gear assembly permits a single operator to adjust the ADV position manually (Reference 32). TDAFW system will be controlled to maintain S/G level between (-) 24 and (+) 30 inches (normal S/G water level band) via manual AFW operation.

Operators conduct the plant cooldown at an initial rate of approximately 75°F/hour and then gradually reduce the rate due to the capacity limitations of ADVs. Simulator validations demonstrated that the cooldown to an RCS cold leg temperature of approximately 340°F and S/G pressure of 120 psia can be accomplished in approximately 3.75 hours. The cooldown is terminated when S/G pressure reaches 120 psia and RCS pressure is slightly above the 215 – 225 psig N_2 overpressure in the SITs. This point is reached at the end of Phase 1 at about 5.5 to 6 hours into the event.

By adjusting AFW flow for the cooldown rate described above, decay heat removal and cooldown of both units is accomplished in approximately four (4) hours with sufficient remaining 12 CST volume to maintain hot standby conditions for > 6 hours. Per EOP Attachments, Attachment 9, Makeup Water Required for RCS Cooldown (Reference 33), using a water consumption rate over 6 hours of 164 gpm per unit, 12 CST will have a useable volume for approximately 10 hours.

The reactor core is maintained sufficiently shutdown for up to thirty two hours as determined by Calculation CA08023, Minimum Allowable RCS Temperature to Support FLEX Implementation (Reference 29) while maintaining RCS temperature greater than 325°F. The cycle-independent established time for which a cooldown to 325°F could be performed without boration while maintaining reactivity more negative than -1000 pcm is 32 hours following reactor trip. Beyond 32 hours, boration is required in order to provide confidence that the reactor remains shut down by more than 1000 pcm.

This duration is established using the results documented above in conjunction with engineering judgment by including the following additional considerations:

- The established time of 32 hours is conservative with considerable margin to the actual results (~40 hours).
- The limiting case (0 ppm at Hot Full Power) is most restrictive. In the likely event that the trip occurred at any other time in the cycle, the time at which the -1000 pcm threshold is reached quickly increases.
- The actual RCS temperature following cooldown will be near 350°F, not 325°F as assumed.

Concurrent with the above actions for deep DC load shedding and plant cooldown, on-site minimum shift staff personnel (operations and nuclear security) will begin FLEX equipment deployment per FSG-5, Initial Assessment and FLEX Equipment Staging (Reference 34). Per FSG-5, the FLEX equipment is deployed from the fully protected FSRB in a specified order to the associated FLEX setup areas inside and outside of the plant protected area. Equipment initially deployed comprises FLEX 500 KW DG and associated cable cart trailers for vital load center repower, hose manifold trailers with hoses and booster pump for 12 CST makeup, FLEX AFW pumps for S/G makeup, and FLEX RCS make-up pumps with onboard hoses for RCS makeup. FLEX deployment includes, if needed, debris removal along the primary or alternate deployment routes into the plant protected area (PA), as well as debris removal inside the PA. See FLEX deployment route map (Figure 14-1).

3.5.1. Vital 480 VAC Load Center and 480 VAC Reactor MCC Repower

The CCNPP approach for vital 480 VAC load center and vital 480 VAC reactor MCC repower comprises preferred and alternate strategies.

Preferred Strategy

Refer to Power to 480 VAC Load Center 11B, 14A, 21B, or 24A from 500 KW DG FLEX Drawings (Figures 14-2 through 14-5) for the following 480 VAC load center re-power description. Figures 14-3 through 14-5 show deployment to Unit 1 Load Centers only; deployment to Unit 2 Load Centers are similar.

The preferred strategy utilizes FLEX 500 KW, 480 VAC DGs to repower one vital 480 VAC load center on each unit. The selected load centers are 11B or 21B (A-Train) and 14A or 24A (B-Train). These are the load centers that provide power to vital 480 VAC reactor MCCs-104R and 114R (Unit 1), and MCCs-204R and 214R (Unit 2). The primary loads of interest for re-power are as follows:

Load Center

- Battery Charger
- Charging Pump
- Vital 480 VAC reactor MCCs

Vital 480 VAC Reactor MCCs

- SIT Outlet MOVs

- Hydrogen Purge Exhaust MOVs
- Saltwater Air Compressors (SWAC)
- Battery Room supply and exhaust fans
- Inverter backup bus

11B (Unit 1) and 21B (Unit 2) vital 480 VAC load centers are located in switchgear rooms on plant elevation 27', and 14A (Unit 1) and 24A (Unit 2) vital 480 VAC load centers are located in switchgear rooms on plant elevation 45'.

Based on the initial assessments of plant condition and vital area accessibility, and utilizing FSG-5, Initial Assessment and FLEX Equipment Staging, Attachment 11, 480 VAC Load Center Re-Powering Logic, control room supervisors determine the two vital 480 VAC load centers that will be repowered. To provide for restoration of two independently powered vital 125 VDC battery chargers an "A" train and "B" train 480 VAC load center must be repowered. The preferred re-power alignment is an "A" Train 480 VAC load center on one unit and a "B" train 480 VAC load center on the opposite unit. However, due to load center availability and accessibility, an "A" and "B" train vital 480 VAC load center on the same unit can be repowered.

Following completion of the DC load shedding operators prepare selected vital 480 VAC load centers and reactor motor control centers (MCC) for re-power via on-site FLEX 480 VAC DGs. Per FSG-4, ELAP DC Bus Load Shed and Management (Reference 31) operators will open all of the breakers on vital 480 VAC load centers (11B, 14A, 21B, and 24A) and vital reactor MCCs (104R and 114R, and 204R and 214R). The operators then install the bus connection device (BCD) into the specified FLEX BCD compartment on the selected 480 VAC load center. Each vital 480 VAC load center has a designated BCD located in a seismic storage box within the same switchgear room as the vital 480 VAC load center. The vital 480 VAC load center designated BDC installation locations are as follows:

- 11B: 52-1124
- 14A: 52-1408
- 21B: 52-2124
- 24A: 52-2403

Two FLEX 500 KW DG cable cart trailers and two FLEX 500 KW DGs are deployed into the protected area with one cable cart trailer and one DG positioned adjacent to the elevation 45' roll-up door at the north end of the common Turbine Building and the other set adjacent to the elevation 45' roll-up door at the south end. As described above, both cable cart trailers and 500 KW DGs can be deployed to the north or south end of the Turbine Building as dictated by vital 480 VAC load center availability and accessibility.

Each cable cart trailer carries eighteen TPC cable reel carts, each with 200' of 1/C #4/0 AWG cable with color-coded connectors (Brown – L1, Orange – L2, and Yellow – L3). To support the calculated load, three cables per load center phase L1, L2, and L3 are required for connection between the load center and the FLEX 500 KW DG. In addition, two 200' green 1/C #4/0 AWG ground cable reel carts are provided to connect load center ground to the FLEX 500 KW DG ground. Each FLEX 500 KW DG has connected to the DG frame 100' of 1/C #4/0 AWG green ground cable for grounding the DG frame to any metal structure adjacent to the designated FLEX 500 KW DG setup areas.

To support repower of the "A" Train vital 480 VAC load centers 11B and 21B located on elevation 27' of the plant, TPC cable reels are stored in FLEX cable storage cabinets located on the west wall of the Unit 1 and Unit 2 Turbine Building 27' elevations respectively. The cable storage cabinets contain ten TPC cable reels, each with 100' of 1/C #4/0 AWG cable with color-coded connectors (Brown – L1, Orange – L2, and Yellow – L3). Three cable reels for each phase L1, L2, and L3, and one green ground cable. Each set of cabinets also contain three 10' "splitters" with color-coded ends (Brown – L1, Orange – L2, and Yellow – L3) for connection to the bus connection device (BCD) phase connections. The splitters comprise three 10' 1/C #4/0 AWG cables molded together to a single 500 MCM cable that connects to the corresponding color-coded BCD phase connection. During the first three hours of Phase 1, concurrent with FLEX cable cart trailer and 500 KW DG deployment, minimum shift staff personnel from nuclear security, chemistry, and radiation protection under the direction of operations personnel will deploy the cable and the splitters from the FLEX cable storage cabinets into the selected 27' elevation switchgear room and connect the splitters to the BCD, then connect the cables to the splitters.

When the cable cart trailers arrive, minimum shift staff personnel from nuclear security, chemistry, and radiation protection under the direction of operations personnel will begin cable deployment. The first ten set of cable carts (3 Brown, 3 Orange, 3 Yellow, and 1 Green) are deployed onto the 45' elevation Turbine Building approximately at the mid-point between the vital 480 VAC load center and the FLEX

500 KW DG set up location. The cable is then pulled off of the each cable cart reel and deployed to the load center (either into the 45' elevation switchgear room or down through a maintenance opening in the 45' elevation deck to the 27' elevation switchgear room. The second set of cable carts (3 Brown, 3 Orange, 3 Yellow, and 1 Green) are deployed adjacent to the FLEX 500 KW DG. The cable is then pulled off of the each cable cart reel and deployed to the setup location of the first set of ten cable carts. Connection of the splitters to the BCD, cable to splitters, between each 200' section of cable, and cable to the FLEX 500 KW DG connection panel is made by operations personnel. When completed, these connections are independently verified by a second operator.

Time response validation using a combination of in-plant walkdown, in-plant cable deployment and BCD connection, and use of cable deployment path replication in the station's main parking lot, and considering adverse impacts to implementer time response, have demonstrated that the first load center can be connected to a FLEX 500 KW DG in approximately 6.25 hours from time "0".

Connection of the second load center to the second FLEX 500 KW DG replicates the sequence and steps described above for the first load center. Based on validation of load center cable deployment, the second load center can be connected to the second 500 KW DG in approximately 6.5 hours from time "0".

Alternate Strategy

If the vital 480 VAC load centers that supply power to either vital 480 VAC reactor MCC on either Unit 1 or Unit 2 are not available, then the vital reactor MCCs will be re-powered directly from a FLEX 480 VAC 100 KW DG.

Refer to Figure 14-6, Power to 480 VAC MCC-104R from 100 KW DG for the following 480 VAC MCC re-power description.

The alternate strategy utilizes FLEX 100 KW, 480 VAC DGs to repower vital 480 VAC reactor MCCs-104R on Unit 1 and/or MCC-204R on Unit 2.

A-Train vital 480 VAC MCCs-104R and 204R are located on elevation 45' of the Auxiliary Building inside of electrical penetration rooms on the west side of the building. Each A-Train vital reactor MCC has a redundant B-Train reactor MCC-114R and 214R located on elevation 69' of the Auxiliary Building inside of electrical penetration rooms on the west side of the Auxiliary Building. The A-Train and B-Train reactor MCCs can be connected together via tie breakers, one located on each vital reactor MCC.

Per FSG-4, ELAP DC Bus Load Shed and Management (Reference 31), concurrent with preparing the vital 480 VAC load centers for re-power, operators dispatched to the Auxiliary Building will prepare the vital 480 VAC reactor MCCs for re-power by opening all of the breakers on MCCs-104R, 114R, 204R, and 214R. The operators then install the reactor MCC BCD into the specified FLEX BCD compartment on vital 480 VAC MCCs-104R and 204R. Vital 480 VAC MCCs-104R and 204R have a designated BCD located in a seismic storage box mounted on the west wall within the same electrical penetration room as the vital reactor MCC. The vital 480 VAC reactor MCC designated BCD installation locations are as follows:

- 104R: 52-10462
- 204R: 52-20460

Two FLEX 100 KW DG cable cart trailers and two FLEX 100 KW DGs are deployed into the protected area along the West Road with one cable cart trailer and one DG positioned adjacent to and north of the elevation 45' roll-up door to the truck bay of the Auxiliary Building and the other set adjacent and south of the truck bay roll-up door.

Each cable cart trailer carries four TPC cable reel carts, each with 300' of 1/C #4/0 AWG cable with color-coded connectors (Brown – L1, Orange – L2, and Yellow – L3). In addition, a 300' green 1/C #4/0 AWG ground cable reel cart is provided to connect MCC ground to the FLEX 100 KW DG ground. Each FLEX 100 KW DG has connected to the DG frame 100' of 1/C #4/0 AWG green ground cable for grounding the DG frame to any metal structure adjacent to the designated FLEX 100 KW DG setup areas. Included on the cable cart trailers are four white 10' 1/C #4/0 AWG adapter cables to connect the TPC cables to the L1, L2, L3 phase connectors and ground connector on the 100 KW DG. The adapter cables are color coded at both ends to ensure proper phase connections.

When the cable cart trailers arrive, minimum shift staff personnel from nuclear security, chemistry, and radiation protection under the direction of operations personnel will begin cable deployment. The cable carts (1 Brown, 1 Orange, 1 Yellow, and 1 Green) are deployed adjacent to the FLEX 100 KW DG. The cable is then pulled off of the each cable cart reel and deployed across the Auxiliary Building Truck Bay 45' elevation to the vital reactor MCC-104R or MCC-204R located inside the Unit 1 or Unit 2 west electrical penetration rooms. Connection of the cable to BCD and to the FLEX 100 KW DG connection panel is made by operations personnel. When completed, these connections are independently verified by a second operator.

3.5.2. 12 CST Makeup

The strategy for providing makeup water to 12 CST in less than ten hours relies on deploying two FLEX hose manifold trailers and a FLEX booster pump to FLEX setup areas adjacent to the Tank Farm at the north end of the plant protected area such that suction can be taken from any surviving water storage tank in the Tank Farm; 11 and 21 CST, 11 DWST, 11 and 12 PWST, or if needed from well water (No. 11 Well), or from the Chesapeake Bay (Ultimate Heat Sink) as a last resort. Two FLEX hose manifolds are installed to form a ring header for a more reliable feedwater source. The hose manifolds can be used to provide a reliable makeup supply to 12 CST as well as allow a direct supply to the FLEX AFW Pumps. See Figure 14-7.

11 and 21 CSTs each have a capacity of 350,000 gallons. The CSTs are vertical, cylindrical stainless steel tanks that are seismically qualified under the CCNPP Seismic Verification Program.

11 DWST also has a capacity of 350,000 gallons. The DWST is a vertical, cylindrical stainless steel tank that is seismically qualified under the CCNPP Seismic Verification Program.

11 and 12 PWST each have a capacity of 500,000 gallons. Each tank is a Seismic Class II vertical, cylindrical carbon steel tank.

The five tanks described above are not protected from wind-driven missile hazards.

Each of the five tanks described above have external 2-1/2 hose connections that have been modified per ECP-15-000401 (Reference 35) to add female stainless steel camlock connectors for ease of hose connection for the hoses that will connect to the two FLEX hose manifolds.

Each FLEX trailer mounted hose manifold has one 3" NH (well water connection), four 4" camlock (tank connections) and 6" NH hose connections (12 CST, booster pump, and FLEX AFW pump connections) to accommodate the hoses connected to the surviving Tank Farm water storage tanks, to No. 11 well water pump, to the FLEX booster pump, and connection to 12 CST.

When the FLEX hose manifold trailers and FLEX booster pump arrive, minimum shift staff personnel from nuclear security, chemistry, and radiation protection under the direction of operations personnel will begin hose deployment. One operator and three personnel from chemistry, radiation protection, and/or security will deploy the 4" and 6" hoses from the two hose manifold trailers to the designated hose connection points on each water storage tank. Twenty foot and ten foot sections of

4" rigid hoses with camlock fittings connect 11 and 21 CST, 11 DWST, and 11 and 12 PWST to the two FLEX hose manifolds. Ten foot sections of 6" rigid hose with NH fittings connect 12 CST to the manifolds and the FLEX booster pump to manifold #1 and then to 12 CST. See FLEX Drawings Available Tank Farm Connections to 12 Condensate Storage Tank (Figure 14-7) for the various hose connections and hose run configurations.

FSG-06, Alternate CST Makeup (Reference 36) provides the actions for makeup to 12 CST from various sources of both condensate grade and low quality water.

For 12 CST makeup, a minimum of two tanks from a combination of 11 and 21 CST, 11 DWST, and 11 and 12 PWST must be connected to the two FLEX hose manifolds to supply sufficient suction head (Reference 37).

Based on timed validation, the hoses were deployed and connected to the six tanks, the two FLEX hose manifolds, and the FLEX booster pump in approximately 75 minutes (Reference 38). The FLEX hose manifold trailers are deployed in trip #2 from the FSRB at approximately 5 hours into the event such that hose deployment can begin while the FLEX booster pump is deployed to the Tank Farm in trip #3 approximately 30 minutes later. Connection of the water storage tank 4" hoses to FLEX hose manifold is completed in the last hour of Phase 1. Final connection of the 6" hoses and the FLEX booster pump is completed early in Phase 2.

3.6. Phase 2

During Phase 2, as in Phase 1, core cooling is maintained by steaming from the S/Gs via local manual operation of the ADVs and feeding S/Gs using TDAFW with suction from the fully protected 12 CST.

At the transition from Phase 1 to Phase 2 (At time 6 hours into the event) the RCS cooldown to approximately 340°F will just have been terminated. The cooldown is terminated when S/G pressure reaches 120 psia and RCS pressure is slightly above the 215 – 225 psig N_2 overpressure in the SITs. Per EOP-7, Appendix 1, ADV position and AFW flow rates are adjusted to maintain S/G pressure approximately 120 psia and RCS temperature of approximately 340°F. S/G level is maintained between (-) 24 and (+) 30 inches (normal S/G water level band). The TDAFW pumps can operate reliably provided there is >65 psia steam pressure in one of the S/Gs. Based on calculation CA07970, AFW Availability during ELAP (Reference 39), these conditions can be maintained for >24 hours. The results of this evaluation demonstrate that for various times up to 72 hours after shutdown the AFW pump will continue to supply adequate flow for decay heat removal at reduced S/G pressures.

Per EOP-7, if AFW flow is lost or cannot be established, then operators concurrently implement FSG-3, Alternate Low Pressure Feedwater and EOP-7. FSG-3 provides actions to establish an alternate low pressure source to feed S/Gs through the AFW system when the TDAFW are not available. In Phase 1, the FLEX AFW Pumps are deployed to the Tank Farm per FSG-5, Initial Assessment and FLEX Equipment Staging. FSG-3 provides the actions to connect the suction of the one FLEX AFW pump to each FLEX hose manifold using four ten foot sections of rigid 6" hose. 100 foot sections of 2.5-inch discharge hose are connected to each connection of the pump discharge duplex connection and then successive 100 foot sections are connected and routed south along the West Road to Auxiliary Building truck bay roll-up door 419. Inside door 419 the hoses are routed from the 45 foot elevation down an escape hatch ladder way to the 5 foot elevation. 100 foot sections of 2.5-inch hoses that are stored in FLEX dedicated hose storage boxes on the 5 foot elevation are connected to the hoses lowered down from the 45 foot elevation. These hoses are routed east up the east-west corridor of the Auxiliary Building to the FLEX hose connections on the Unit 1 and Unit 2 AFW Systems. The Unit 1 and 2 AFW Systems were modified per ECP-14-000087 and ECP-14-000089 (References 40 and 41) respectively to add a duplex FLEX hose connection on to each AFW motor train cross-connect header. The Unit 1 and 2 duplex FLEX hose connections are located on either side of the 5 foot elevation east-west corridor adjacent to the entrance way into the Component Cooling Water Heat Exchanger Rooms. The 2.5-inch hoses are connected to each leg of the duplex hose connection. Each FLEX AFW pump will have two 2.5-inch hose runs from the pump discharge along the West Road, into the Auxiliary Building to each unit's AFW system FLEX hose connections. See FLEX drawings Unit 1 S/G Makeup from Manifold (Preferred) (Figures 14-9 and 14-10) for more details. Alternate hose routes are provided through the Unit 1 and 2 Turbine buildings, into the Unit 1 and 2 Service Water Pump Rooms on the twelve foot elevation to post-event installed temporary connections at the discharge of 13 and 23 motor-driven AFW (MDAFW) pumps. See Figure 14-11, Alternate S/G Makeup Hose Connection Path.

3.6.1. Initial RCS Makeup and Boration

By lowering RCS temperature and therefore lowering pressure slightly, SIT injection into the RCS will begin from the four SITs. Important to this strategy is the ability to monitor SIT level and N_2 pressure in the control room. The instrument power supplies to the SIT level and pressure indicators have been modified per ECP-14-000024 and 000025 (References 42 and 43) such that the instruments are now powered from station battery backed vital 120 VAC instrument buses to provide control room operator reliable indication of Wide Range SIT level and pressure response. To prevent N_2 entry into the RCS, the ability to isolate SIT injection is an important action. The SITs have outlet isolation motor operated valves (MOV) that are remotely operated from the control room; however, the MOVs are without power from their associated reactor MCCs until the MCCs are repowered via FLEX DGs. By maintaining S/G pressure at approximately 120 psia SIT injection into the RCS is controlled affording operators the time needed for repower of the two vital reactor MCCs and the associated SIT outlet MOVs. SITs are isolated by shutting the outlet MOVs when pumped borated water injection method becomes available or before SIT level lowers to <10 inches.

EOP-7 Appendix 2, S/G Depressurization for Max SIT Injection, can be implemented if maximum SIT injection is required for borated makeup until pumped boration is available. EOP-7, Appendix 2 directs further plant cooldown until any SIT reaches a level of 10 inches or S/G pressure lowers to 75 psia.

3.6.2. <u>Long-term RCS Makeup and Boration</u>

Per FSG-1, Long Term RCS Inventory Control and FSG-8, Alternate RCS Boration (References 44 and 45), once one of the select vital 480 VAC load center for that unit is repowered, the installed charging pump associated with that load center is started to commence RCS refill and RCS boration. Per FSG-1, the target RCS level is 180 inches in the Pressurizer. Per FSG-8, the target RCS boron concentration is 2300 ppm.

- 11 Charging Pump (11B 480 VAC load center)
- 13 Charging Pump (14A 480 VAC load center)
- 21 Charging Pump (21B 480 VAC load center)
- 23 Charging Pump (24A 480 VAC load center)

The suction sources for the charging pumps are either:

- Boric Acid Storage Tanks (BAST, two per unit)
- Refueling Water Tank (RWT)

If an installed charging pump is not available, then the FLEX RCS Makeup Pump is used for RCS makeup and boration. The suction source for the FLEX RCS Makeup Pump is either unit's RWT. The FLEX RCS Makeup Pumps are deployed per FSG-

5, Initial Assessment and FLEX Equipment Staging into the PA to the West Road outside of 11 RWT and 21 RWT pump rooms respectively.

The FLEX RCS Makeup Pump is connected per FSG-1 and FSG-8 (References 44 and 45). The pump six inch suction hose is connected to the RWT at a new FLEX hose connection at each RWT. Each RWT's 8 inch line to the Spent Fuel Pool Cooling System has been modified per ECP-14-000100 and ECP-14-000102 (References 46 and 47) to install a 4 inch FLEX hose connection for the suction of the FLEX RCS Makeup Pump.

The two and one half inch discharge hose is connected to the pump discharge connection and then routed to the a new two inch FLEX hose connection on 12A high pressure safety injection (HPSI) header (Unit 1) and 22A HPSI header (Unit 2). The new two inch FLEX hose connections were installed on Unit 1 and 2 per ECPs-14-000100 and ECP-14-000102 (References 46 and 47) respectively. See Figures 14-12 Unit 1 FLEX RCS Makeup 45' Elevation and 14-13, Unit 1 FLEX RCS Makeup 27' Elevation.

The FLEX RCS Makeup Pump is operated per FSG-ATT, Attachment 104, FLEX RCS makeup Pump (Reference 48). Emergency Response Mechanical Maintenance personnel will connect and operate the FLEX RCS Makeup Pumps when needed.

3.6.3. Vital 480 VAC Load Center and 480 VAC Reactor MCC Repower

As described in Phase 1 for vital 480 VAC load center cable connection to a FLEX 500 KW DG, the first vital 480 VAC load center can be energized from a FLEX 500 KW DG in approximately 6.3 hours from time "0". The Load Center is energized following FLEX DG Connection and a short warm-up period. The second vital 480 VAC load center can be energized from the second 500 KW DG in approximately 6.9 hours from time "0". As each vital 480 VAC load center is energized, these supplied loads are started or re-energized in the following order:

1 – Battery Charger

2 – Vital reactor MCCs re-energized (MCCs-104R and -114R, -204R, and -214R)

3 – Charging pump

3.6.4. 12 CST Makeup

As described above in Phase 1, connection of the Tank Farm water storage tank 4" hoses to FLEX hose manifold is completed in the last hour of Phase 1. Final connection of the 6" hoses between 12 CST, the two hose manifold trailers, and the FLEX booster pump spans the Phase 1 and Phase 2 transition and is completed early in Phase 2.

Connection of the 6" hoses for the manifolds and the FLEX booster pump to 12 CST is accomplished via a specifically designed CST Connection Tool (FLEX hose connection "T") that mounts to the 12 CST demineralized water makeup line check valve 0-DW-283 bonnet. The CST Connection Tool is seismically stored inside of the 12 CST tornado building. The connection tool is manufactured of high-density poly and includes two manual isolation valves, a 6" female NH connection on one side of the "T" and a 6" male NH connection on the other side. The bottom of the "T" includes the mounting flange to mate up with the bolt pattern of the check valve bonnet (Reference 49). Installation of CST Connection Tool is directed by FSG-6, Alternate CST Makeup, Attachment 5, CST Connection Tool Installation (Reference 36). See Figures 14-7, 14-14 through 14-16: Available Tank Farm Connections to 12 CST; 12 CST Makeup From Well Water; and 12 CST Makeup From Chesapeake Bay for the CST Connection Tool, various hose connections, and hose run configurations. ERO Mechanical Maintenance (MM) Team personnel will install the CST Connection Tool. When ERO MM Team personnel arrive at the site installation of the CST Connection Tool is their first assigned priority task to be completed by time nine hours into the event. Validation table top determined that the CST Connection Tool can be installed in less than two hours as shown in the Sequence of Events in Table 9.1.

The FLEX Booster Pump is operated per FSG-ATT, Attachment 106, FLEX Booster Pump (Reference 48). ERO MM Team personnel will operate the FLEX Booster Pump.

FSG-6, Alternate CST Makeup directs the actions to align preferred and alternate sources water from water storage tanks, #11 Well, or from the Chesapeake Bay for 12 CST makeup. Makeup to 12 CST is provided to restore level as directed by Operations supervision to a level greater than at least five feet to ensure adequate TDAFW pump suction. If 12 CST level cannot be maintained greater than five feet then FSG-6 directs concurrent actions to select an alternate water source or initiate FSG-2, Alternate AFW Suction Source (Reference 28), or initiate FSG-3, Alternate Low Pressure Feedwater (Reference 50).

ECP-14-000376, Add Protected Connections to Wells to Improve Well Survivability in Severe Weather Events and provide 480 VAC Diesel Connection (Reference 27) established protection from wind-driven missiles for the #11 Well Pump motor, and hose connection.

Use of water from #11 Well, 11 and 12 Pretreated Water Storage Tanks, or the Chesapeake Bay (Ultimate Heat Sink) may have long-term detrimental effects on S/G heat transfer. Calculation CA10021, Calvert Cliffs Units 1 & 2 Steam Generator Fouling and Degraded Heat Transfer Analysis Through 72 Hours (Reference 51), using the Chesapeake Bay as the worst case water source concluded that S/G makeup using water from the Chesapeake Bay for 72 hours would only result in a 9.7% reduction in heat transfer capability.

Per calculation CA10021, the heat transfer capabilities of each steam generator will be reduced by 9.7% when using bay water from 10 to 72 hours following a BDBEE. The heat removal requirement at 1 hour for both units is 1.759×10^6 BTU/min, while the heat removal requirement at 72 hours is 5.785×10^5 BTU/min. Based on the difference in these heat removal requirements, the steam generators could lose 67% of their heat transfer capability and still meet the heat removal requirement at 72 hours. There remains significant margin in the heat transfer capability of the steam generators after 72 hours following a BDBEE. The bay water quality bounds well water quality in the analysis. Therefore, the results of the analysis bound any fouling or heat transfer degradation that could occur due to using well water as a source of secondary coolant within 72 hours post-event.

3.7. Phase 3

During Phase 3, as in Phases 1 and 2, core cooling is maintained by steaming from the S/Gs via local manual operation of the ADV and feeding S/Gs using TDAFW with suction from the fully protected 12 CST.

Per EOP-7, Appendix 1, ADV position and AFW flow rates are adjusted to maintain S/G pressure approximately 120 psia and RCS temperature of approximately 340°F. S/G level is maintained between (-) 24 and (+) 30 inches (normal S/G water level band). The TDAFW pumps can operate reliably provided there is greater than 65 psia steam pressure in one of the S/Gs. Based on calculation CA07970, AFW Availability During ELAP, these conditions can be maintained for up to 72 hours (Reference 39).

Per EOP-7, if AFW flow is lost or cannot be established, then FSG-3, Alternate Low Pressure Feedwater (Reference 50) is concurrently implemented. FSG-3 provides actions to establish an alternate low pressure source to feed S/Gs through the AFW system when the TDAFW are not available. The FLEX AFW Pumps are deployed to the Tank Farm per FSG-5, Initial Assessment and FLEX Equipment Staging (Reference 34).

3.7.1. Long-Term RCS Cooling

Operators take action per EOP-7 Appendix 3, S/G Depressurization For Long-Term Cooling, to control S/G level between (-) 24 and (+) 30 inches, isolate SITs, and then depressurize S/Gs to 75 psia (RCS temperature approximately 310°F). Conditions are then stabilized to maintain S/G pressure at approximately 75 psia and S/G level between (-) 24 and (+) 30 inches (Reference 17). If S/G pressure cannot be maintained greater than the 65 PSIA minimum pressure needed for TDAFW Pump operation, then FSG-9, Low Decay Heat Temperature Control (Reference 52) is implemented.

FSG-9, Low Decay Heat Temperature Control provides actions to stop RCS cooldown due to decay heat levels not adequate to allow continuous operation of the TDAFW pump for S/G makeup. FSG-9 directs intermittent use of the TDAFW pump if available or operation of the FLEX AFW pump per FSG-3, Alternate Low Pressure Feedwater to maintain S/G level above the top of the feed ring at (-) 40 to (+) 30 inches. FSG-9 provides correction graphs for determining actual S/G level versus indicated level when S/G temperature and pressure are low.

When activated, the NSRC will provide to CCNPP two (one per unit) 500 PSI, 500 GPM S/G Makeup Pumps, including suction and discharge hoses to provide backup to the onsite FLEX AFW pumps.

The CCNPP ERO TSC staff and operations shift management will determine and coordinate the use of the NSRC S/G Makeup Pumps.

3.7.2. Long-term RCS Makeup and Boration

Per FSG-1, Long Term RCS Inventory Control and FSG-8, Alternate RCS Boration (Reference 44 and 45), the installed charging pump associated with that unit is operated as needed to maintain pressurizer level. The suction source for the charging pump is either the BASTs or the RWT for the associated unit. Per FSG-1, the target RCS level band is 30 inches to 180 inches in the Pressurizer. RCS boration to 2300 ppm per FSG-8, Alternate RCS boration will be completed in Phase 2. If an installed charging pump is not available, then the FLEX RCS Makeup Pump taking suction on 11 or 21 RWT is operated as needed for RCS makeup and boration.

When activated, the NSRC will provide to CCNPP two (one per unit) 2000 PSI, 60 GPM High Pressure Injection Pumps, including suction and discharge hoses to provide backup to the onsite FLEX RCS Makeup pumps.

Also provided by the NSRC are two (one per unit) 1000 gallon Mobile Boration units. With the included 130 (55 pound) bags of boric acid, operators will be able to borate the RCS or replenish borated water volume in the RWTs (Reference 53).

The CCNPP ERO TSC staff and operations shift management will determine and coordinate the use and alignment of the NSRC High Pressure Injection Pumps and Mobile Boration units.

3.7.3. Vital 480 VAC Load Center and 480 VAC Reactor MCC Repower

As described in Phase 2 for vital 480 VAC load center repower from a FLEX 500 KW DG, the first and second vital 480 VAC load centers have been powered from the FLEX DG from approximately time 6.3 hours and 6.9 hours respectively. The following supplied loads have been placed in service:

1 – Two Battery Chargers

2 – Vital reactor MCCs re-energized (MCCs-104R and -114R, -204R, and -214R)

3 – A Charging pump on each unit

In Phase 3 expanded repower of the CCNPP class 1E electric distribution system will be established via medium voltage 4160 VAC, 1 MW gas turbine generators (GTG) and low voltage 480 VAC 1100 KW DGs provided from the NSRC. A total of four 4160 VAC, 1 MW GTGs and two 480 VAC 1100 KW DGs will be provided to CCNPP by the NSRC (Reference 53). Included for connection of pairs of 1 MW GTGs to each unit's class 1E distribution are two 4160 VAC, 1200 AMP distribution systems, one for each unit.

FSG-4, ELAP DC Bus Load Shed and Management, Attachment 12, Unit 1 NSRC Gas Turbine Generator Connection to 4KV Bus System (Reference 31) provides the direction for connection of the NSRC 4160 VAC, 1 MW GTGs and associated distribution system to 4160 VAC vital buses 14 (Unit 1) and 21 (Unit 2). Tie in to the class 1E 4160 VAC buses 14 and 21 are made at manual disconnects located on the output of the station Fairbanks Morse 1B and 2A emergency DGs respectively. The disconnects are located inside the 1B and 2A DG rooms. FSG-4, Attachments 14 and 15 (Reference 31) provide 4KV one line diagrams showing the NSRC 4KV GTG connection to the station 4KV buses.

Repower of vital 4160 VAC buses 14 and 21 allows power up of additional downstream vital 480 VAC load centers and start of equipment such as:

- Vital 480 VAC load centers 14B and 24B
- Additional battery chargers for instrumentation and control
- Additional charging pumps for RCS makeup
- Component cooling water (CC) pumps for restoration of RCS letdown to the chemical volume and control system (CVCS)
- Containment air coolers (CACs) for containment cooling

Additionally, either 14 4KV bus can be tied to 11 4KV bus or 21 4KV bus can be tied to 24 4KV bus via the station blackout diesel generator (0C DG) 4160 VAC distribution system. The 0C DG distribution system allows connection to any one of the four vital 4160 VAC class 1E buses via a network of manual disconnects and breakers. This interconnected system allows tying any two of the four vital 4160 VAC buses. This allows additional 4KV and downstream vital 480 VAC load centers on the associated unit to be repowered such as:

- Motor driven AFW pump (11 or 23 from 4KV buses 11 or 24)
- Vital 480 VAC load centers 11A and 21A

The NSRC 4160 VAC, 1 MW GTGs, as well as the NSRC 480 VAC, 1100 KW DGs, will replace and allow securing of the station's FLEX 500 KW and 100 KW DGs.

The CCNPP ERO TSC staff and operations shift management will determine and coordinate the use and alignment of the NSRC 1MW GTGs and 1100 KW DGs.

3.7.4. <u>12 CST Makeup</u>

FSG-6, Alternate CST Makeup directs the actions to align preferred and alternate sources water from water storage tanks, #11 Well, or from the Chesapeake Bay for 12 CST makeup. Makeup to 12 CST is provided to restore level as directed by Operations supervision to a level greater than at least five feet to ensure adequate TDAFW pump suction. If 12 CST level cannot be maintained greater than five feet then FSG-6 directs concurrent actions to select an alternate water source, initiate FSG-2, Alternate AFW Suction Source (Reference 28), or initiate FSG-3, Alternate Low Pressure Feedwater (Reference 50).

For long-term replenishment of S/G makeup water supply the NSRC will provide to CCNPP four water treatment units comprised of two 500 GPM pre-filter units and two 250 GPM reverse osmosis units. Included are various lengths and sizes of connection hoses. Also provided from the NSRC are four 20000 gallon water storage bladders (Reference 53).

The CCNPP ERO TSC staff and operations shift management will determine and coordinate the use and alignment of the NSRC supplied water treatment units and associated support equipment to replenish S/G makeup water in 12 CST or any other surviving water storage tank.

4. Maintain Core Cooling (Hot Standby, Hot Shutdown, Cold Shutdown – S/Gs Available, Modes 3 - 5)

4.1. Objectives

To maintain Core Cooling Modes 3 – 5 with S/Gs available requires heat removal via the S/G and sufficient makeup to maintain or restore S/G level to provide core cooling. Baseline capabilities include the use of installed plant and FLEX equipment for Phase 1, 2, and 3 coping strategies. Also, in Phase 3 CCNPP ERO TSC staff and operations shift management will determine and coordinate the use and alignment of the NSRC provided equipment.

Core inventory coping time is increased by performing an early and extensive RCS cooldown if RCS temperature is greater than 340°F.

FLEX guidance includes, if needed to back-up the installed TDAFW pumps, depressurizing the S/Gs for makeup with FLEX AFW Pump utilizing primary and alternate injection points. Analyses demonstrate that the guidance and equipment for combined S/G depressurization and makeup capability supports continued core cooling. Sustained, diversely located, sources of water are available and sufficient to supply S/G makeup water indefinitely.

4.2. Acceptance Criteria

No core damage will occur. Coping times have been determined such that they preclude core damage. Analysis has determined no core damage occurs including maintaining saturation conditions in the core region, keeping peak clad temperature below core melt limits, preventing clad rupture and maintaining two-phase water level above the top of the active fuel.

4.3. Strategies

NOTE: The core cooling strategy descriptions below are the same for Calvert Cliffs Nuclear Power Plant Unit 1 and Unit 2. Any differences and/or unit specific information is included where appropriate.

Maintain Core Cooling Modes 3 through 5 with S/Gs available encompasses the following strategies:

- TDAFW and ADVs maintained for core and RCS heat removal
- Deep DC load shed to extend station vital 125 VDC battery coping time for plant control and key reactor parameter monitoring

- Early RCS cooldown to extend RCS coping time (when RCS temperature is greater than 340°F)
- Vital 480 VAC load center repower via FLEX DGs for:
  - Vital instrument bus power and station battery recharging
  - RCS makeup and boration using installed charging pump
  - Reactor MCC repower for SIT isolation to prevent N_2 injection into the RCS
- 12 CST makeup via FLEX equipment and the following water sources:
  - 11 and 21 CSTs
  - 11 DWST
  - 11 and 12 PWSTs
  - Well Water
  - Chesapeake Bay (Ultimate Heat Sink)
- FLEX AFW pump deployed and connected ready to backup and then replace installed TDAFW for S/G makeup (a FLEX AFW pump may also be used for RCS makeup)
- FLEX RCS Makeup pump deployed and connected ready to backup installed charging system pump for RCS makeup and boration.

The strategy for Maintain Core Cooling from initial unit operation in Modes 3 through 5 when S/Gs are available is to maintain heat removal using the S/Gs via TDAFW and steaming to atmosphere via the ADV. The RCS is intact and is pressurized or is capable of being pressurized.

The attributes and use of the AFW system and TDAFW pumps taking suction from the fully protected 12 CST are the same as for event response initiated from Mode 1 or 2.

Initial SDM is established and maintained per CCNPP Technical Specification (TS) requirements for plant operation in Modes 3 through 5. The assumed RCS boron concentration is between Mode 3 TS boron concentration requirements to as high as TS refueling boron concentration.

To accommodate a unit on Shutdown Cooling (SDC), CCNPP AOP-3B, Abnormal Shutdown Cooling Conditions has been revised to incorporate the Combustion Engineering Abnormal Procedure Guideline A1, Station Blackout While Shutdown Guideline, Rev 0.0 dated 12/23/2014 (Reference 54). FSG-14, Shutdown RCS Makeup (Reference 55) has also been implemented.

Deployment of FLEX equipment should commence immediately from the time of the event. This is achievable due to the significantly larger number of personnel onsite during outages to provide the necessary resources to aid in FLEX equipment deployment, debris removal, area access, FLEX equipment connection, and FLEX equipment operation.

Exelon fleet procedure OU-AA-103, Shutdown Safety Management Program (Reference 56) provides for use of FLEX equipment when developing shutdown safety contingency plans. Contingency plans are implemented to maintain shutdown safety defense in-depth by alternate means. If FLEX equipment will be used to support a shutdown safety contingency plan consideration should be given to pre-staging the equipment, particularly those outage work windows where RCS time to boil and core uncovery are relatively short. If FLEX equipment is pre-staged, it is preferable that the "+1" equipment be used.

CCNPP procedure CC-CA-118, Calvert Cliffs Implementation of Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program (Reference 17), Section 5, Implementation in All Modes provides additional discussion of outage risk mitigation via FLEX equipment pre-deployment.

Key reactor parameter instrumentation will be maintained by the 125 VDC station batteries. Station battery coping will be extended by performing DC load shedding.

RCS level monitoring has been enhanced by providing a FLEX power source to the RCS wide range level monitoring system. The RCS wide range level monitoring system which is part of the Refueling Level Cart that is placed in service per plant cooldown procedures. The RCS wide range level monitoring system has a 30 minute uninterruptable power supply (UPS). ECP-14-000024 (Reference 42) provided a dedicated connection panel and 120 VAC wall outlets for RCS wide range level monitoring system repower from a 5500W FLEX DG.

4.4. Key Reactor Parameters

Table 4.4 identifies the Key Reactor and Plant Parameters, the specific instrument identifier, and location available to operators in an ELAP event.

Table 4.4: Key Reactor and Plant Parameters, Modes 3 – 5, S/G Available

Key Parameter	**Instrument**	**Location**
S/G Pressure	PI-1013/1023A - D	Control Room
S/G Level	LI-1114/1124A - D	Control Room
RCS Subcooled Margin	PAMS A & B	Control Room
Core Exit Temperature	PAMS A& B	Control Room
RCS Hot Leg Temperature	TI-112H/122H	Control Room
RCS Hot Leg Temperature	TI-112C/T122C	Control Room
Pressurizer Level	LI-110X-1/110Y-1	Control Room
Wide Range Pressurizer Level	LI-103-1	Control Room
Pressurizer Wide Range Pressure	PI-105/105A	Control Room
Pressurizer Narrow Range Pressure	PI-103/PI-103-1	Control Room
Reactor Vessel Level	Reactor Vessel Level Monitoring System (RVLMS) PAMS A & B	Control Room
RCS/RFP Wide Range Level (Mansell Level Monitoring System)	LI-4136 and 4137 (Refueling Level Cart)	Control Room
SIT Wide Range Level	LI-311, 321, 331, 341	Control Room
SIT Wide Range Pressure	PI-311, 321, 331, 341	Control Room
Wide Range Log Power	JI-001, 002, 003, 004	Control Room
AFW Steam Train Flow	FIC-4511A and FIC-4512A	Control Room
AFW Motor Train Flow	FIC-4525A and FIC-4535A	Control Room

Key Parameter	**Instrument**	**Location**
12 CST Level	LIA-5610/LI-5611	Control Room
Refueling Water Tank Level	LIA-4143	Control Room
Boric Acid Storage Tank Level	LIA-206/LIA-208	Control Room
11, 12, 21, 22 Vital DC Bus Voltage	EI-211, 212, 221, 222	Control Room
11. 12, 13, 14 Vital AC Instrument Bus Voltage	EI-1911, 1912, 1913, 1914	Control Room
21. 22, 23, 24 Vital AC Instrument Bus Voltage	EI-1921, 1922, 1923, 1924	Control Room
11, 12, 21, 22 Vital Battery Amps	II-201, 202, 204, 205	Control Room
TDAFW Pump Steam Supply Pressure	PI-3986, PI-3988	Local at TDAFW Pump
TDAFW Pump Discharge Pressure	PI-4501, PI-4502	Local at TDAFW Pump
11 and 21 CST Level	Thermography gun or portable instrument	Local at tank
11 DWST Level	Thermography gun or portable instrument	Local at tank
11 and 21 PWST Level	Thermography gun or portable instrument	Local at tank

4.5. Phase 1

At event time "0", the LOOP will be indicated by a loss of main control room normal lighting on both units, 500 KV Red Bus and Black Bus power available lights de-energized, 13 KV Service Buses 12 and 22 power available lights de-energized, alarms for loss of RCS flow if RCPs had been operating, and various alarms associated with DG start failures.

At the initiation of the LOOP and given the above indications/entry conditions, control room operators will enter AOP-3F, Loss of Offsite Power While in Modes 3, 4, 5, or 6 (Reference 57). AOP-3F directed actions will be taken to protect the main condenser from over pressurization and minimize S/G inventory loss.

Control room operators check vital 4KV bus (Unit 1 – 11 or 14 Bus and Unit 2 – 21 or 24 Bus) energized state. If both buses are de-energized on a unit, actions are attempted to re-energize at least one vital 4KV bus on each unit.

If DGs are not available and the unit is not on SDC, then EOP-7, Station Blackout (Reference 26) is implemented. EOP-7 directed actions will be taken to minimize RCS inventory loss and maintain an RCS heat sink using TDAFW and ADVs. The remainder of event response per EOP-7 for the unit in Mode 3 – 5 with S/Gs available will be as previously described for Mode 1 and 2 ELAP. If RCS temperature is greater than 340°F, then a RCS cooldown to 340°F is performed as described in Phase 1 Mode 1 and 2 ELAP response.

If DGs are not available, and the unit is on SDC, then AOP-3B, Abnormal Shutdown Cooling Conditions (Reference 58) is implemented.

At CCNPP, placing a unit on SDC is coordinated from a plant cooldown operating procedure (OP) and a SDC operating instruction (OI). Low pressure Safety Injection System (SIS) valve re-alignment for SDC is commenced when RCS pressure is less than 1750 psia. SDC is placed in service with a low pressure safety injection (LPSI) pump when RCS temperature and pressure are less than 250°F and 250 psia respectively.

Per AOP-3B, if one vital 4KV bus cannot be energized within one hour of the station blackout initiation or power is not likely to be restored, then ELAP is determined. Following ELAP determination, operators initiate actions for ELAP response per AOP-3B, Appendix 1 ELAP Actions (Reference 58).

Phase 1 actions for deep DC load shed, FLEX equipment deployment, alignment and cable deployment for vital 480V load center and vital 480 VAC reactor MCC repower, and alignment for 12 CST makeup are as previously described for Mode 1 and 2 ELAP response.

Since a S/G can be made available, decay heat is removed via the S/Gs. AOP-3B, Appendix 1 directs actions to ensure the RCS can be pressurized, a S/G can be pressurized and has level indication, and that a TDAFW feed flow path and steam release path via ADVs can be made available.

The preferred AFW alignment for S/G makeup is a TDAFW pump with suction from the fully protected 12 CST. S/G pressure must be at least 65 psia for TDAFW pump operation. If a TDAFW pump is available and S/G pressure is less than 65 psia, then the ADVs are adjusted to allow the RCS to heatup to raise S/G pressure to between 65 psia and 120 psia. If a TDAFW pump is not available, then AOP-3B directs implementation of FSG-3, Alternate Low Pressure Feedwater (Reference 50). The target S/G water level established is (-) 40 inches to (+) 30 inches.

ADVs are adjusted to establish RCS natural circulation flow conditions. AOP-3B, Appendix 1 also provides actions when the RCS side of the S/G tubes have been drained and air is trapped in the S/G tubes. ADVs are operated as needed for a higher RCS temperature and pressure for initiation of RCS natural circulation flow.

4.6. Phase 2

During Phase 2, as in Phase 1, core cooling is maintained by steaming from the S/Gs via local manual operation of the ADVs and feeding S/Gs using TDAFW with suction from the fully protected 12 CST.

Phase 2 actions for FLEX equipment deployment, repower of vital 480V load center and vital 480 VAC reactor MCC repower from FLEX DGs, start of 12 CST makeup, and use of makeup water sources for 12 CST are as described previously for Mode 1 and 2 ELAP response Phase 2.

4.6.1. RCS Makeup and Boration

Per AOP-3B, Appendix 1, FSG-14, Shutdown RCS Makeup is initiated to establish RCS makeup flow paths. RCS makeup capability is evaluated using a makeup decision chart attachment. RCS preferred and alternate makeup sources are selected based on RCS pressure greater than or less than 260 psia and S/Gs available for cooling. Method and sources:

- Installed charging pump with suction from BASTs or RWT (requires vital 480 VAC load center repowered) – 44 GPM makeup flow rate
- FLEX RCS Makeup pump with suction from Unit 1 or Unit 2 RWT – 80 GPM makeup flow rate
- FLEX AFW Makeup pump with suction from Unit 1 or Unit 2 RWT – Greater than 100 GPM makeup flow rate
- SITs, if pumped RCS injection is not available.

Use of SITs for RCS makeup provides a limited capability until pumped injection can be made available. SIT N_2 pressure must be greater than RCS pressure.

4.7. Phase 3

During Phase 3, as in Phases 1 and 2, core cooling is maintained by steaming from the S/Gs via local manual operation of the ADV and feeding S/Gs using TDAFW with suction from the fully protected 12 CST.

Operators will use site installed and FLEX equipment for long-term RCS cooling, RCS makeup and boration, 480 VAC load center and 480 VAC Reactor MCC repower, and 12 CST makeup as previously described for Mode 1 and 2 Phase 3 ELAP response.

When activated, the NSRC will provide equipment to CCNPP as previously described for Mode 1 and 2 Phase 3 ELAP response.

The CCNPP ERO TSC staff and operations shift management will determine and coordinate the use of the NSRC provided equipment

5. Maintain Core Cooling (Cold Shutdown – No S/Gs Available, and Refueling, Modes 5 and 6)

5.1. Objectives

Maintain Core Cooling Mode 5 Cold Shutdown – No S/Gs Available, and Mode 6 Refueling requires heat removal via the Refueling Pool (RFP) or via RCS boil off to Containment. Sufficient makeup water will be required to fill or makeup to the RFP, or provide for gravity feed or injection into the RCS with flow out any RCS openings to provide core cooling. Baseline capabilities include the use of installed plant and FLEX equipment for Phase 1, 2, and 3 coping strategies. Also, in Phase 3 CCNPP ERO TSC staff and operations shift management will determine and coordinate the use and alignment of the NSRC provided equipment.

5.2. Acceptance Criteria

No core damage will occur. Coping times have been determined such that they preclude core damage. Analysis determined no core damage occurs including maintaining saturation conditions in the core region, keeping peak clad temperature below core melt limits, preventing clad rupture and maintaining two-phase water level above the top of the active fuel.

5.3. Strategies

NOTE: The core cooling strategy descriptions below are the same for Calvert Cliffs Nuclear Power Plant Unit 1 and Unit 2. Any differences and/or unit specific information is included where appropriate.

Maintain Core Cooling Mode 5 Cold Shutdown – No S/Gs Available, and Mode 6 Refueling encompass the following strategies:

- Deep DC load shed to extend station vital 125 VDC battery coping time for plant control and key reactor parameter monitoring
- Vital 480 VAC load center repower via FLEX DGs for:
  - Vital instrument bus power and station battery recharging
  - RCS makeup and boration using installed charging pump
  - Reactor MCC repower for SIT outlet MOV operation
- 12 CST makeup via FLEX equipment and the following water sources:

  - 11 and 21 CSTs
  - 11 DWST
  - 11 and 12 PWSTs
  - Well Water
  - Chesapeake Bay (Ultimate Heat Sink)

- FLEX Alternate AFW pump deployed and connected ready to backup installed charging system pump for RCS makeup or for RFP makeup.
- FLEX RCS Makeup pump deployed and connected ready to backup installed charging system pump for RCS makeup and boration.

The strategy for Maintain Core Cooling Mode 5 Cold Shutdown – No S/Gs Available, and Mode 6 Refueling is determined by 1) the capability of the RCS to be pressurized and 2) reactor vessel head not installed and RFP available as a heat sink.

If the RCS cannot be pressurized, then decay heat is removed via RCS boil-off. If the reactor vessel head is not installed and the RFP can be filled, then decay heat is removed via the RFP.

Initial SDM is established and maintained per CCNPP TS requirements for plant operation in Modes 5 and 6. The assumed initial RCS boron concentration is between Mode 5 TS boron concentration requirements to as high as Mode 6 TS refueling boron concentration.

To accommodate a unit on SDC, CCNPP Abnormal Operating Procedure (AOP) – 3B, Abnormal Shutdown Cooling Conditions has been revised to incorporate the CE Abnormal Procedure Guideline A1, Station Blackout While Shutdown Guideline, Rev 0.0 dated 12/23/2014 (Reference 54). FSG-14, Shutdown RCS Makeup (Reference 55) has also been implemented.

Deployment of FLEX equipment should commence immediately from the time of the event. This is achievable due to the significantly larger number of personnel onsite during outages to provide the necessary resources to aid in FLEX equipment deployment, debris removal, area access, FLEX equipment connection, and FLEX equipment operation.

Exelon fleet procedure OU-AA-103, Shutdown Safety Management Program (Reference 56) provides for use of FLEX equipment when developing shutdown safety contingency plans. Contingency plans are implemented to maintain shutdown safety defense in-depth by alternate means. If FLEX equipment will be used to support a shutdown safety contingency plan consideration should be given to pre-staging the equipment, particularly those outage work windows where RCS time to boil and core uncovery are relatively short. If FLEX equipment is pre-staged, it is preferable that the "+1" equipment be used.

CCNPP procedure CC-CA-118, Calvert Cliffs Implementation of Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program (Reference 17), Section 4.2.4.5, Implementation in All Modes provides additional discussion of outage risk mitigation via FLEX equipment pre-deployment.

Key reactor parameter instrumentation will be maintained by the 125 VDC station batteries. Station battery coping will be extended by performing DC load shedding.

During lower modes of operation RCS level is monitored via wide range compensated and uncompensated pressurizer level indication channels, Reactor Vessel Level Monitoring System (RVLMS), and/or the RCS wide range Mansell Level Monitoring System (MLMS).

RCS level monitoring has been enhanced by providing a FLEX power source to the RCS wide range level monitoring system. The MLMS, which is part of the Refueling Level Cart, is placed in service per plant cooldown procedures. The MLMS is normally powered from a dedicated control room 120 VAC outlet, plus the system has a 30 minute uninterruptable power supply (UPS). ECP-14-000024 (Reference 42) provided a dedicated connection panel and 120 VAC wall outlets for MLMS repower from a 5500W FLEX DG.

5.4. Key Reactor Parameters

Table 5.4 identifies the Key Reactor and Plant Parameters, the specific instrument identifier, and location available to operators in an ELAP event.

Table 5.4: Key Reactor and Plant Parameters, Modes 5 and 6, No S/G Available

Key Parameter	Instrument	Location
RCS Subcooled Margin	PAMS A & B	Control Room
Core Exit Temperature	PAMS A& B	Control Room

Key Parameter	**Instrument**	**Location**
RCS Hot Leg Temperature	TI-112H/122H	Control Room
RCS Hot Leg Temperature	TI-112C/T122C	Control Room
Pressurizer Level	LI-110X-1/110Y-1	Control Room
Wide Range Pressurizer Level	LI-103-1	Control Room
Pressurizer Wide Range Pressure	PI-105 and PI-105A	Control Room
Pressurizer Narrow Range Pressure	PI-103/PI-103-1	Control Room
Reactor Vessel Level	Reactor Vessel Level Monitoring System (RVLMS) PAMS A & B	Control Room
RCS/RFP Wide Range Level (Mansell Level Monitoring System)	LI-4136 and 4137 (Refueling Level Cart)	Control Room
Wide Range SFP Level	LI-2003/2003A/2004/2004A	45 Ft Switchgear Room and Auxiliary Building
Containment Wide Range Water Level	LI-4146/4147	Control Room
SIT Wide Range Level	LI-311, 321, 331, 341	Control Room
SIT Wide Range Pressure	PI-311, 321, 331, 341	Control Room
Wide Range Log Power	JI-001, 002, 003, 004	Control Room
12 CST Level	LIA-5610/LI-5611	Control Room
Refueling Water Tank Level	LIA-4143	Control Room
Boric Acid Storage Tank Level	LIA-206/LIA-208	Control Room
11, 12, 21, 22 Vital DC Bus Voltage	EI-211, 212, 221, 222	Control Room
11. 12, 13, 14 Vital AC Instrument Bus Voltage	EI-1911, 1912, 1913, 1914	Control Room
21. 22, 23, 24 Vital AC Instrument Bus Voltage	EI-1921, 1922, 1923, 1924	Control Room

Key Parameter	Instrument	Location
11, 12, 21, 22 Vital Battery Amps	II-201, 202, 204, 205	Control Room
11 and 21 CST Level	Thermography gun or portable instrument	Local at tank
11 DWST Level	Thermography gun or portable instrument	Local at tank
11 and 21 PWST Level	Thermography gun or portable instrument	Local at tank

5.5. Phase 1

At event time "0", the LOOP will be indicated by a loss of main control room normal lighting on both units, 500 KV Red Bus and Black Bus power available lights de-energized, 13 KV Service Buses 12 and 22 power available lights de-energized, and various alarms associated with DG start failures.

At the initiation of the LOOP and given the above indications/entry conditions, control room operators will enter AOP-3F, Loss of Offsite Power While in Modes 3, 4, 5, or 6 (Reference 57).

Control room operators check vital 4KV bus (Unit 1 – 11 or 14 Bus and Unit 2 – 21 or 24 Bus) energized state. If both buses are de-energized on a unit, actions are attempted to re-energize at least one vital 4KV bus on each unit.

In the cold shutdown (Mode 5) or Refueling (Mode 6) conditions, prior to the event and depending on the time after shutdown, either one or two SDC loops will be in operation providing core cooling. The ELAP will result in loss of power for the low pressure safety injection (LPSI) pumps providing core cooling flow and the loss of the component cooling water (CCW) pumps providing cooling flow to the SDC heat exchangers. In addition, the saltwater (SW) pumps that providing cooling water flow from the Ultimate Heat Sink (UHS) (Chesapeake Bay) to the CCW heat exchangers will lose power.

If the station installed DGs are not available, and the unit is on SDC, then AOP-3B, Abnormal Shutdown Cooling Conditions (Reference 58) is implemented.

Per AOP-3B Section IV, Preliminary actions, personnel will be evacuated from containment and containment closure will be established. AOP-3B Preliminary actions are implemented concurrent with actions described below in AOP-3B Section IX.

If fuel handling is in progress, then any fuel assembly being handled will be placed in a safe condition. The fuel transfer carriage will be returned to the Spent Fuel Pool (SFP) and the fuel transfer tube gate will be closed. Because of the loss of power the Fuel Transfer System will have to be manually operated per station operating instructions for the Fuel Transfer System.

If the Refueling Level Cart is installed, and power cannot be restored to at least one 4KV bus, and ELAP is declared, then steps are initiated to provide FLEX DG power to the Refueling Level Cart per FSG-5, Initial Assessment and FLEX equipment Staging (Reference 34).

AOP-3B Section IX, Complete Loss of SDC Due to the Loss of 4KV Power Supplies addresses loss of both vital 4KV buses on a unit (Station Blackout). Actions are implemented to secure any RCS draining evolutions to conserve RCS inventory.

Per AOP-3B, if one vital 4KV bus cannot be energized within one hour of the station blackout initiation or power is not likely to be restored, then ELAP is determined. Following ELAP determination, operators initiate actions for ELAP response per AOP-3B, Appendix 1 ELAP Actions (Reference 58).

Phase 1 actions for deep DC load shed, FLEX equipment deployment, and alignment of and cable deployment for vital 480V load center and vital 480 VAC reactor MCC repower are as previously described for Mode 1 and 2 ELAP response.

Per AOP-3B, Appendix 1 the RCS cooling method is evaluated by assessing the ability to pressurize the RCS:

- Reactor vessel head installed and tensioned
- Pressurizer manway installed
- Pressurizer piloted operated relief valves (PORVs) and safety valves installed and closed

If the RCS cannot be pressurized, then decay heat is removed via RCS boil-off.

If the reactor vessel head is not installed and the RFP can be filled, then decay heat is removed via the RFP.

5.5.1. Decay Heat Removal Via RCS Boil Off

AOP-3B, Appendix 1 directs implementation of FSG-14, Shutdown RCS Makeup (Reference 55). FSG-14 provides instructions for makeup to the RCS using either pumped makeup or gravity fill from the RWT.

Using the actions directed by FSG-14 RCS level is established and maintained between the middle and bottom of the RCS hot legs. This level band corresponds to the 50 inch and 29 inch lights on the Reactor Vessel Level Monitoring System or 37.33 feet and 35.58 feet on the Mansell Level Monitoring System.

Per FSG-14, RCS makeup capability is evaluated using a makeup decision chart attachment. RCS preferred and alternate makeup sources are selected based on RCS vented with reactor vessel head installed. Method and sources include:

- Gravity fill from RWT – flow path through a LPSI pump
- Installed charging pump with suction from BASTs or RWT (requires vital 480 VAC load center repowered) – 44 GPM makeup flow rate
- FLEX RCS Makeup pump with suction from Unit 1 or Unit 2 RWT and discharge connected to HPSI header FLEX hose connection – 80 GPM makeup flow rate. Refer to FSG-14, Attachment 20, Unit 1 FLEX RCS Makeup Using 11 RWT As Suction Source (Reference 55) for hose connections and routing.
- FLEX AFW Makeup pump with suction from Unit 1 or Unit 2 RWT and discharge connected to HPSI header FLEX hose connection – 770 GPM makeup flow rate. Refer to FSG-14, Attachment 22, Unit 1 FLEX AFW Pump RCS Makeup (Reference 55) for hose connections and routing.
- SITs, if pumped RCS injection is not available.

The RWTs are 420,000 gallon stainless steel seismic Category 1 water storage tanks. However, the RWTs are not protected from wind-driven missiles. TS minimum volume is 400, 000 gallons of water borated to an administrative limit 2500 to 2700 ppm.

Use of SITs for RCS makeup provides a limited capability until pumped injection can be made available. SIT N_2 pressure must be greater than RCS pressure. Use of the SITs also requires SIT volume greater than 10 inches and outlet MOVs open or power available to open the outlet MOVs.

Makeup to the RCS is controlled to limit inventory loss via any existing RCS openings. During the loss of power RCS inventory loss to the containment floor will not be recoverable. The makeup flow rate is also controlled to prevent water from being forced into the pressurizer, which results in raising RCS pressure and reduces the ability to gravity feed.

A containment vent path is established to prevent containment pressure build up which can restrict RCS makeup via RWT gravity fill or pumped injection.

5.5.2. Decay Heat Removal Via RFP

AOP-3B, Appendix 1 directs implementation of FSG-14, Shutdown RCS Makeup. Makeup for the RFP is normally directly to the RCS/RFP using direction in FSG-14. If unable to makeup to the RFP, then guidance in FSG-14 provides instruction for using makeup to the SFP to makeup to the RFP through the Fuel Transfer Tube Gate Valve.

Using the actions directed by FSG-14 RFP level is restored to and maintained between 60 foot and 67 foot elevation. The RFP is allowed to steam down to 60 feet and then makeup is re-initiated to refill the RFP to 67 feet.

Per FSG-14, RFP makeup capability is evaluated using a makeup decision chart attachment. RFP preferred and alternate makeup sources are selected based on equipment availability. Method and sources include:

- Installed charging pump with suction from BASTs or RWT for RCS/RFP makeup (requires vital 480 VAC load center repowered) – 44 GPM makeup flow rate

- FLEX RCS Makeup pump with suction from Unit 1 or Unit 2 RWT and discharge connected to HPSI header FLEX hose connection for RCS/RFP makeup – 80 gpm makeup flow rate. Refer to FSG-14, Attachment 20, Unit 1 FLEX RCS Makeup Using 11 RWT as Suction Source (Reference 55) for hose connections and routing.

- FLEX AFW Makeup pump for RCS direct makeup with suction from Unit 1 or Unit 2 RWT and discharge connected to HPSI header FLEX hose connection for RCS/RFP makeup – >125 gpm makeup flow rate. Refer to FSG-14, Attachment 22, Unit 1 FLEX AFW Pump RCS Makeup (Reference 55) for hose connections and routing.

- FLEX AFW Makeup pump for RFP or SFP makeup with suction from any available Tank Farm water storage tank, well water, or the Chesapeake Bay – 251 GPM makeup flow rate. The pump discharge hose is connected to the FLEX SFP Makeup spool piece installed in the SFP heat exchanger room (Reference 59).
- FLEX SFP Makeup pump for SFP makeup per FSG-11, Alternate SFP Makeup and Cooling (Reference 60).
- SITs, if pumped RCS injection is not available.

The RWTs are 420,000 gallon stainless steel seismic Category 1 water storage tanks. However, the RWTs are not protected from wind-driven missiles. TS minimum volume is 400,000 gallons of water borated to an administrative limit of 2500 to 2700 ppm.

Use of SITs for RCS makeup provides a limited capability until pumped injection can be made available. SIT N_2 pressure must be greater than RCS pressure. Also requires SIT volume greater than 10 inches and outlet MOVs open or power available to open the outlet MOVs.

A containment vent path is established to prevent containment pressure build up which can restrict pumped injection.

5.6. Phase 2

During Phase 2, as in Phase 1, core cooling is maintained via RFP steaming and makeup.

Phase 2 actions for FLEX equipment deployment, repower of vital 480V load center and vital 480 VAC reactor MCC repower from FLEX DGs, and use of FLEX equipment for RCS cooling, RCS makeup and boration, RFP makeup are as described previously for Mode 1 and 2 ELAP response Phase 2.

5.7. Phase 3

During Phase 3, as in Phase 2, core cooling is maintained via RFP steaming and makeup.

Phase 3 actions include use of site installed and FLEX equipment for long-term RCS cooling, RCS makeup and boration, RFP makeup, 480 VAC load center and 480 VAC Reactor MCC repower are as previously described for Mode 1 and 2 Phase 3 ELAP response.

When activated, the NSRC will provide equipment to CCNPP as previously described for Mode 1 and 2 Phase 3 ELAP response. The repower of additional vital 480 VAC load centers via NSRC medium voltage GTGs or low voltage DGs will allow restart of additional charging pumps and SFP Cooling System for cooling RFP with a SFP pump and heat exchanger.

The CCNPP ERO TSC staff and operations shift management will determine and coordinate the use of the NSRC provided equipment

6. Maintain Containment

6.1. Objectives

Provide redundant means of monitoring containment environment conditions as the containment heats up and pressure increases by providing the control room operators the reliable temperature instrumentation to monitor containment temperature.

Provide method for reducing containment pressure and temperature utilizing existing plant equipment as well as equipment delivered from the NSRC.

6.2. Acceptance Criteria

Containment integrity is maintained. Containment design temperature (276°F) and pressure limit (50 psig) are not challenged

6.3. Strategies

NOTE: The maintain containment strategy descriptions below are the same for Calvert Cliffs Nuclear Power Plant Unit 1 and Unit 2. Any differences and/or unit specific information is included where appropriate.

The Phase 1 through 3 strategies for "Maintain Containment" is to verify containment integrity and monitor containment parameters. No portable equipment is required to maintain containment in Phases 1 and 2.

6.4. Key Containment Parameters

Table 6.4 identifies the Key Containment Parameters, the specific instrument identifier, and location available to operators in an ELAP event.

Table 6.4: Key Containment Parameters

Key Parameter	**Instrument**	**Location**
Containment wide range pressure	PI-5307 and PI-5310	Control Room
Containment Dome Temperature	TI-5309	Control Room
Reactor Cavity Temperature	TI-5311	Control Room

6.5. Phase 1

During Phase 1, containment integrity is maintained by normal design features of the containment, such as the containment isolation valves. In accordance with NEI-12-06 (Reference 3), the containment is assumed to be isolated following the event. Per EOP-7, Station Blackout (Reference 26), Block Step N, operators are directed to ensure containment integrity. The containment isolation valves are verified shut in order to ensure containment integrity. Per EOP-7 Technical Basis (Reference 61), containment integrity is verified to the extent required by NUREG 1.155, Station Blackout (Reference 62).

Early in the response to Containment cooling, air lines that penetrate Containment to supply loads inside Containment are isolated. Any air leakage from these lines will add to the post-ELAP pressurization of Containment, increasing the likelihood of releases from Containment to the environment and reducing the length of time to reach Containment design pressure. Therefore, any non-essential air lines supplying loads inside Containment are isolated to preclude this possibility (Reference 63).

Due to the loss of power to the Containment Air Cooling (CAC) Units and loss of flow in the Service Water Cooling System (SRW) that supplies cooling water to the CAC heat exchangers, and loss of the UHS, the containment will begin to heat up and pressurize from sensible heat transferred from the Nuclear Steam Supply System components.

Containment narrow range pressure, Containment wide range pressure, and Containment Dome temperature can be monitored in the Control Room at panel 1C09. Containment Reactor Cavity Temperature can be monitored at panel 1C10. Containment narrow and wide range pressure is powered from a vital 120 VAC power supply. Originally, Unit 1 and 2 Containment Dome and Reactor Cavity temperatures were powered from a non-vital 120 VAC power supply (Unit 1 – 1Y10, Unit 2 – 2Y10). ECP-14-000025, FLEX Instrument Re-power (Unit 1) (Reference 43) and ECP-14-000024, FLEX Instrument Re-power Modification (Unit 2) (Reference 42), moved the power supply for Containment Dome and Reactor Cavity temperatures to vital 120 VAC power supplies (Unit 1 – 1Y02, Unit 2 – 2Y02). With these Containment parameters powered by vital 120 VAC, Containment temperature and pressure can be monitored during a blackout situation.

The containment concrete surface design temperature is 276 °F (Reference 7 Section 5.1.1 and Section 14.20). Per CCNPP Station Blackout Analysis (Reference 64), containment temperature is predicted to reach 185°F at four (4) hours into the event. Containment temperature is expected to rise from nominal summer temperature of 115°F and stabilize at a temperature well below 276°F.

The containment design pressure is 50 psig (Reference 7). Containment pressure limits are not expected to be approached during the event.

Calculation CA07961, Analysis of Containment Response to Extended Loss of AC Power (Reference 65), evaluated the containment temperature and pressure response over a period of 72 hours, considering situations with and without RCS cooldown as well as with and without restoration of containment air cooling. The result of Case D1 (RCS cooldown with high RCS leakage, no Containment Air Cooler, No Containment Spray) illustrated that 72 hours after loss of all AC power, Containment pressure and temperature will NOT reach the design limits of 50 psig and 276°F. Under Case D1, peak pressure reaches 10 psig and temperature reaches 200°F.

CCNPP utilized industry developed guidance from the Westinghouse Owners Group, EPRI and NEI Task team to develop site specific procedures or guidelines to address the criteria in NEI 12-06 (Reference 3). These guidelines (FSGs) support the existing symptom based command and control strategies in the EOP-7, Station Blackout (Reference 26), and AOP-3B, Abnormal Shutdown Cooling Conditions (Reference 58). Both procedures direct the implementation of FSG-12, Alternate Containment Cooling, (Reference 63) to maintain containment temperature and pressure within design limits.

CCNPP EOP-7, Station Blackout (Reference 17), directs operators to verify containment isolation to ensure containment integrity. Both EOP-7 (Reference 17) and AOP-3B (Reference 58) direct the implementation of FSG-12, Alternate Containment Cooling (Reference 63), if Containment pressure rises to 50 psig or Containment temperature increases to 250°F.

6.6. Phase 2

Phase 2 strategy for containment integrity is to continue monitoring containment parameters. The RCS cooldown to a temperature of 340°F performed in Phase 1 for Core Cooling is assumed to have a positive effect on containment temperature and pressure. If the event occurs while the unit is on Shutdown Cooling, RCS temperature will already be below 340°F.

Actions taken in Phase 1 to strip loads off of the 125 VDC batteries as detailed in FSG-4, ELAP DC Bus Load Shed and Management, (Reference 31) will extend battery life past seven hours to provide time for connection of the FLEX Diesel Generator to the 480 VAC buses which power the battery chargers.

If containment pressure should rise, the following options are available:

- If the unit was originally in Modes 1 to 4 when the event occurs, then either of the following can be done to lower Containment pressure with noted conditions:
  - If Containment Purge blank flange is removed and Containment pressure is within 0.3 psig of atmosphere, then Containment pressure can be lowered using the Containment Purge System.
  - If Containment pressure is greater than 0.3 psig and rises to 10 psig, then pressure can be relieved using the Hydrogen Purge System
- If the unit was originally in Modes 5 and 6 when the event occurs, then pressure can be relieved using either the Containment Outage Door (COD) or the Personnel Airlock (PAL). The COD is preferred since opening the PAL could disrupt SFP area ventilation established in FSG-15, Alignment for Area Cooling (Reference 69).

6.7. Phase 3

The Phase 3 strategy for containment integrity is continued monitoring of containment temperature and pressure, and maintenance of containment integrity either by the use of fire suppression equipment spraying the outside of the containment, or use of the NSRC supplied equipment (4 KV generators and saltwater pumps) to provide containment cooling.

6.7.1. Primary Strategy

Restore at least one Containment Air Cooling Unit to service and support systems (SW and SRW) to operation with a NSRC supplied 4KV DG with NSRC supplied Saltwater Pump. When NSRC equipment arrives, a 4 KV safety bus can be restored using the NSRC supplied generators. Also supplied are saltwater pumps to provide a cooling medium for the Service Water system which is the cooling medium for the Containment Air Coolers (CACs). A new 36" flange to connect an NSRC set of hoses and Low Pressure/ High Flow pump to the SW system has been provided under ECP-14-000105 (Reference 49). See Figure 14-17, SW Makeup from Chesapeake Bay to 36" Flange.

Instructions are provided in FSG-12, Alternate Containment Cooling, (Reference 63) for initiating flow to a CAC when it is determined that Containment cooling is required. A precaution in the FSG is to select a CAC on the 45 foot elevation since those on the 69 foot elevation are subjected to higher temperatures. Service Water for cooling is applied slowly to the CAC to avoid possible water hammer which could damage the system. The CAC then can be started when the Service Water inlet isolation is fully open.

6.7.2. Alternate Strategy

Fire suppression equipment can be used to spray the external Containment surfaces to cool Containment and maintain temperature less than 276 °F (Reference 63).

7. Maintain Spent Fuel Pool Cooling

7.1. Objectives

In Phase 1 and 2, the objective is to maintain a minimum water level of 6 feet above the top of the fuel storage racks (44 ft. elevation) to protect the stored spent fuel and limit radiation exposure to personnel onsite and offsite. A new wide range level indication with integral backup power supply is installed for remote monitoring of SFP level to satisfy Order EA-12-051 (Reference 4).

In Phase 2, deploy and connect the SFP makeup FLEX pump ready to makeup to the SFP to maintain level ≥50 feet. Provide makeup to the SFP from portable injection sources via diverse means.

- Dedicated hose connection tied into the SFP Cooling System such that access to the SFP Area is not required.
- Lay Hose from the Auxiliary Building 45 foot elevation to the Auxiliary Building 69 ft. el. SFP Area to the pool edge to provide makeup or spray water into the SFP.

Under Phase 3 (using off-site NSRC supplied equipment), portable equipment and consumables will be used to reinforce and secure for an indefinite coping time, the measures implemented during Phase 2.

7.2. Acceptance Criteria

No fuel damage occurs. Coping times are calculated such that they preclude fuel damage, by maintaining water level at a predetermined level above the top of the active fuel.

7.3. Strategies

NOTE: The maintain Spent Fuel Pool cooling strategy descriptions below are the same for Calvert Cliffs Nuclear Power Plant Unit 1 and Unit 2. Any differences and/or unit specific information is included where appropriate.

The Spent Fuel Pool Cooling Phase 1 and Phase 2 strategies monitor Spent Fuel Pool (SFP) level to ensure adequate water level remains over the fuel. At the onset of the ELAP, the operating SFP Cooling pump loses power, the SFP will begin to heat-up and over time reach a temperature at which bulk fluid boiling will occur. The time to 200°F immediately following a full core offload assuming a SFP water temperature of 120°F is 11.8 hours. Makeup to the SFP is not expected to be needed in Phase 1. The time to fuel uncovery in this condition is approximately 102 hours.

7.4. Key Spent Fuel Pool Parameters

Table 7.4 identifies the Key Spent Fuel Pool Parameters, the specific instrument identifier, and location available to operators in an ELAP event.

Table 7.4: Key Spent Fuel Pool Parameters

Key Parameter	Instrument	Location
Wide Range SFP Level	LI-2003/2003A/2004/2004A	45 Ft Switchgear Room and Auxiliary Building
SFP temperature	Portable Thermocouple	Containment Lighting Locker

The Containment Lighting Locker is located in the SFP Exhaust Ventilation Equipment Room, 69' Auxiliary Building (Reference 66).

7.5. Phase 1

Per EOP-7, Station Blackout, Operators will be directed to implement AOP-6F, Spent Fuel Pool Cooling System Malfunctions, (Reference 66) Section VIII for a sustained loss of SFP cooling. Actions include placing a portable battery powered digital thermocouple in the SFP for monitoring temperature from outside of the SFP area and monitoring SFP level to ensure adequate water level remains over the fuel. Modification ECP-13-000665, Fukushima – Wide Range SFP Level Instrumentation, (Reference 67) installed a remote reading level instrumentation for SFP Wide Range level. This indication can be read remotely at two diverse locations on the Aux Building 45 foot elevation, Unit 1 45-foot Switchgear Room south wall, or in the Unit 2 45-foot Switchgear Room north wall.

Makeup to the SFP is not needed in Phase 1. However, hose alignments on the Aux Building 69-Foot elevation are performed early in the event to minimize personnel entering the area during a high heat and humidity conditions which occur in later phases.

7.5.1. SFP Area Ventilation

To provide a SFP area vent path, maintain temperatures lower on the Auxiliary Building 69 foot elevation in the SFP area, and to make areas more accessible to personnel, doors are aligned in the first two hours of the ELAP to provide a pathway for natural circulation cooling of the 69 foot elevation. According to Calculation

CA08253, Room Heat Up for FLEX Evaluation (Loss of HVAC), Auxiliary Building, Charging Pump, and TDAFWP Rooms, (Reference 68) alignment of area doors as outlined in the calculation and implemented in FSG-15, Alignment for Area Cooling, (Reference 69) will limit SFP area temperatures to 122°F with a wet bulb temperature of 126°F at eight hours after initiation of the ELAP.

7.6. Phase 2

The normal SFP water level at the event initiation is approximately 67.25 feet (CCNPP Technical Specification 3.7.8 requires > 21.5 feet of water over the top of the stored spent fuel). Per CCNPP UFSAR Section 9.4 (Reference 7), the Spent Fuel Pool Cooling System (SFPC) is designed to remove the maximum decay heat expected from 1613 fuel assemblies, not including a full core off-load. In the case of a total loss of SFPC with 1613 fuel assemblies in the pool, it would take more than 8 hours to raise the pool temperature from 155°F to 210°F.

Per Calculation CA06535, Spent Fuel Pool Decay Heat for 24-M Value Added Pellet (VAP) Core with Appendix K Power Uprate (Reference 70), CCNPP developed a bounding SFP decay heat load that considers 24-month low-leakage fuel cycles, a full core of VAP fuel, and an Appendix K power uprate to a core power level of 2738 MWt. The analysis of record for the current core power level of 2700 MWt (Reference 7 Section 9.4.1) is based on the simplified ANS-5.1-1979 Decay Heat Standard (Reference 71). The simplified method has limited value for high burnup spent fuel due to the inability to accurately treat actinide formation and neutron capture effects. Therefore, this analysis utilizes the SAS2H/ORIGEN-S sequence of the SCALE 4.4 code system to calculate decay heat loads (Reference 61).

To be consistent with the current UFSAR, two sequences are defined: "normal" and "abnormal." Normal operation of the spent fuel pool means that there is extra fuel rack storage capacity for the offload of a complete core (at least 217 empty spaces in the racks) and the last fuel discharge is from a partial defueling during a normally scheduled refueling outage. Abnormal indicates the SFP fuel racks are filled to capacity, with the last 217 assemblies coming from a core offload. The abnormal case bounds a full core offload during a normally scheduled refueling outage.

During normal operation, it is assumed that the SFP is cooled only by the Spent Fuel Pool Heat Exchangers (SFPHXs). Each of the two SFPHXs has a cooling capacity of 10.1×10^6 Btu/hr under design conditions; therefore, under normal operation, the SFP cooling system can remove 20.2×10^6 Btu/hr. During abnormal operation it is assumed the SFP cooling system is supplemented with one shutdown cooling heat exchanger from the offloaded unit. The heat removal capacity under these conditions is limited to 38.6×10^6 Btu/hr by the UFSAR (note that the maximum heat removal capacity in this configuration is actually reported in Reference 7 as $47.5x10^6$ Btu/hr).

This paragraph provides contradictory info.Calculation CA09973, Hydraulic Analysis of Spent Fuel Pool Makeup from Portable FLEX Pumps, (Reference 59) the required makeup flow rate for the Spent Fuel Pool during an ELAP is 81 gpm. The FLEX SFP Makeup pump exceeds the required makeup with recirculation flow while operating at speeds of 1480 to 2000 RPM.

7.6.1. Full Core Offload Unit 2 2013 Refueling Outage

Engineering Calculation CA07900, CCNPP Spent Fuel Pool Decay Heat Load During the 2013 RFO, (Reference 72) determined SFP decay heat load prior to 2013 RFO full core offload; SFP decay heat load during the 2013 refueling outage full core offload and onload; total decay heat in SFP and SFP temperature at different times during 2013 RFO; time for SFP to boil with loss of all SFP cooling; time for SFP to reach 200°F with loss of all SFP cooling for an entire year after 2013 RFO. This calculation concluded that the time to 200°F in the SFP for a full core offload is 11.86 hours, and the time to fuel uncovery is 102.11 hours. However, maintaining the SFP full at all times during the ELAP event is not required. The important requirement is to maintain adequate level to protect the stored spent fuel and limit radiation exposure to personnel onsite and offsite. Interpolating from the Tables provided in CA07900 (Reference 72) yields approximately 65 hours to reach a SFP level of 50 feet.

7.6.2. SFP Reactivity

Both the Unit 1 and Unit 2 SFPs will remain sub-critical when fully flooded with unborated water. A 5 percent margin to criticality will be maintained if the SFP soluble boron concentration remains above 350 ppm and the racks remain fully flooded as shown in calculations CA06011 (Reference 73) for Unit 1 and CA06015 (Reference 74) for Unit 2.

During an ELAP event, the borated water in the SFP will boil off, but the boron in solution will remain in the pool and concentrate. Addition of non-borated water to the SFP will not dilute the SFP to a boron concentration below the original concentration.

7.6.3. Primary Strategy

As soon as manpower resources are available, and prioritized with Core Cooling strategies, a FLEX SFP Makeup pump will be staged near and take suction from the

Chesapeake Bay (either intake or discharge structure) and connected to provide SFP makeup before SFP level lowers to 50 feet. Using the most conservative bounding condition of heat load on the SFP described above, this level will be approached during Phase 3. The N+1 SFP Makeup Pump for SFP Cooling is the site B.5.b. pump, stored in the FSCB.

If a unit is in Modes 6, with the Reactor Vessel Head removed, the SFP may be filled as part of the strategy to keep water inventory in the shutdown unit RCS per FSG-14, Shutdown RCS Makeup (Reference 55). This strategy consists of adding inventory to the SFP, which will flow through the fuel transfer tube into the Refueling Pool and maintain a level of water over the core.

The FLEX SFP Makeup Pump takes suction on the Chesapeake Bay through a six inch rigid hose with a barrel strainer attached to minimize debris entering the pump suction. See Figures 14-18 and 14-19 for locations where Bay water can be obtained. Pump discharge is through a five inch hose which is routed from the pump to a hose manifold located on the 45-foot elevation outside of the Auxiliary Building Rollup Door (Door 419).

The hose manifold for SFP Makeup consists of a five inch Storz inlet connection with three outlets (one 5-inch Storz outlet and two 3-inch male NH connections). Detail C in Figure 14-18 shows the hose manifold arrangement.

7.6.4. <u>SFP Makeup Routing</u>

From the hose manifold, hose selection and routing will depend whether SFP Makeup will go to a direct injection connection on the Auxiliary Building 27 foot elevation or to a surface feed on the Auxiliary Building 69 foot elevation. One 3 inch hose connection will always have a recirculation hose connected which is routed to a nearby storm drain.

7.6.5. <u>SFP Direct Injection</u>

If performing a direct injection, the remaining 3-inch hose connection will have a hose connected and routed down the Escape Hatch from the 45 foot elevation to the 27 foot elevation. The hose will then be routed East down the hallway to the Spent Fuel Pool Cooling Heat Exchanger Room. A spool piece with a 3 inch ball valve will be installed in place of a blank spool piece upstream of 0-SFP-154 (Reference 49). The spool piece will be installed by ERO mechanical maintenance personnel upon their arrival on site early in Phase 2. The 3 inch discharge hose will connect to the ball valve on the spool piece. Guidance is given in procedure FSG-11, Alternate SFP

Makeup and Cooling, (Reference 60) for the required valve lineup (See Figure 14-19).

7.6.6. SFP Surface Makeup

SFP Surface Makeup is an option to provide makeup water on the Auxiliary Building 69 foot elevation directly into the Spent Fuel Pool. Pump staging and hose layout from the pump to the SFP Makeup Manifold is the same as for direct injection. However, surface makeup uses a 3 inch hose connected to the manifold 3 inch outlet going up to the Auxiliary Building 69 foot elevation via the AB4 stairway. On the 69 foot elevation, a 10 foot long, 4 inch diameter rigid hose is passed through the B.5.b gate on the south side of the SFP FME Barrier. The 3 inch discharge hose from the SFP Makeup Manifold is connected to the rigid hose. When the SFP Makeup Pump is started and the 3 inch outlet valve on the FLEX Makeup Manifold opened, makeup water will flow into the SFP (See Figure 14-20).

7.7. Phase 3

The same strategies employed in Phase 2 will be employed in Phase 3. Personnel will continue monitoring SFP level and adding inventory as necessary using the FLEX SFP Makeup Pump.

Additionally, NSRC supplied 4KV diesel powered generators are employed to power 14 or 24 Class 1E 4160 VAC buses to power the 480 VAC buses that power 11 or 12 SFPC pumps. ECP-14-000153. FLEX 4KV Diesel Generator Connections, (Reference 75) installed connection points for the NSRC supplied 4KV diesel powered generators to supply the 4KV safety related buses. Once NSRC supplied equipment is installed, plant personnel can begin the process of restoring cooling to the SFP.

8. Safety Function Support

8.1. Objectives

The objective of Safety Function Support is to maintain the continuity of the mitigating strategies for each of the Safety Functions such that severe accident conditions are prevented, and also provide for Industrial and Radiological safety of plant personnel that will implement those strategies.

The Phase 1 through 3 strategies for Safety Function Support focuses on providing support equipment that facilitates, but does not directly implement, the safety function strategies. This includes the following:

- Vital 125 VDC power for Key Parameter Instrumentation
- Emergency lighting
- Ventilation
- Debris removal
- UHS access
- Communications
- FLEX equipment refueling
- Personnel Habitability

8.2. Phase 1

8.2.1. Vital 125 VDC power for Key Parameter Instrumentation

If at least one 4KV Vital Bus cannot be re-energized, then the operator will continue efforts to energize a 4KV Bus. The operator verifies the battery discharge rates are below those listed in procedure. If the discharge rate is above those listed, then, based on Unit need, loads are stripped to reduce the discharge rate. The discharge rates listed, when maintained on a steady state basis, will yield times to discharge in excess of 4 hours (Reference 64).

During an ELAP, all AC power is lost, leaving only the station batteries to power 125 VDC loads and those vital 120 VAC instrument buses that are supplied from the batteries via inverters. Once an ELAP is declared, actions are specified in plant procedures EOP-7, Station Blackout, (References 17 and 61) or AOP-3B, Shutdown Cooling Malfunction (Reference 58) for loss of AC power are predicated on use of instrumentation and controls powered by station batteries. However, with no operator action, the batteries will eventually drain until the DC bus voltage is no longer sufficient for supporting instrumentation and controls. When this happens, all critical instrumentation for monitoring the plant will be lost and the operator will be "blind" to plant conditions and the safety state of the plant. If batteries are allowed to deplete to a low voltage (typically in the range of 105 volts), associated invertors, batteries, and other electrical components may be damaged and become unrecoverable.

In order to extend battery life, NEI 12-06 required that a minimum set of parameters be defined to demonstrate the success of the strategies for maintaining the key safety functions as well as indicate imminent or actual core damage. The PWROG project that developed the FSGs (PA-PSC-0965) further defined a set of recommended instruments for monitoring key parameters for coping with and recovering from an ELAP. This instrument set supports a symptom-based approach to the ELAP event for plant control and FSG implementation, with a timeframe of availability for each instrument and alternate instruments where appropriate.

Plant Operations reviewed plant design and developed a list of 125 VDC loads and Vital 120 VAC loads to be removed from service to extend battery life. The loads are listed in FSG-4, ELAP DC Bus Load Shed and Management, (Reference 31) Attachments 1 and 2. From this list of loads, four calculations were performed to determine the length of time each of the four 125 VDC batteries would last. The results are shown in Table 8.2:

Table 8.2: 125 VDC Battery Coping Times with Deep Load Shed

Calculation	Title	Coping Time
CA08256	Battery 11 Load Shed Coping Time for ELAP Event (Reference 76)	7.07 Hours
CA08257	Battery 12 Load Shed Coping Time for ELAP Event (Reference 77)	12 Hours
CA08258	Battery 21 Load Shed Coping Time for ELAP Event (Reference 78)	7.33 Hours
CA08259	Battery 22 Load Shed Coping Time for ELAP Event (Reference 79)	12 Hours

To preclude loss of vital battery voltage and required instrumentation and controls, FSG-4, (Reference 31) implements BDBE FLEX strategies to extend the DC battery lifetimes to keep critical instrumentation and vital controls available long enough to deploy and use FLEX equipment. The deep load shedding FSG-4, Attachments 1 and 2 (Reference 31) is completed within two hours of the ELAP to ensure maximum coping time. Once load stripping is complete, the output amps are checked for each 125 VDC battery to ensure amperage output is less than or equal to the load determined in the respective battery calculation. Load stripping in an ELAP situation is performed more deeply than in a typical Station Blackout due to the need to extend battery beyond the four hour design bases of the station 125 VDC batteries. With the deep load stripping, battery life is extended to at least seven hours which is a sufficient time to provide FLEX temporary power from onsite FLEX equipment.

Loads are stripped off 125 VDC buses (DC-11, 12, 21, 22) to extend battery life from approximately four hours to approximately 7 hours to greater than 12 hours, depending on the battery and battery load. The loads to strip were chosen to ensure at least two channels of instrument indication considered vital to plant operation. The designated DC load breakers have been uniquely labeled for ease of identification. FLEX strategy validation has demonstrated that the DC load shedding for both units can be accomplished in less than one hour. Per Calculation CA08256, CA08257, CA08258, CA08259 (References 76, 77, 78, 79), the DC load shedding extends station vital 125 VDC battery coping to approximately 7 hours (for 11 and 21 station batteries) and to greater than 12 hours (for 12 and 22 station batteries).

If the battery supply to the vital 120 VAC is lost, then actions provided in FSG-7-1, Loss of Vital Instrument and Control Power (Unit 1), (Reference 80) and FSG-7-2, Loss of Vital Instrument and Control Power (Unit 2) (Reference 81), instructions are provided to obtain parameter readings using local measurements with portable instruments.

8.2.2. Emergency Lighting

Battery backed emergency lighting exists in many areas of the plant. The majority of lights consist of 12 watt lamps powered by local battery packs rated for eight hours. Lighting levels are only sufficient for entering and exiting rooms and some important equipment. Personnel will use flashlights or portable lanterns for supplemental lighting.

Per CCNPP Station Blackout Analysis (Reference 64), the Control Room has a sufficient level of battery backed lighting to perform all essential tasks for over four hours. The Control Room and adjacent plant computer data acquisition (DAS) rooms have a separate emergency lighting system powered from vital 125 VDC Station Battery 22.

The CCNPP Station Blackout Analysis (Reference 64), Chapter VI, Table 4, Emergency Lighting, has a list of rooms that might be entered by personnel during an SBO, emergency lighting wattage per room, and drawing references for each lighting circuit. Exterior area lighting will be without power during an ELAP.

Internal lighting can be provided by Miners Lights that are available to each individual as part of the FLEX strategy with twenty four lights stored in the FLEX Storage Cabinet in the Control Room Annex, and additional lights stored in the FSRB.

Control Room emergency lighting is powered from DC panel 2D14 which is connected to 125 VDC Battery 22. According to Calculation CA08259, Battery 22 Load Shed Coping Time for ELAP Event (Reference 79), Battery 22 has a coping time of greater than 12 hours following load stripping in FSG-4, ELAP DC Bus Load Shed and Management, (Reference 31). During the ELAP, When either 480 VAC Load Center 11B or 21B is energized from a FLEX 500 KW Diesel Generator, then the associated battery charger for DC Bus 22 (Battery 22) is placed in service to supply power to DC Bus 22 and maintain Battery 22 and associated loads. If emergency lighting should fail in the Control Room, then personnel will use the FLEX Miner's lights for needed illumination.

Portable diesel generator powered Light Towers provide lighting in the exterior areas where FLEX equipment will be deployed and for safety purposes. FSG-5, Initial Assessment and FLEX Equipment Staging, (Reference 34) details the location for these Light Towers. Operation of the Light Towers is described in FSG-ATT, FSG Attachments, (Reference 48) Attachment 122, Light Towers.

8.2.3. <u>Ventilation</u>

Ventilation of areas is important during an ELAP situation to provide ability for personnel to access and maintain a presence in vital areas of the plant. Also ventilation is required to ensure equipment is able to function to support plant functions.

Calculation CA08253, Room Heat Up for FLEX Evaluation (Loss of HVAC), Auxiliary Building, Charging Pump, and TDAFWP Rooms (Reference 68), evaluates the temperature response of Auxiliary and Turbine Building areas during an ELAP, during which forced ventilation (HVAC) would be lost. The main body of this calculation addresses ELAP during Operating Modes 1 through 5 and Appendix G addresses ELAP during Operating Mode 6. The analysis established the necessary mitigating actions and required timing of actions to support the FLEX Phase 2 Strategies. Various areas and rooms of the plant are analyzed in this calculation; listed in Reference 68, Section 1.2 Scope.

FSG-15, Alignment for Area Cooling, (Reference 69) utilized conclusions in CA08253 (Reference 68) to detail required actions for alignment of doors and ventilation access openings to minimize area temperature increases. Magnetic FLEX door stops are available to block open doors as established in CA08253. Notable actions that are done in Phase 1 include:

- Control Room panel lower covers are removed per EOP-7, Station Blackout (Reference 26). This will establish natural circulation air flow through the control room panels. A Phase 1 or 2 strategy blocks open the doors to the Control Room and setup portable air circulation fans powered by small portable AC units.
- Opening Turbine Building Rollup Doors (North and South) to ventilate the Turbine Building to minimize temperature rise.
- Opening select doors in the Auxiliary Building to provide ventilation for the SFP area on the 69 foot elevation
- Ensuring only one TDAFW Pump in operation on each unit to minimize heat load in the TDAFW Pump Rooms.
- Opening the Unit 1 and 2 Exhaust Plenum Hatches to provide a vent path for the SFP and Aux Building 69 foot elevation.
- Opening Aux Building Truck Bay Rollup Door to ventilate the 45' elevation which includes the ADV operators and the electrical penetration rooms where MCCs 104R and 204R are located.
- Doors are opened for the Cable Spreading Rooms to minimize temperature increase.
- Battery Room doors are open to minimize temperature increase and prepare for forced ventilation which will be necessary to remove hydrogen following repowering of the battery chargers.

Control Room Habitability

Per CCNPP Station Blackout Analysis (Reference 64), the Control Room will reach 103°F at four hours into the event. Under ELAP conditions with no mitigating actions taken, the blackout analysis states that the control room may surpass 110°F (the assumed maximum temperature for efficient human performance as described in NUMARC 87-00) at some point during a blackout.

Calculation CA08253, FLEX - Gothic Room Heat Up for FLEX Evaluation (Loss of HVAC): Auxiliary Building, Charging Pump, and TDAFW Rooms, (Reference 68), determined that the Main Control Room will reach a maximum wet bulb globe temperature (WBGT) of 97°F at 53 hours. Compensatory action is taken per FSG-15 at 12 hours to block open control room access doors and initiate cooling with a portable fan and/or air conditioning unit. WBGT at the time of these actions is predicted to be 88°F.

<u>TDAFW Pump Rooms</u>

Per CCNPP Station Blackout Analysis (Reference 64), the TDAFW Pump Room will reach 137°F at four hours into the event. This calculation assumed that the double watertight doors to the room would be open and operators could enter the room for short periods of time to control and monitor TDAFW pump performance.

Calculation CA08253, FLEX - Gothic Room Heat Up for FLEX Evaluation (Loss of HVAC): Auxiliary Building, Charging Pump, and TDAFW Rooms, (Reference 68), determined that even with the operator actions identified above, the TDAFW room temperature will slightly exceed the temperature limit of 140°F in the second hour as the room cools in response to the isolation of the 2nd TDAFW pump. An action derived from this calculation is to verify only one TDAFW pump is in operation in the first hour of the ELAP to minimize heat load in the room. FSG-15, Alignment for Area Cooling, (Reference 69) has directions in Step A to ensure only one TDAFW Pump in operation for each unit.

<u>Aux Building 45 Foot Elevation ADV Enclosure</u>

Within four hours of the ELAP initiation, the Aux Building Rollup Door 419 is opened. This action limits WBGT to 113°F which is acceptable for occupancy with possible stay time limitations.

<u>Unit 1 and 2 Turbine Building Switchgear Room 45 Foot Elevation</u>

When either Turbine Building Temperature is less than 45 Foot Switchgear Room temperature, or at least three hours have elapsed since initiation of the Loss of All AC power, the 45 Foot Switchgear Room Rollup Door can be opened.

<u>Unit 1 and 2 Turbine Building Switchgear Room 27 Foot Elevation</u>

The Switchgear Room 27 foot elevation Rollup door is kept closed for the first three hours of the event. At the end of three hours the rollup door can be opened six inches to allow for the passing of power cables from the FLEX 500 KW Diesel Generator into the switchgear room to repower the associated 480 VAC Load Center (Load Center 11B for Unit 1 and Load Center 21B for Unit 2). When Turbine Building temperature is less than 27 foot Switchgear Room temperature, then the rollup door can be fully opened.

8.2.4. Debris Removal

Following initial declaration of the ELAP and plant assessment performed in FSG-5, Initial Assessment and FLEX Equipment Staging (Reference 34), personnel are dispatched to the FLEX Storage Robust Building (FSRB) to begin the process of retrieving FLEX equipment. Depending on external events which may be related to the ELAP initiation, there may be debris blocking entryways and roads. Debris removal has been incorporated in the CCNPP plan.

In Phase 3, the receipt of assistance and equipment from offsite sources with various commodities such as fuel and supplies. Transportation of deliveries from the NSRC will be through airlift or via ground transportation utilizing the Calvert Cliffs SAFER Response Plan (Reference 53). Debris removal will commence in Phase 2 for the pathway between Staging Areas 'A' and the NSRC receiving location Staging Area 'B' and from the various plant access routes may be required based on conditions present.

Operating instructions for equipment is provided in FSG-ATT, FLEX Attachments (Reference 48). All equipment is maintained with continuous battery charge and fuel tanks at least ¾ full.

In the FSRB are the required items for Phase 1 debris removal to clear a pathway for FLEX equipment deployment into the plant.

FLEX Forklift – The FLEX Big Red Forklift is stored in the FSRB providing protection from external hazards. This forklift has a rated capacity of 36, 000 pounds which provides enough lifting capacity to move heavy debris and obstructions such as concrete barriers blocking selected equipment deployment routes.

Bobcat T650 Skid Steer Tracked Loader – The T650 Bobcat has a tracked drive with an operating load capacity of 2,690 pounds. It can travel at 7 mph for small debris removal as well as snow clearance in areas where the larger snow plows cannot be deployed.

F550 Pickup Truck with snow plow – The F550 pickup trucks are used to move heavy FLEX equipment such as the 500 KW FLEX Diesel Generators. Each F550 is equipped with a versatile snow plow which can be placed into various shapes of deflection. With the plow, the F550 can clear a path through heavy snow to allow for deployment of FLEX equipment following harsh winter conditions. The plow can also be used for pushing aside small debris.

F350 Pickup Truck with snow plow attachment – The F350 pickup truck can tow any FLEX equipment or trailers with a pintle hitch. The F350 pickup truck is not stored with a snow plow blade attached, but connection points are installed and a blade is available.

Small tools stored in the FSRB include chain saws, gas-powered metal cutting saws, and acetylene torches to allow FLEX implementers to cut or remove any debris or doors blocking access to the FLEX staging and deployment locations.

Three of the deployment routes pass under the 500 KV power lines. In the event that a 500 KV line was downed, instructions are provided in FSG-5, Initial Deployment and Assessment, (Reference 34) for checking and de-energizing the downed line while maintaining personnel safety. Required safety equipment is stored in the FSRB.

At the FSCB are additional items which to support debris removal as backup to supplement the equipment from the FSRB.

Bobcat S650 Skid Steer Wheeled Loader – The S650 Bobcat is wheeled and has an operating load capacity of 2,690 pounds and can travel at 7 mph. It can be used for small debris removal as well as snow clearance is in areas where the larger snow plows cannot be used.

JCB 436 Wheel Loader – The Wheel Loader is stored outside the FSCB as a supplemental debris removal component. It has a 3 cubic yard bucket attached to aid in debris removal.

8.2.5. Communications

FSG-16, FLEX Communications, (Reference 76) describes communications capabilities for CCNPP during an ELAP situation. During Phase 1, it is expected that initial communication for on-site notification and plant control in an ELAP situation will require use of bullhorns, installed sound powered phones, 800 MHz radios in a Talk-Around mode, and face-to-face communications and use of runners. Offsite communication will require the use of the Fixed Satellite Phone system, if still intact, or the hand-held Iridium Satellite Phones if the Fixed Satellite Phone system is not available. Further discussion of Communications can be found in Section 8.8, Communications.

8.3. Phase 2

8.3.1. Vital 125 VDC power for Key Parameter Instrumentation

Once the FLEX 500 KW Diesel Generators are powering a 480 VAC Load Center (11B, 14A, 21B, or 24A) battery chargers for the individual battery buses (21 and 22) can be energized to supply continued power to charge the 125 VDC batteries. Once Battery Bus 22 is powered from a battery charger, it is cross-connected with Battery Bus 11 to maintain 125 VDC for battery bus 11. Battery Bus 12 has a much lower load and was determined to have at least a 12 hour capability following DC load stripping. If Battery Bus 12 voltage should drop to the minimum required voltage of 105 VDC, then the reserve batter can be aligned to supply Battery Bus 12. Instructions for cross-connecting Battery Bus 22 to Battery Bus 11 as well as instructions for aligning the reserve battery to Battery Bus 12, are in FSG-4, ELAP DC Bus Load Shed and Management (Reference 31).

If a 480 VAC Load Center on a unit cannot be powered from a FLEX 500 KW diesel generator, then an alternate strategy is initiated to use a FLEX 100 KW diesel generator to power a Reactor MCC (Unit 1 – 104R, Unit 2 – 204R). When a Reactor MCC is powered, then the Inverter Backup Bus for that unit can be powered to supply 120 VAC power to the output of one inverter to maintain power to loads on that inverter, such as instrumentation. Thus additional load can be removed from the DC bus and allow for a longer battery coping time

8.3.2. Emergency Lighting

During Phase 2, personnel will continue to use the miners lights issued in Phase 1. Battery 22 should still be available for powering the Control Room emergency lighting well after the start of Phase 2. Battery 22 has a coping time of at least 12 hours which is well beyond Phase 1. Once a 480 VAC Load Center 11B or 21B is powered at seven hours into the ELAP, the associated battery charger (Battery Charger 14 for Load Center 11B or Battery Charger 22 for Load Center 21B) can be energized which will provide continuous power to the Control Room emergency lighting.

8.3.3. Ventilation

Actions are continued to cool rooms and areas by blocking open doors and employing portable fans.

TDAFW Pump Rooms – Per Calculation CA08253, Room Heat Up for FLEX Evaluation (Loss of HVAC), Auxiliary Building, Charging Pump, and TDAFWP Rooms (Reference 68) recommendations, hatches are opened for the return paths for the Unit 1 and 2 TDAFW Pump Rooms by 7 hours and 30 minutes into the ELAP. When at least one of the Reactor MCC buses (104R and 114R on Unit 1, 204R and 214R on Unit 2) are powered on a unit, ONE of the TDAFW Pump Room exhaust fans is energized to aid in cooling the TDAFW Pump Room. If a room exhaust fan is not available, then the TDAFW Pump Room double doors can be opened and a 2000 CFM portable blower powered from a 5500W Pramac Portable generator used to exhaust air from the TDAFW Pump Room into the Turbine Building.

Charging Pump Rooms – If a charging pump is started, the associated doors are opened to provide ventilation for the room.

Control Room – As soon as possible and within 12 hours, the Control Room doors are aligned as directed in FSG-15, Alignment for Area Cooling, (Reference 69) to align Control Room for cooling. Doors between the Control Room and Turbine Building are not opened until Turbine Building temperature drops to less than Control Room temperature. Once Turbine Building temperature is low enough (within 12 hours of ELAP), a 2000 CFM blower powered from a 5500W Pramac Portable generator is set up with the exhaust directed into the Control Room. Portable cooling using a MOVINCOOL portable AC unit is setup in the Control Room to provide localized cooling, Completion of these actions limits maximum WBGT to less than 97°F. Aux Building 69 foot elevation – Within 24 hours of ELAP, two 2000 CFM blowers are set up on the Aux Building 69 foot elevation roof, powered from a 5500W Pramac generator, to blow outside air through exhaust trunks into the Unit 1 and 2 West Electrical Penetration Rooms. These actions limit maximum dry bulb temperatures for the Unit 1 and Unit 2 West Electrical Penetration Rooms to 116°F.

Unit 1 and 2 Turbine Building Switchgear Room 45 Foot Elevation

Rollup doors will be open to cool these rooms.

Unit 1 and 2 Turbine Building Switchgear Room 27 Foot Elevation

Rollup doors will be open to cool these rooms.

Unit 1 and Unit 2 Cable Spreading Rooms

Doors remain open to cool these rooms.

Battery Rooms

FSG-4, ELAP DC Bus Load Shed and Management, (Reference 31) contains instruction to restore Battery Room ventilation when either Reactor MCCs 114R or

204R are energized. MCC-114R supplies the Battery Rooms exhaust fan and MCC-204R supplies the Battery Rooms supply fan. Restoring either of these fans provides both cooling and hydrogen gas removal.

8.3.4. Debris Removal

Any required debris removal will use the same equipment as indicated in Phase 1.

8.3.5. Communications

In Phase 2, the communications strategies employed in Phase 1 continue. If the fixed satellite communications system is not available, then the portable satellite communication system can be set up to provide off-site communications. Guidance for the setup of this equipment is provided in FSG-16, FLEX Communications (Reference 82) and in EPUA-001, CCNPP Portable TSC/OSC/BU MCR Satellite Communication System Operating User Aid (Reference 83). Further discussion of Communications can be found in Section 8.8, Communications.

8.3.6. Fuel Oil

CCNPP has purchased two 2800 gallon fuel oil tanker trucks for transport of diesel fuel oil to the FLEX portable equipment. Additionally, an air-powered fuel oil transfer pump has been installed for transfer of fuel oil from Fuel Oil Storage Tank (FOST) 21 to the fuel oil tanker trucks. 21 FOST is the fully protected storage of diesel fuel oil for the station, but contains low sulfur diesel fuel oil vice ultra-low sulfur fuel oil.(Reference 7). 21 FOST has a TS minimum stored volume of 85,000 gallons and a useable stored volume of 107,000 gallons of diesel fuel oil. ECP-14-000743 installed an air-powered pump inside the protected 21 FOST structure to obtain the fuel oil for transfer to the tanker trucks. (Reference 84).

One tanker truck containing ultra-low sulfur diesel fuel oil is stored in the FSRB while the other is stored in the FSCB. One truck is dispatched into the protected area, after FLEX equipment is staged, to provide refueling services with the other truck in standby. FSG-5, Initial Assessment and FLEX Equipment Staging, (Reference 34) provides a FLEX Equipment Fuel Cycle, derived from Calculation CA09986, FLEX Fuel Oil Consumption Rate Analysis, (Reference 85) with estimated times to 50% level and empty. This attachment also divides the FLEX equipment into Non-Tier 4 and Tier 4 equipment. Tier 4 equipment must use ultra-low sulfur fuel oil or engine damage may occur. Non-Tier 4 equipment can operate or either ultra-low sulfur fuel or low sulfur fuel.

Initially all refueling will occur from a fuel truck filled with ultra-low sulfur fuel oil. When that tanker truck is empty, then the truck will be filled with low sulfur fuel from 21 FOST. To pump this fuel from the tank to the truck, an air –powered fuel oil pump will receive air supplied from a FLEX Diesel Driven Air Compressor set up outside of the 21 FOST structure.

Once the Fuel Oil Tanker Truck is filled with the higher sulfur fuel from FOST 21, it cannot be used to service the Tier 4 FLEX equipment. The other tanker truck, with ultra-low sulfur fuel still loaded, will be used for servicing Tier 4 equipment.

The F350 pickup truck, stored in the FSRB, has a 100 gallon fuel tank for dispensing ultra-low sulfur diesel oil to small Tier 4 engines, such as the Pramac 5500W generators or the light towers.

A 4000 gallon fuel oil storage tank is located outside the FSRB to resupply FLEX Equipment following preventative maintenance. If it is not damaged by the beyond design basis event, fuel from the tank is available to supply ultra-low sulfur diesel fuel for FLEX equipment.

8.3.7. Ultimate Heat Sink (UHS)

During Phase 2, access to the UHS could be necessary as a limitless source of makeup water to the Condensate Storage Tanks for Steam Generator Makeup. The FLEX Booster Pump can be staged either at the intake or discharge structure, or at any available access point depending on Chesapeake Bay water level conditions, and take suction on the bay water. Pump suction utilizes a six inch non-collapsible suction hose to pull in bay water that can then be pumped directly to the 12 Condensate Storage Tank for S/G makeup.

8.4. Phase 3

In phase 3, the unit will be supported as detailed in phase 2. However, between 24 and 72 hours into the ELAP, offsite support from the NSRB will be arriving to support plant safety functions. Once the NSRB supplied 4KV Gas Turbine Generators arrive, power to safety 4 KV buses on Units 1 (4KV Bus 14) and 2 (4KV Bus 21) can be initiated. Instructions for connection of the 4KV Gas Turbine Generators to the plant 4KV safety buses is provided in FSG-4, ELAP DC Bus Load Shed and Management (Reference 31).

Once the safety 4KV buses are powered, then actions can be initiated to restore support equipment. When saltwater cooling and component cooling are restored, a LPSI or CS pump can be restored to initiate Shutdown Cooling. Also, power can be made available to operate the ECCS Pump Room Air Coolers. Control Room HVAC system chillers and air handling units can then be reenergized to restore Control Room temperature to normal levels.

8.4.1. Ultimate Heat Sink (UHS)

During Phase 3, in addition to makeup water to the Condensate Storage Tanks for Steam Generator Makeup, the Chesapeake Bay is also available as a source of makeup to the Spent Fuel Pool as discussed in Section 7, Maintain Spent Fuel Pool Cooling. It will also be utilized for restoration of saltwater cooling once equipment arrives from the NSRC.

8.5. Protection of Equipment

CCNPP has constructed a single hardened FLEX storage structure of approximately 8,400 square feet that will meet the requirements for the external events identified in NEI 12-06, such as earthquakes, external floods, storms (high winds, and tornadoes), extreme snow, ice, extreme heat, and cold temperature conditions. The FSRB is located on elevated ground of 127.1 feet which is above the maximum probable flood elevation of 47 feet. As required by NEI 12-06, equipment credited for implementation of the FLEX strategies (N) at CCNPP is stored in the FSRB.

The FSRB was designed and constructed to prevent water intrusion and built to protect the housed FLEX equipment from other hazards such as earthquakes, tornados, hurricanes, blizzards, and extremes of temperature. The FSRB has its own heating and ventilation to maintain temperature between 40°F and 100°F (Reference 17).

Large FLEX portable equipment such as pumps, generators, trailers, and trucks are secured with tie-down straps to floor anchors inside the FSRB to protect them during a seismic event. The FSRB anchors are integrated into the floor slab.

Debris removal equipment such as the Big Red Fork Lift, F550 Trucks, F350 Truck and Bobcat T650 are stored inside the FSRB in order to be reasonably protected from external events such that the equipment will remain functional and deployable to clear obstructions from the pathway between the FSRB and its deployment location(s).

Deployments of the FLEX and debris removal equipment from the FSRB are not dependent on off-site power. All actions required to access and deploy debris removal equipment and BDB/FLEX equipment can be accomplished manually. Equipment within the FSRB are connected to battery chargers, where needed, to maintain equipment ready for operation.

During an ELAP event where all AC power is lost to the FSRB, a portable Kubota generator is available to connect into the building electrical system for powering lights and other electrical components. The generator has a rated output of 6.5 KW and connections for 120 VAC and 240 VAC. During an ELAP the generator would be staged by the West Atrium door and connected to a receptacle on the breaker panel by the west atrium door.

The FLEX Storage Commercial Building (FSCB) is a commercial grade building located in the plant parking lot at elevation 67.1 feet. The FSCB is not considered a seismic Class I building but equipment stored inside is strapped down to prevent movement in a seismic event. The building is high wind resistant and provides weather protection for equipment stored inside. The FSCB contains an additional Bobcat which is a backup to the one in the FSRB. N+1 equipment is stored in the FSCB as well as additional equipment such as two Dewatering Pumps which are not essential to the FLEX Strategies. FSCB is located in Parking Lot 5 over 2100' from the FSRB and closer to the PA. The FSCB has its own heating and ventilation to maintain temperature between 40°F and 100°F (Reference 17).

8.6. Personnel Habitability

Following a BDB external event and subsequent ELAP event at CCNPP, ventilation providing cooling to occupied areas 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. The primary concern with regard to ventilation is the heat buildup which occurs when forced ventilation is lost in areas that continue to have heat loads.

Calculation CA08253, Room Heatup for FLEX Evaluation, (Reference 68) evaluates the temperature response of Auxiliary and Turbine Building areas during an Extended Loss of AC Power (ELAP), during which forced ventilation (HVAC) is lost. The calculation addresses ELAP during Operating Modes 1 through 5 and Appendix G addresses ELAP during Operating Mode 6. The purpose of the calculation was to establish the necessary mitigating actions and required timing of those actions.

The key areas identified for all phases of execution of the FLEX strategy activities are:

- Main Control Room (MCR)
- Spent Fuel Pool Area on the Aux Building 69 foot elevation
- Spent Fuel Pool Level Instrument Area on Aux Building 45 foot elevation
- Truck Bay on Aux Building 45 foot elevation

- Unit 1 and 2 Switchgear Rooms (45 foot and 27 foot elevations)
- Unit 1 and 2 ADV enclosure areas in the Aux Building 45 foot elevation
- Unit 1 and 2 Turbine Driven Auxiliary Feedwater (TDAFW) Pump Rooms
- Cable Spreading Room
- West Electrical Penetration Rooms (Unit 1 and 2)
- Spent Fuel Pool Heat Exchanger and Pump Room on Aux Building 27 foot elevation
- Charging Pump Rooms
- Mechanical Equipment Fan Rooms
- Unit 1 and 2 West Electrical Penetration Rooms.

These areas have been evaluated to determine the temperature profiles following an ELAP event. The conclusions of Calculation CA08253 (Reference 68) resulted in actions that are provided in FSG-15, Alignment for Area Cooling, (Reference 69) to minimize temperature increase due to the loss of ventilation and maintain areas acceptable for personnel entry and continued equipment operation.

Discussion of the actions derived from Calculation CA08253, Room Heatup for FLEX Evaluation, (Reference 68) actions are done in Sections 8.2.3, (Phase 1) Ventilation, and 8.3.3, (Phase 2) Ventilation.

8.7. Lighting

As noted in section 4.3.2, personnel will use Miner's lights for individual illumination is various areas of the plant where lighting is needed. The Control Room emergency lights should be available powered from DC Bus 22 which will be powered from the Load Center 11B or 21B that is also supplied by a FLEX 500 KW Diesel Generator.

Outdoor lighting will be provided by diesel powered light towers placed in strategic locations as indicated in Section 8.3.2. Small magnetized-back LED lights are stored in the FSRB to attach to equipment panels for additional illumination.

8.8. Communications

FSG-16, FLEX Communications Equipment, (Reference 82) describes communications capabilities for CCNPP during an ELAP situation.

Plant Control communication occurs using 800 MHz radios, commercial telephones and/or the plant public address system. If these are not available then two alternate methods are available;

- 800 MHz radios set to the Talk-Around mode for operations command and control,
- Sound Powered Phones using the robust backup system

CCNPP has an extensive sound-powered phone network, both primary and backup circuits. Phone jacks are located on multiple panels in the Control Room and vital areas of the plant. This system initially will be used by operations personnel for plant control. Fourteen (14) Sound powered phones and four (4) extension cable reels are located in the FLEX Storage Locker in the Control Room Annex. Emergency Sound Powered Phone System circuit panel is located in the Control Room Briefing Area. During an ELAP situation, FSG-16, FLEX Communications, (Reference 82) directs the operator to ensure four specific circuits are ON and all others are OFF. The four circuits that remain ON are:

- 4 (Stairway AB-2) Used for Unit 1 ADV operations
- 5 (AFW Pump Rooms, Service Water Pump Rooms on 27 foot elevation' & 45 foot Switchgear Rooms) Used for Control of TDAFW Pumps and S/G Control
- 9 (AB-5 Stairway) Used for Unit 2 ADV operations
- 10 (AB-4 Stairway) Used for Truck Bay and Rollup Door 419 phone talker.

On-site notification normally uses the Plant Public Address System or the Emergency Response Notification System (ERONS). If these are not available then the alternate method is used;

- Bullhorns

Offsite notification normally uses commercial telephones, ERONS, 800 MHz siren activation, fixed Satellite Phones or the NRC hotline. If these are not available then the alternate method is used;

- Portable Iridium Satellite Phones
- Portable Satellite Communications System

During Phase 1 of the ELAP response, onsite communications will consist of using bullhorns, sound powered phones, and 800 MHz radios set to talk-around mode.

Offsite communications will require use of the Iridium Satellite Phone, unless the fixed satellite phone system is still functional.

In Phase 2, the Phase 1 communications strategies continue. If the fixed satellite communications system is not available, then the portable satellite communication system can be set up to provide off-site communications. Guidance for the setup of this equipment is provided in FSG-16, FLEX Communications (Reference 82) and in EPUA-001, CCNPP Portable TSC/OSC/BU MCR Satellite Communication System Operating User Aid (Reference 83).

The FLEX Communications Trailer contains the Portable Satellite Dish with support equipment, eight Pramac diesel powered generators, 25 800 MHz radios programmed for talk-around mode with installed batteries on chargers, and 75 spare radio batteries on charge. One Pramac generator is always placed with the trailer during setup to provide Satellite Dish power and maintain power for battery chargers.

8.9. Deployment Routes

Pre-determined, preferred haul paths have been identified and documented in procedure FSG-5, Initial Assessment and FLEX Equipment Staging (Reference 34). These haul paths have been reviewed for possible obstructions, Debris removal equipment is stored inside the FLEX Storage Robust Building to be protected from the severe storm and high wind hazards such that the equipment remains functional and deployable to clear obstructions from the pathway between the FLEX Storage Building and the deployment location(s). When an ELAP is declared, personnel utilize instructions within FSG-5, Initial Assessment and FLEX Equipment Staging (Reference 34) to assess plant and area conditions and determine equipment needs. As part of the assessment, pathways are evaluated to determine the most appropriate pathway for moving equipment into the protected area. Conditions such as fallen trees, downed power lines, road damage, etc., may dictate the route used.

CCNPP utilizes four pathways (Refer to Figure 14-1, FLEX Deployment Routes) from the FSRB and FSCB to move FLEX equipment into the protected area in response to an ELAP situation.

Path 1 – (Preferred) Calvert Cliffs Parkway to Camp Canoy Road to road along switchyard to FLEX Primary PA Access north of Warehouse 1.

Path 2 – (Alternate 1) Calvert Cliffs Parkway to Camp Canoy Road to ISFSI Haul Route to NSF Sallyport.

Path 3 – (Alternate 2) Lake Davies Road by the ISFSI to ISFSI Haul Route to NSF Sallyport.

Path 4 – (Alternate 3) Old North Road to North Perimeter gate. (Bypasses 500 KV Highlines)

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 Areas" 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.

8.10. Offsite Support

8.10.1. National SAFER Response Center

The industry has established two National SAFER Response Centers (NSRCs) to support utilities during BDB events. CCNPP established contracts with and issued purchase orders to Pooled Inventory Management (for participation in the establishment and support of two NSRCs through the Strategic Alliance for FLEX Emergency Response (SAFER). Each NSRC holds five sets of equipment, four of which will be able to be fully deployed when requested. The fifth set will have equipment in a maintenance cycle. In addition, on-site FLEX equipment hoses and cable end fittings are standardized with the equipment supplied from the NSRC. In the event of a BDB external event and subsequent ELAP condition, equipment will be moved from an NSRC to a local assembly area established by the Strategic Alliance for FLEX Emergency Response (SAFER) team. For Calvert Cliffs the local assembly area is the Baltimore-Washington International Airport. From there, equipment can be taken to the Northern High School in Owings, MD by helicopter if ground transportation is unavailable or inhibited. Communications will be established between the Calvert Cliffs 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 at which equipment is delivered is identified in the Calvert Cliffs SAFER Response Plan documented in procedure CC-CA-118-1001, SAFER Response Plan for CCNPP (Reference 53)

8.10.2. Equipment List

The equipment stored and maintained at the NSRC for transportation to the CCNPP Staging Area 'B' to support the response to a BDB external event at Calvert Cliffs is listed in Table 11.2: Offsite Phase 3 Equipment List. Table 11.2 identifies the equipment that is specifically credited in the FLEX strategies for Calvert Cliffs but also lists the equipment that will be available for backup/replacement should on-site equipment break down. Since all the equipment will be located at the CCNPP Staging Area 'B', the time needed for the replacement of a failed component will be minimal.

9. Sequence of Events

The Table 9.1 below presents a Sequence of Events (SOE) Timeline for an ELAP/LUHS event at CCNPP. Validation of each of the Flex time constraint actions has been completed in accordance with the Flex Validation Process document issued by NEI and includes consideration for staffing. Time to clear debris to allow equipment deployment is assumed to be up to 2 hours. This time is considered to be reasonable based on site reviews of the deployment paths and the location of the FSRB. Debris removal equipment is stored in the FSRB and FSCB.

Table 9.1: Sequence of Events Timeline

Action Item	Action	Personnel	Event Elapsed Time Start	Duration	FLEX Time Constraint Y/N	Applicability/ Remarks
0	Event starts, both units automatically trip on LOOP	N/A	0	N/A	N/A	Both units initially at 100% power
1	Implement EOP-0, Standard Post Trip Actions to stabilize plant in Hot Standby	U1 and U2 CRS, STA, U1 and U2 RO, U1 and U2 CRO, AB-1 and AB-2	< 1 min (1)	11 min	N	Stabilize plant at 532°F and 2250 PSIA; Both ADVs opened (Local manual control)
2	TDAFW Pump begins to deliver AFW flow to S/Gs	U1 and U2 CRO, TBO-1 and TBO-2	< 10 min	N/A	N	Plant original design basis
3	EOP-7, Station Blackout Implemented	U1 and U2 CRS, STA, U1 and 2 RO, U1 and U2 CRO	11 min (1)	N/A	N	EOP-7 is the controlling procedure for implementing ELAP response.
4	ELAP determined and declared	SM	24 min (1)	N/A	N	ELAP determined and declared in < 60 min

Action Item	Action	Personnel	Event Elapsed Time Start	Duration	FLEX Time Constraint Y/N	Applicability/ Remarks
5	FSG-15 implemented. Operators open U1 and U2 Turbine Building roll-up doors	U1 CRO, TBO-1 and TBO-2	41 min (1)	10 min (1)	Y	Room Heat-up for FLEX Evaluation calculation CA08253 Sect 8.0 1 hr compensatory actions 1 and 2
6	FSG-15, Alignment for Area Cooling implemented. Operators ensure only 1 TDAFW Pump in operation on each unit	U1 and U2 CRO	41 min	1 min	Y	Room Heat-up for FLEX Evaluation calculation CA08253, Sect 8.0 1 hr compensatory actions 3 and 4
7	Deep 125V vital DC and 120V vital AC load shed performed	U2 CRO, PO-6 and PO-9	45 min (1)	50 min (1)	Y	Station battery load shed calcs assume that load shed completed at < 2 hrs. When validated, both units were performed by a single PO in 50 min, 15 sec.
8	RCS cooldown conducted at an initial rate of 75°F/ hr	U1 and U2 CRS, U1 and 2 RO, AB-1 and AB-2	47 min (1)	231 min (1)	Y	WCAP-17601P recommendation to perform an early RCS cooldown starting at <2 hrs to extend core inventory coping to >10 days.

Action Item	Action	Personnel	Event Elapsed Time Start	Duration	FLEX Time Constraint Y/N	Applicability/ Remarks
9	Lower Main Generator hydrogen pressure to 2 PSIG, then secure the EMERG H_2 SEAL OIL PP	TBO-1 and TBO-2	60 min	N/A	N	
10	27 ft FLEX DG cables routed into 27 ft Switchgear Room	PO-6, PO-9, 2 Auxiliary Personnel	118 min (1)	26 min (1)	Y	
11	FSG-15 implemented. Nuclear Security performs Appendix 1 to establish Spent Fuel Pool area vent path	1 NSO and 1 PO	120 min (3)	20 min (1)	Y	Room Heatup for FLEX Evaluation calculation CA08253 Sect. 8.0 - 2, 4, and 8 hr compensatory actions. Doors 412, 419, and 524 opened per App. 1 (2 hr actions).
12	FSG-15 implemented. Operators fully open 45ft Switchgear Room rollup doors	PO-6, 7, 8, and/or 9	180 min (3)	5 min (1)	Y	Room Heatup for FLEX Evaluation calculation CA08253 Sect. 8.0 – 3 hr compensatory actions 17 and 18.
13	500 KW DGs and 2 cable cart trailers deployed to Turbine Building roll-up doors	OSO, 3 Auxiliary Personnel	183 min (1)	22 min (1)	Y	

Action Item	Action	Personnel	Event Elapsed Time Start	Duration	FLEX Time Constraint Y/N	Applicability/ Remarks
14	FLEX DG cable deployed on 45 ft Elevation of Turbine building	PO-6, 7, 8, and 9, 3 Auxiliary personnel	186 min (1)	49 min (1)	Y	
15	FLEX hose manifolds deployed to Tank Farm and hoses connected to tanks for 12 CST makeup	OSO, Chem, RPT-1 and RPT-2, Auxiliary Personnel	195 min (2)	86 min (1)	Y	ERO MM Team arrives at site between T+6 and T+7 hours to install 12 CST connection tool.
16	FSG-15 implemented. Operators open 4 Battery Room doors	PO-7 and PO-9	240 min (3)	< 15 min (1)	Y	Room Heatup for FLEX Evaluation calculation CA08253 Sect. 8.0 – 4 hr compensatory actions 24 – 27.
17	FSG-15 implemented. Operators open 3 Cable Spreading Room doors and 2 stairwell doors	PO-7 and PO-9	240 min (3)	< 15 min (1)	Y	Room Heatup for FLEX Evaluation calculation CA08253 Sect. 8.0 – 4 hr compensatory actions 20 - 23 and 28.
18	FLEX AFW pumps deployed to Tank Farm	OSO, 3 Auxiliary Personnel	240 min (2)	10 min (1)	N	WCAP-17601P recommendation
19	Cables connected from 1st 500 KW DG to vital 480 VAC load center	PO-6, 7, 8, and 9	303 min (2)	20 min (1)	Y	

Action Item	Action	Personnel	Event Elapsed Time Start	Duration	FLEX Time Constraint Y/N	Applicability/ Remarks
20	1st vital 480 VAC Load Center energized	PO-7 and PO-8	310 min (2)	5 min (2)	Y	5 min DG warm-up.
21	1st Battery Charger started	PO-8	315 min (2)	8.5 min (1)	Y	7 hr time constraint based on station battery load shed calc
22	Cables connected from 2nd 500 KW DG to vital 480 VAC load center	PO-6 and PO-9	315 min (2)	20 min (1)	Y	
23	2nd vital 480 VAC Load Center energized	PO-6	345 min (2)	5 min (2)	Y	5 min DG warm-up.
24	2nd Battery Charger started	PO-9	360 min (2)	8.5 min (1)	Y	7 hr time constraint based on station battery load shed calc
25	12 CST Tool installed, hoses attached and ready to start makeup to the CST	OSO, Chem, RPT-1 and RPT-2, Auxiliary Personnel, ERO MM Team	420 min (2)	120 min (1)	Y	ERO MM Team arrives at site between T+6 and T+7 hours to install 12 CST connection tool. 12 CST make up to commence by T+10 hrs. Consistent with CCNPP calculation CA03767. Per FSG-6, commence makeup prior to reaching 5 ft.

Action Item	Action	Personnel	Event Elapsed Time Start	Duration	FLEX Time Constraint Y/N	Applicability/ Remarks
26	FSG-15 implemented. Operators align TDAFW Room vent path and start installed emergency vent fans	PO-7 and PO-9	450 min (3)	32.5 min (1)	Y	Room Heatup for FLEX Evaluation calculation CA08253 Sect. 8.0 – 7.5 hr compensatory actions 29 – 32.
27	FSG-15 implemented. Operators open doors 401 and 403 to Main Control Room and start 2,000 cfm portable fan	PO-7 and PO-9	720 min (3)	N/A	N	Room Heatup for FLEX Evaluation calculation CA08253 Sect. 8.0 – 12 hr compensatory actions 41 – 43.

(1) Times based on CCNPP Simulator and field validation of ELAP procedures.
(2) Times based on CCNPP Phase 2 Staffing Assessment.
(3) Times based on calculation CA08253, Room Heatup for FLEX Evaluation (Loss of HVAC) compensatory action times.

10. Programmatic Elements

10.1. Overall Program Document

CCNPP procedure CC-CA-118 (Reference 17) provides a description of the Diverse and Flexible Coping Strategies (FLEX) Program for Calvert Cliffs. This procedure implements Exelon fleet program document CC-AA-118 which contains governing criteria and detailed requirements. The key elements of the program description include:

- Responsibilities of site personnel for FLEX program implementation
- Summary of CCNPP FLEX Strategies
- FLEX Equipment and Commodities design, quality, and identification
- Maintenance and Test Procedure requirements
- Availability of FLEX Equipment and Connections
- Storage and Staging of FLEX Equipment including the National SAFER Response Center
- Deployment of FLEX Equipment
- Procedures and Guideline Requirements
- Plant Configuration Control
- Staffing and Training to support FLEX Strategies

The instructions required to implement the various elements of the FLEX Program at Calvert Cliffs and thereby ensure readiness in the event of a BDBEE are contained in Exelon fleet program document CC-AA-118, Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program Document.

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.

10.2. Procedural Guidance

The inability to predict actual plant conditions that require the use of BDB equipment makes it impossible to provide specific procedural guidance. As such, the FSGs provide guidance that can be employed for a variety of conditions. Clear criteria for entry into FSGs will ensure that FLEX strategies are used only as directed for 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 Procedure (AOP) strategies, the EOP or AOP, Severe Accident Mitigation

Guidelines (SAMGs), or Extreme Damage Mitigation Guidelines (EDMGs) will direct the entry into and exit from the appropriate FSG procedure.

FSGs were developed in accordance with PWROG guidelines. The FSGs provide available, pre-planned FLEX Strategies for accomplishing specific tasks in the EOPs or AOPs. FSGs will be used to supplement (not replace) the existing procedure structure that establishes command and control for the event.

Procedural interfaces have been incorporated into EOP-7, Station Blackout, to the extent necessary to include appropriate reference to FSGs and provide command and control for the ELAP. Additionally, procedural interfaces have been incorporated into AOP-3B, Abnormal Shutdown Cooling Conditions, to include appropriate reference to FSGs.

Changes to FSGs are controlled by Exelon fleet procedure AD-AA-101, Processing of Procedures and T&RMs (Reference 86). FSG changes will be reviewed and validated by the involved groups to the extent necessary to ensure the strategy remains feasible. Validation for existing FSGs has been accomplished in accordance with the guidelines provided in NEI APC14-17, FLEX Validation Process, issued July 18, 2014 (Reference 87).

10.3. Staffing

Using the methodology of NEI 12-01, *Guideline for Assessing Beyond Design Basis Accident Response Staffing and Communications Capabilities*, an assessment of the capability of CCNPP on-shift staff and augmented Emergency Response Organization (ERO) to respond to a BDBEE was performed. The results were provided to the NRC in a letter dated October 13, 2014 (Reference 88).

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

1. an extended loss of AC power (ELAP)
2. an extended loss of access to ultimate heat sink (UHS)
3. impact on units (all units are in operation at the time of the event)
4. impeded access to the units by off-site responders as follows:
    - 0 to 6 Hours Post Event – No site access.

- 6 to 24 Hours Post Event – Limited site access. Individuals may access the site by walking, personal vehicle or via alternate transportation capabilities (e.g., private resource providers or public sector support).

- 24+ Hours Post Event – Improved site access. Site access is restored to a near-normal status and/or augmented transportation resources are available to deliver equipment, supplies and large numbers of personnel.

CCNPP Operations, Security, Chemistry, Radiation Protection and FLEX project personnel conducted a table-top review of the on-shift response to the postulated BDBEE and extended loss of AC power for the Initial and Transition Phases using the FLEX mitigating strategies. Resources needed to perform initial event response actions were identified from the Emergency Operating Procedures (EOPs). Particular attention was given to the sequence and timing of each procedural step, its duration, and the on-shift individual performing the step to account for both the task and time motion analyses of NEI 10-05, *Assessment of On-Shift Emergency Response Organization Staffing and Capabilities.*

This Phase 2 Staffing Assessment concluded that the current minimum on-shift staffing as defined in the Emergency Response Plan for CCNPP, as augmented by site auxiliary personnel, is sufficient to support the implementation of the FLEX strategies on both units, as well as the required Emergency Plan actions, with no unacceptable collateral duties.

The Phase 2 Staffing Assessment also identified the staffing necessary to support the Expanded Response Capability for the BDBEE as defined for the Phase 2 staffing assessment. This staffing will be provided by the current CCNPP site resources, supplemented by Exelon fleet resources, as necessary.

10.4. Training

CCNPP's Nuclear Training Program has been revised to assure personnel proficiency in the mitigation of BDB external events is adequate and maintained. These programs and controls were developed and have been implemented in accordance with the Systematic Approach to Training (SAT) Process (References 89, 90, 91).

Using the SAT process, Job and Task analyses were completed for the new tasks identified as applicable to the FLEX Mitigation Strategies. Based on the analysis, training for Operations was designed, developed and implemented for Operations continuing training. "ANSI/ANS 3.5, Nuclear Power Plant Simulators for use in Operator Training" certification of simulator fidelity is considered to be sufficient for the initial stages of the BDB external event scenario training. Full scope simulator models have not been explicitly upgraded to accommodate FLEX training or drills. Overview training on FLEX Phase 3 and associated equipment from the SAFER NSRCs was also provided to CCNPP Operators. Upon SAFER equipment deployment and connection in an event, turnover and familiarization training on each piece of SAFER equipment will be provided to station operators by the SAFER deployment/operating staff.

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 mitigation strategies for BDB external events have received the necessary training to ensure familiarity with the associated tasks, considering available job aids, instructions, and mitigating strategy time constraints.

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

11. FLEX Equipment

11.1. Equipment List

The equipment stored and maintained at the CCNPP FSRB and FSCB plus various pre-staged locations necessary for the implementation of the FLEX strategies in response to a BDB external event are listed in Table 11.1. Table 11.1 identifies the quantity, applicable strategy, and capacity/rating for the major BDB/FLEX equipment components only, as well as, various clarifying notes. Details regarding fittings, tools, hose lengths, consumable supplies, etc. are not in Table 11.1, but are detailed in FLEX Equipment Inventories:

- PE-0-130-04-O-A, FSRB FLEX Equipment Inventory
- PE-0-130-05-O-A, FSCB FLEX Equipment Inventory
- PE 0-130-06-O-A, In-Plant FLEX Equipment Inventory

11.2. Equipment Maintenance and Testing

Periodic testing and preventative maintenance of the BDB/FLEX equipment conforms to the guidance provided in INPO AP-913 (Reference 92). A fleet procedure has been developed to address Preventative Maintenance (PM) using EPRI templates or manufacturer provided information/recommendations, equipment testing, and the unavailability of equipment.

EPRI has completed and has issued "Preventive Maintenance Basis for FLEX Equipment – Project Overview Report" (Reference 93). Preventative Maintenance Templates for the major FLEX equipment including the portable diesel pumps and generators have also been issued. Information from the specific FLEX Equipment Vendor Technical Manuals were also used as input.

The PM Templates include activities such as:

- Periodic Static Inspections
- Fluid analysis
- Periodic operational verifications
- Periodic functional verifications with performance tests

The EPRI PM Templates for FLEX equipment conform to the guidance of NEI 12-06 providing assurance that stored or pre-staged FLEX equipment are being properly maintained and tested. EPRI Templates are used for equipment where applicable. However, in those cases where EPRI templates were not available, Preventative Maintenance (PM) actions were developed based on manufacturer provided information/recommendations and Exelon fleet procedure ER-AA-200, Preventive Maintenance Program (Reference 94). Detailed information on FLEX and FLEX support equipment PM's is contained in FLEX program document CC-CA-118 section 4.4 (Reference 17).

Table 11.1: Onsite Phase 2 and 3 Equipment List

Use and (Potential / Flexibility) Diverse Uses						
List Portable Equipment	**Core**	**Containment**	**SFP**	**Instrumentation**	**Accessibility**	***Performance Criteria***
FLEX diesel-driven pump (3) and assoc. hoses and fittings (3419MX)	X		X			770 gpm @ 268 psig, Supports core and containment cooling
FLEX diesel-driven pump (3) and assoc. hoses and fittings (HL5MS)	X		X			1320 gpm @ 195 psig, Supports core, containment and SFP cooling
FLEX diesel-driven pump (3) and assoc. hoses and fittings (Triplex Plunger)	X					80 gpm @ 300 psig, Supports core inventory control
FLEX generators (2) and associated cables, connectors	X	X	X	X		500kW, 480 VAC, Supports core, containment and SFP cooling, instrumentation and controls
FLEX generators (4) and associated cables, connectors	X	X	X	X		100kW, 480 VAC, Supports core, containment and SFP cooling, instrumentation and controls
FLEX generators (9) and associated cables, connectors[1]	X	X	X	X		5500W, 120/ 240VAC, Supports communication and support functions.

Use and (Potential / Flexibility) Diverse Uses						***Performance Criteria***
List Portable Equipment	**Core**	**Containment**	**SFP**	**Instrumentation**	**Accessibility**	
Ventilation (Fans (6), ducts, cables)[1]	X	X	X	X	X	Support cooling plant spaces
Communications (Satellite Dish, hand-held radios, batteries, cables, chargers)[1]	X	X	X	X	X	Support on-site and off-site communications
Air Compressors (2)[1]	X	X	X			185 SCFM, 100psi, Supports core, containment and SFP cooling,
Tow vehicle (3)	X	X	X		X	Support large FLEX equipment deployment and debris removal
FLEX Manifold Trailers (3)	X	X	X			Support Water Management
Fuel tanker truck (2) with 2800 gal. tank and pump[1]	X	X	X	X	X	Support adding fuel to diesel engine driven FLEX equipment
Air driven fuel transfer pumps (2)[1]	X	X	X	X	X	Support adding fuel to diesel engine driven FLEX equipment
Note 1: Support Equipment, not required to meet N+1.						

Table 11.2: Offsite Phase 3 Equipment List

Use and (Potential / Flexibility) Diverse Uses									Performance Criteria		Notes
List Portable Equipment	Quantity Req'd /Unit	Quantity Provided / Unit	Power	Core Cooling	Cont. Cooling/ Integrity	Access	Instrumentation	SFP Cooling			
Medium Voltage Generators	0	2	GTG	X	X		X		4.16 kV	1 MW	(1)
Low Voltage Generators	0	1	GTG	X	X		X		480 VAC	1100 KW	(1)
High Pressure Injection Pump	0	1	Diesel						2000psi	60 GPM	(1)
S/G RPV Makeup Pump	0	1	Diesel	X	X				500 psi	500 GPM	(1)
Low Pressure / Medium Flow Pump	0	1	Diesel	X	X				300 psi	2500 GPM	(1)
Low Pressure / High Flow Pump	0	1	Diesel	X	X			X	150 psi	5000 GPM	(1)
Lighting Towers	0	3	Diesel			X			440,000 Lu		(1)
Diesel Fuel Transfer	0	1	AC/DC	X	X	X	X	X	500 gallon air-lift container		(1)

Use and (Potential / Flexibility) Diverse Uses									Performance Criteria		Notes
List Portable Equipment	**Quantity Req'd /Unit**	**Quantity Provided / Unit**	**Power**	**Core Cooling**	**Cont. Cooling/ Integrity**	**Access**	**Instrumentation**	**SFP Cooling**			
Diesel Fuel Transfer Tank	0	1							264 gallon tank, with mounted AC/DC pumps		(1)
Portable Fuel Transfer Pump	0	1							60 gpm after filtration		(1)
Electrical Distribution System	0	1					X		4160 V	250 MVA, 1200 A	(1)
Suction Booster Lift Pump	0	2	Diesel	X	X			X	26 Feet Lift	5000 GPM	(2)
Air Compressor	0	1	Diesel	X	X				300 CFM	150 PSI	(2)
Water Treatment	0	1	Diesel	X	X			X		500 GPM	(2) (3)
Water Storage	0	1		X	X			X		20,000 GAL	(2)
Mobile Boration	0	1	Diesel	X				X	7750 ppm Boron	1000 Gal	(2)

Use and (Potential / Flexibility) Diverse Uses									Performance Criteria		Notes
List Portable Equipment	**Quantity Req'd /Unit**	**Quantity Provided / Unit**	**Power**	**Core Cooling**	**Cont. Cooling/ Integrity**	**Access**	**Instrumentation.**	**SFP Cooling**			
Portable Ventilation Fans	0	1	AC			X			200 Feet	3000 CFM	(2)

Note 1 NSRC Generic Equipment – Not required for Phase 2 FLEX Strategy – Provided as Defense-in-Depth.
Note 2 NSRC Non-Generic Equipment needed to support use of NSRC Generic Pumps due to suction lift requirements using Chesapeake Bay as source of make-up water. – Not required for Phase 2 FLEX Strategy – Provided as Defense-in-Depth
Note 3 Water Treatment usage dependent upon availability of other water sources

Table 11.3 CCNPP FLEX Equipment Test and Maintenance Overview

Equipment[1]	Quantity	Monthly	6 Month	Annual	3 Year	Notes
Diesel Pump	9	Walk down	Functional Test and Inspection (Dry Run)	Performance Test, Inspection and PM (Wet Run)	Performance Test, Inspection and PM (100% Loaded Run)	Post-run Inspections on demand
Diesel Generator (Cummins 500 kW)	2	Walk down	Functional Test and Inspection (Unloaded Run)	Performance Test, Inspection and PM (30% Loaded Run)	Performance Test, Inspection and PM (100% Loaded Run)	Post-run Inspections on demand
Diesel Generator (Cummins 100kW)	4	Walk down	Functional Test and Inspection (Unloaded Run)	Performance Test, Inspection and PM (30% Loaded Run)	Performance Test, Inspection and PM (100% Loaded Run)	Post-run Inspections on demand
Air Compressors	2	Walk down	Functional Test and Inspection (Unloaded Run)	Performance Test, Inspection and PM (30% Loaded Run)	Performance Test, Inspection and PM (100% Loaded Run)	Post-run Inspections on demand
Cables (for both generators and battery charger cables)	Stored in Plant and FLEX Building			Visual Inspection and assessment		20 Year Insulation test
Hoses (for both pumps and permanent connections hoses)	Stored in Plant and FLEX Building			Visual Inspection and assessment	Hydrostatic test of all hoses	Replace every 10 years or test and justify extension/life

Equipment[1]	Quantity	Monthly	6 Month	Annual	3 Year	Notes
Communications (hand-held radios, Sound powered phones, 120VAC generators)	14 - SPP 9 - 120VAC generators 25 - radios		Functional test and inspection (Radios), Functional test including associated FLEX circuits (sound powered phones)	Functional test and Inspection (small 120VAC generators)		

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13. Acronyms

AC .... Alternating Current
ADV .... Atmospheric Dump Valve
AFW .... Auxiliary Feedwater
AOP .... Abnormal Operating Procedure
ATWS .... Anticipated Transient Without Scram
BAST .... Boric Acid Storage Tank
BCD .... Bus Connection Device
BDB .... Beyond-Design-Basis
BDBEEs ...... Beyond-Design-Basis External Events
CAC .... Containment Air Cooler
CC .... Component Cooling Water
CCNPP .... Calvert Cliffs Nuclear Power Plant
CE .... Combustion Engineering
CET .... Core Exit Thermocouple
CRO .... Control Room Operator
CRS .... Control Room Supervisor
CST .... Condensate Storage Tank
CVCS .... Chemical Volume and Control System
DWST .... Demineralized Water Storage Tank
DC .... Direct Current
DG .... Diesel Generator
ECP .... Engineering Change Package
EDMG .... Extreme Damage Mitigation Guideline
ELAP .... Extended Loss of Alternating Current (AC) Power
EOP .... Emergency Operating Procedure
ERO .... Emergency Response Organization
ESEP .... Expedited Seismic Evaluation Process
FHRR .... Flood Hazard Reevaluation Report
FCV .... Flow Control Valve
FOST .... Fuel Oil Storage Tank
FSG .... FLEX Support Guideline
FSRB .... FLEX Storage Robust Building
GMRS .... Ground Motion Response Spectrum
GTG .... Gas Turbine Generator
H_2 .... Hydrogen
HHA .... Hierarchal Hazard Assessment

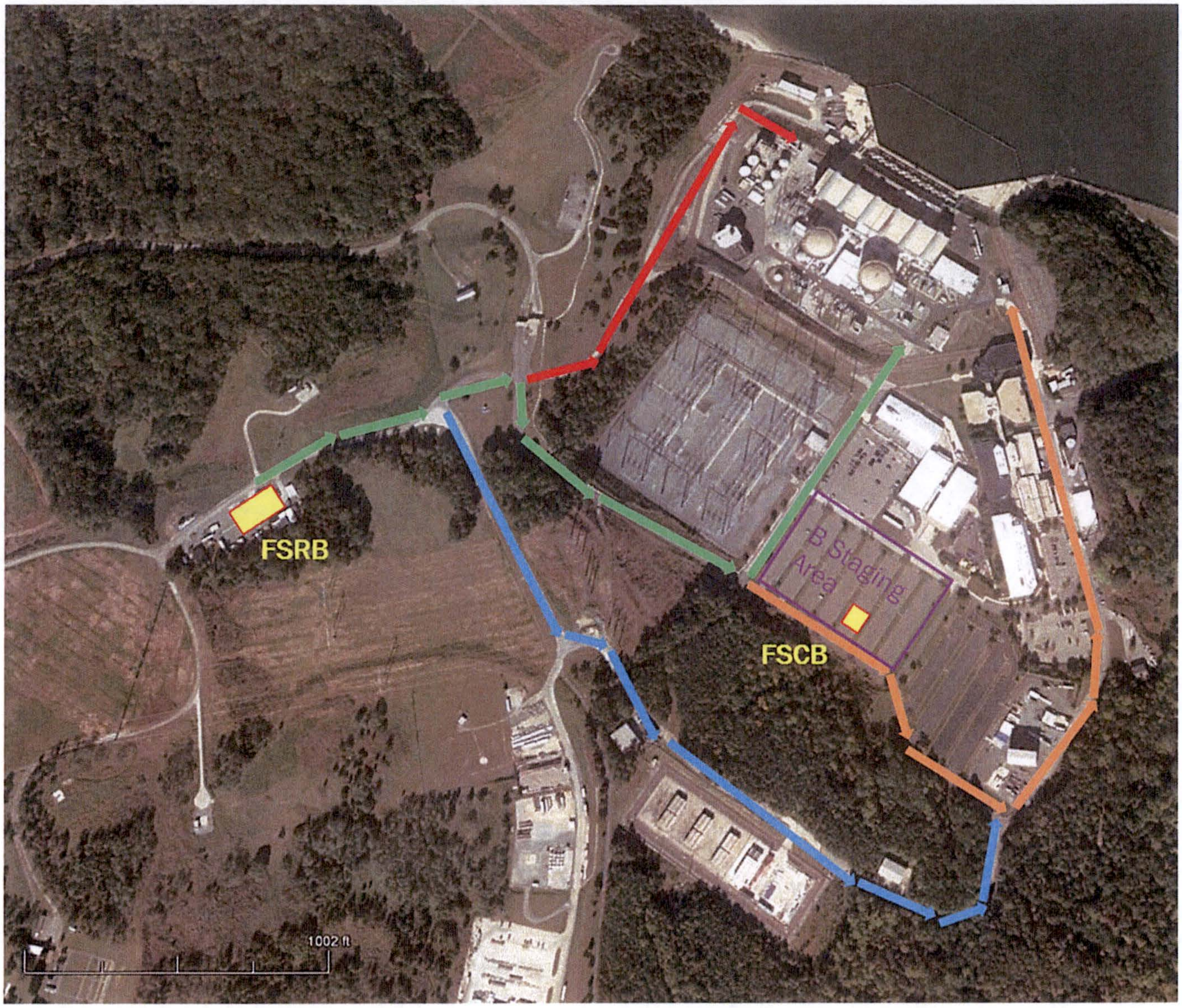
HCLPF .... High-Confidence-of-Low-Probability-of-Failure
Hz................ Hertz
HVAC .... Heating, Ventilation, and Air Conditioning
IHS .... IPEEE HCLPF Spectrum
IPEEE.......... Individual Plant Examination of External Events
ISFSI .... Independent Spent Fuel Storage Installation
ISG .... Interim Staff Guidance
LIP............... Local Intense Precipitation
LOOP .... Loss of Off-site Power
LPSI .... Low Pressure Safety Injection
MCC .... Motor Control Center
MDAFW....... Motor-driven AFW
MLMS.......... Mansell Level Monitoring System
MM .... Mechanical Maintenance
MOV .... Motor Operated Valve
MSL............. Mean Sea Level
MWt............ Megawatt thermal
N_2 .... Nitrogen
NH .... National Hose
NGVD 29..... National Geodetic Vertical Datum of 1929
NSO .... Nuclear Security Officer
NSRC .... National SAFER Response Center
NRC .... Nuclear Regulatory Commission
OI .... Operating Instruction
OP .... Operating Procedure
OSO .... Outside Operator
PA .... Protected Area
pcm .... PerCent Millirho (ρ)
PMSS .... Probable Maximum Storm Surge
PO .... Plant Operator
PP .... Pump
psf .... Pounds per square foot
PWST.......... Pretreated Water Storage Tanks
RAI .... Request for Additional Information
RCS............. Reactor Coolant System
RFP .... Refueling Pool
RLGM.......... Review Level Ground Motion
RO............... Reactor Operator

RPM .... Revolutions per minute
RPS .... Reactor Protective System
RVLMS .... Reactor Vessel Level Monitoring System
RWT .... Refueling Water Tank
SAFER .... Strategic Alliance for FLEX Emergency Response
SAT .... Systematic Approach to Training
SAMG .... Severe Accident Mitigation Guideline
SDC .... Shutdown Cooling
SDM .... Shutdown Margin
SFP .... Spent Fuel Pool
SFPC .... Spent Fuel Pool Cooling System
SFPHXs ...... Spent Fuel Pool Heat Exchangers
SIS .... Safety Injection System
SIT .... Safety Injection Tank
SM .... Shift Manager
SPID .... Screening, Prioritization and Implementation Details
S/G .... Steam Generator
SRW .... Service Water System
SSCs .... Structures, Systems and Components
SSE .... Safe Shutdown Earthquake
STA .... Shift Technical Advisor
SW .... Saltwater System
TS .... Technical Specifications
TSC .... Technical Support Center
TDAFW .... Turbine Driven Auxiliary Feedwater
UFSAR .... Updated Final Safety Analysis Report
UHS .... Ultimate Heat Sink
UPS .... Uninterruptable Power Supply
VAP .... Value Added Pellet
VDC .... Volts Direct Current

14. Figures

Figure 14-1: FLEX Deployment Routes 114
Figure 14-2: CCNPP FLEX Electrical One-line Schematic 115
Figure 14-3: Power to Unit-1 480 VAC Load Center 11B from 500kW DG Turbine Building 45' Elevation 116
Figure 14-4: Power to Unit-1 480 VAC Load Center 11B from 500kW DG Turbine Building 27' Elevation 117
Figure 14-5: Power to Unit-1 480 VAC Load Center 14A from 500kW DG Turbine Building 45' Elevation 118
Figure 14-6: Power to Unit-1 480 VAC Reactor MCC 104R from 100kW DG 119
Figure 14-7: Available Tank Farm Connections to 12 Condensate Storage Tank 120
Figure 14-8: AFW System FLEX Connections 121
Figure 14-9: Unit 1 S/G Makeup from FLEX Manifold 45' Elevation 122
Figure 14-10: Unit 1 S/G Makeup from FLEX Manifold 5' Elevation 123
Figure 14-11: Alternate S/G Makeup Hose Connection Path 124
Figure 14-12: Unit 1 FLEX RCS Makeup 45' Elevation 125
Figure 14-13: Unit 1 FLEX RCS Makeup 27' Elevation 126
Figure 14-14: 12 CST Makeup From Well Water 127
Figure 14-15: 12 CST Makeup From Chesapeake Bay via Intake Structure 128
Figure 14-16: 12 CST Makeup From Chesapeake Bay via Discharge Canal 129
Figure 14-17: SW Makeup from Chesapeake Bay to 36" Flange 130
Figure 14-18: SFP Makeup from Chesapeake Bay to Spoolpiece 45' Elevation 131
Figure 14-19: SFP Makeup from Chesapeake Bay Direct Injection 45' Elevation 132
Figure 14-20: SFP Makeup from Chesapeake Bay to Spoolpiece 27' Elevation 133
Figure 14-21: SFP Makeup from Chesapeake Bay Direct Injection 69' Elevation 134

Figure 14-1: FLEX Deployment Routes



Deployment Route Priority:

1. Green
2. Orange
3. Blue
4. Red

Figure 14-2: CCNPP FLEX Electrical One-line Schematic

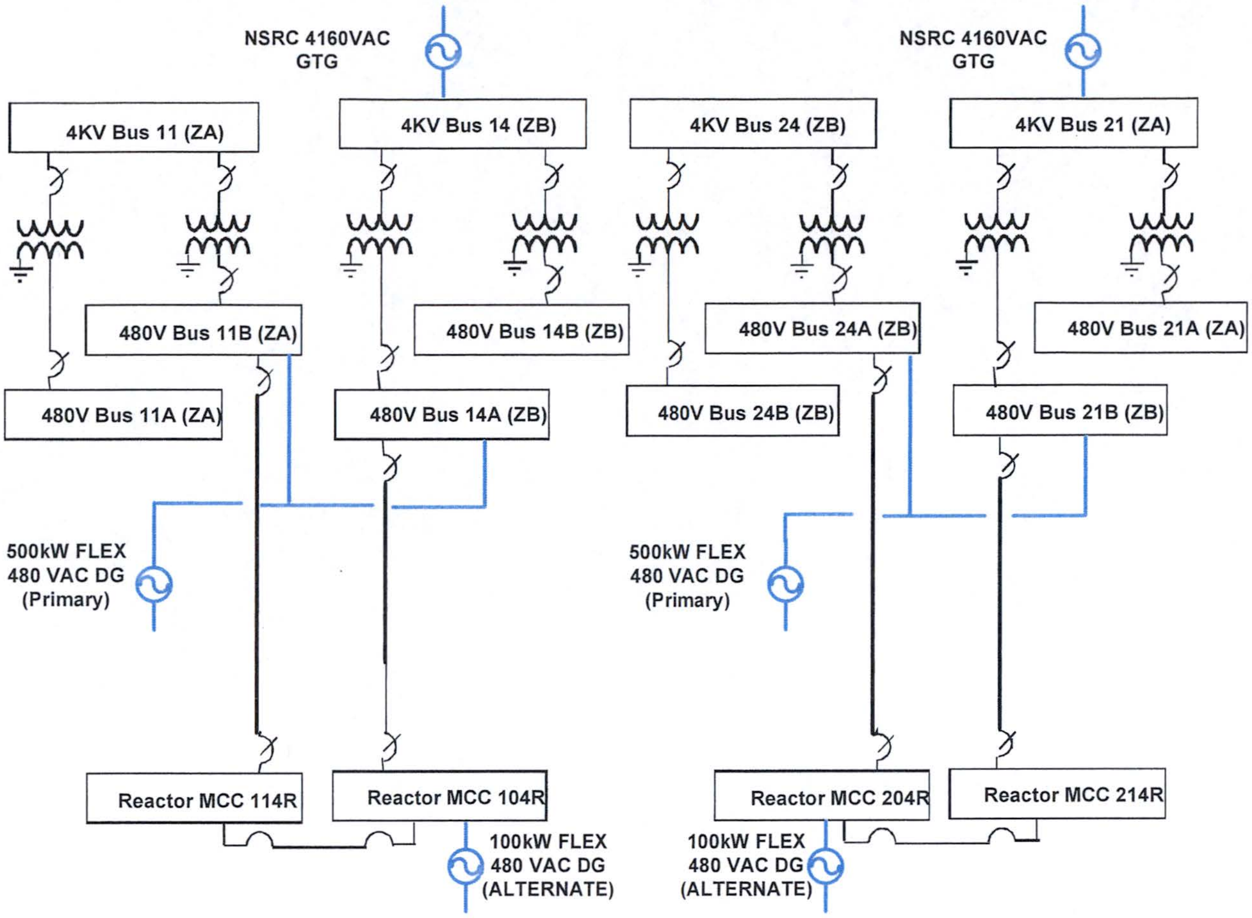
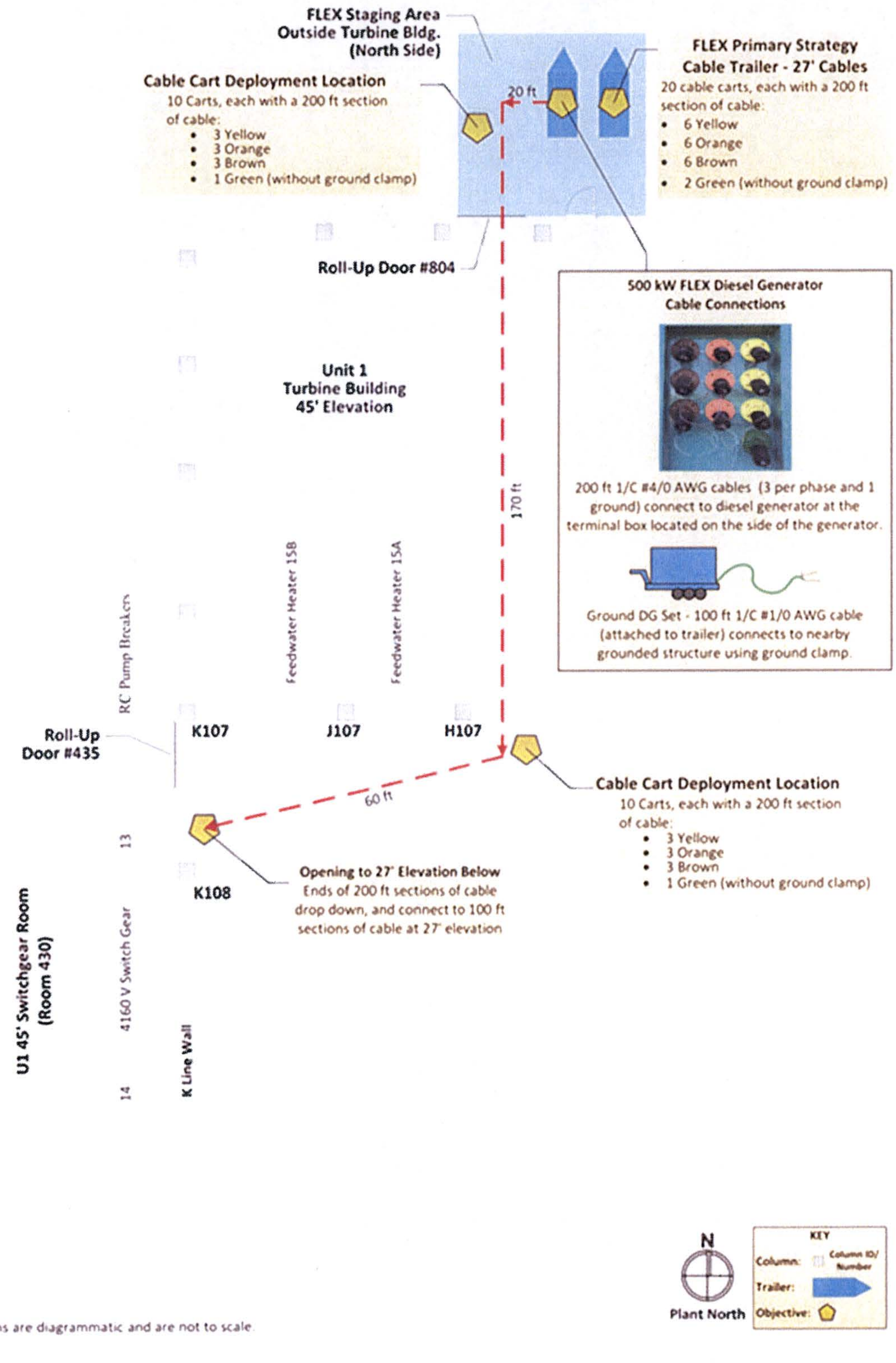
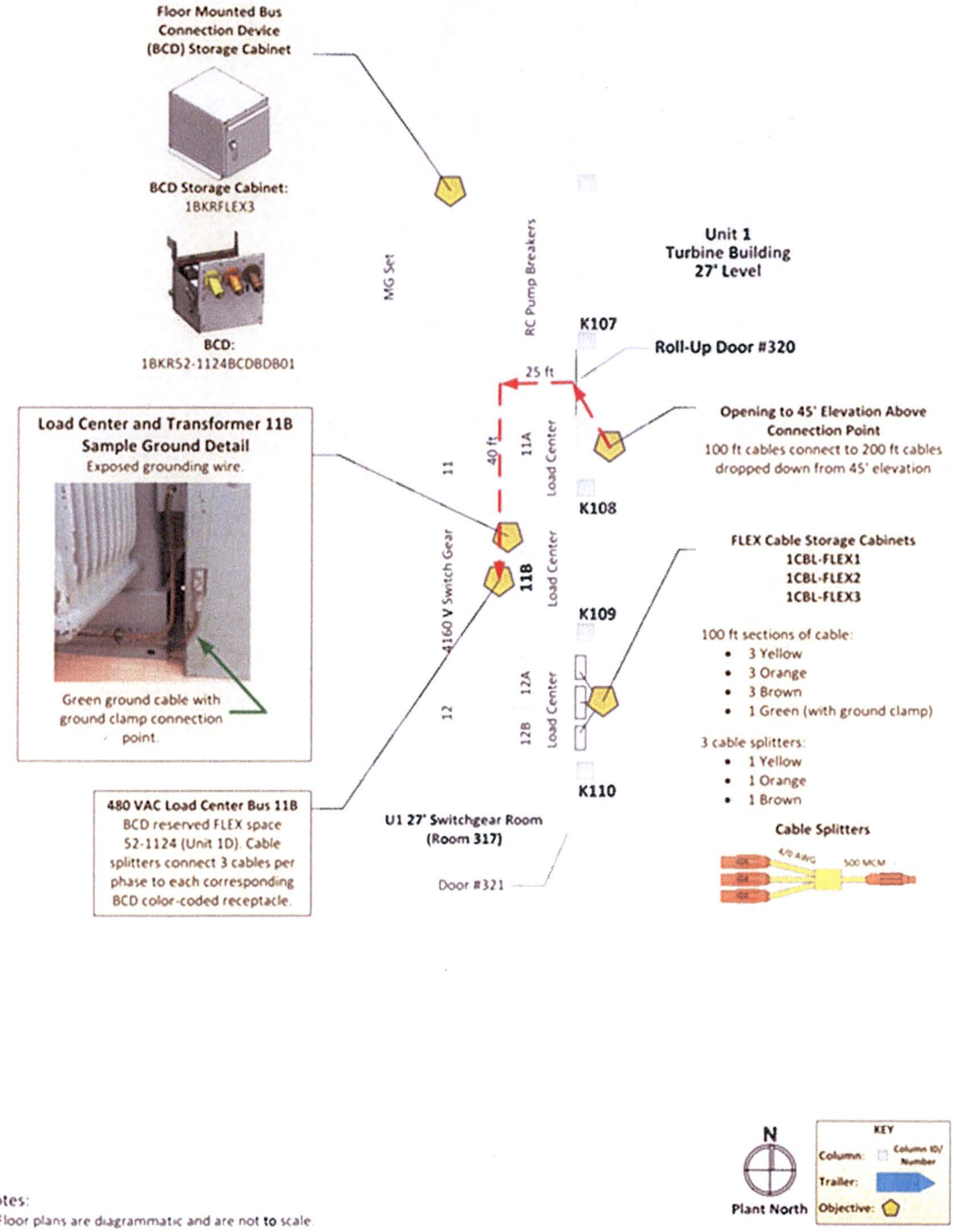


Figure 14-3: Power to Unit-1 480 VAC Load Center 11B from 500kW DG Turbine Building 45' Elevation



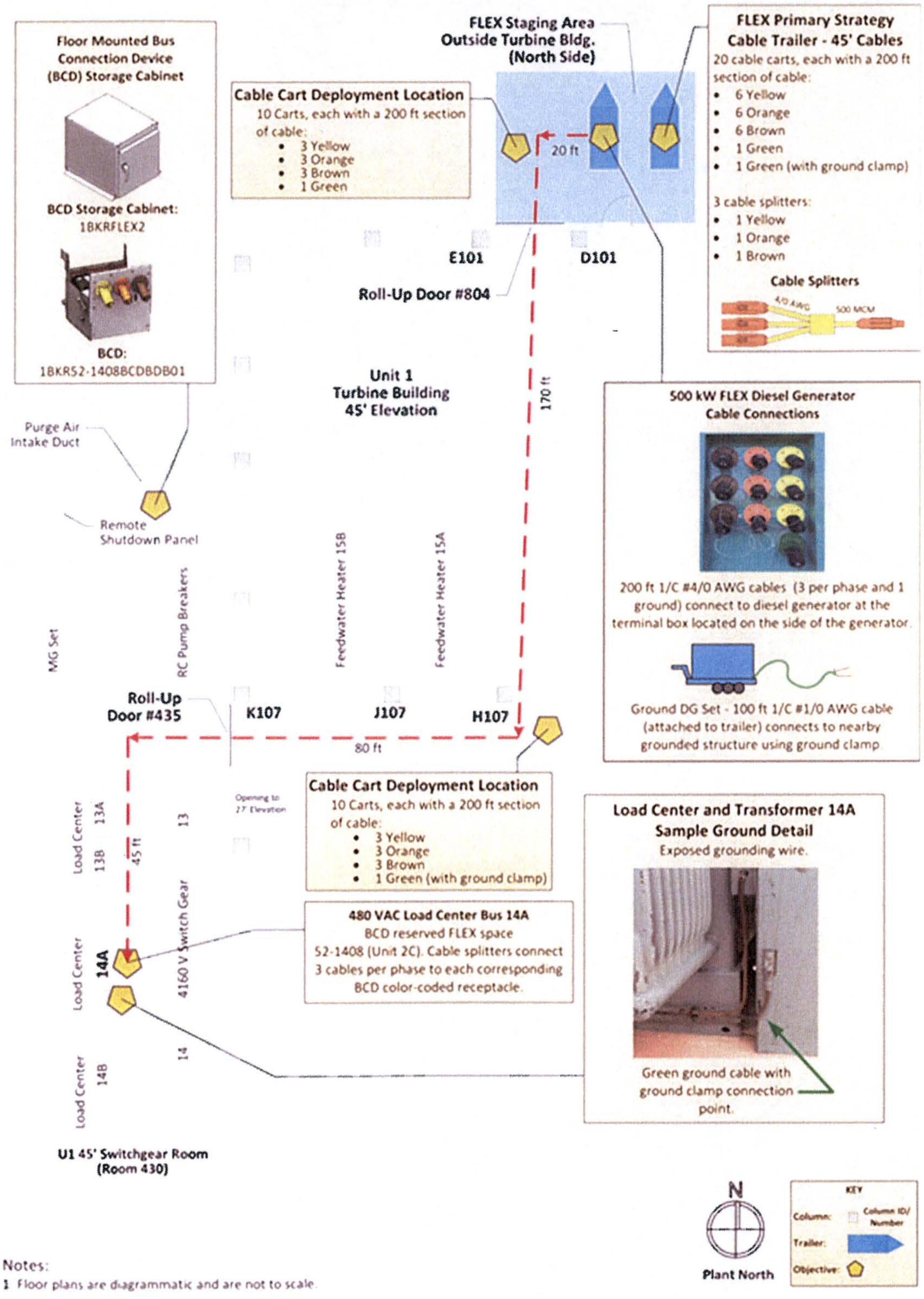
Notes:
1. Floor plans are diagrammatic and are not to scale.

Figure 14-4: Power to Unit-1 480 VAC Load Center 11B from 500kW DG Turbine Building 27' Elevation



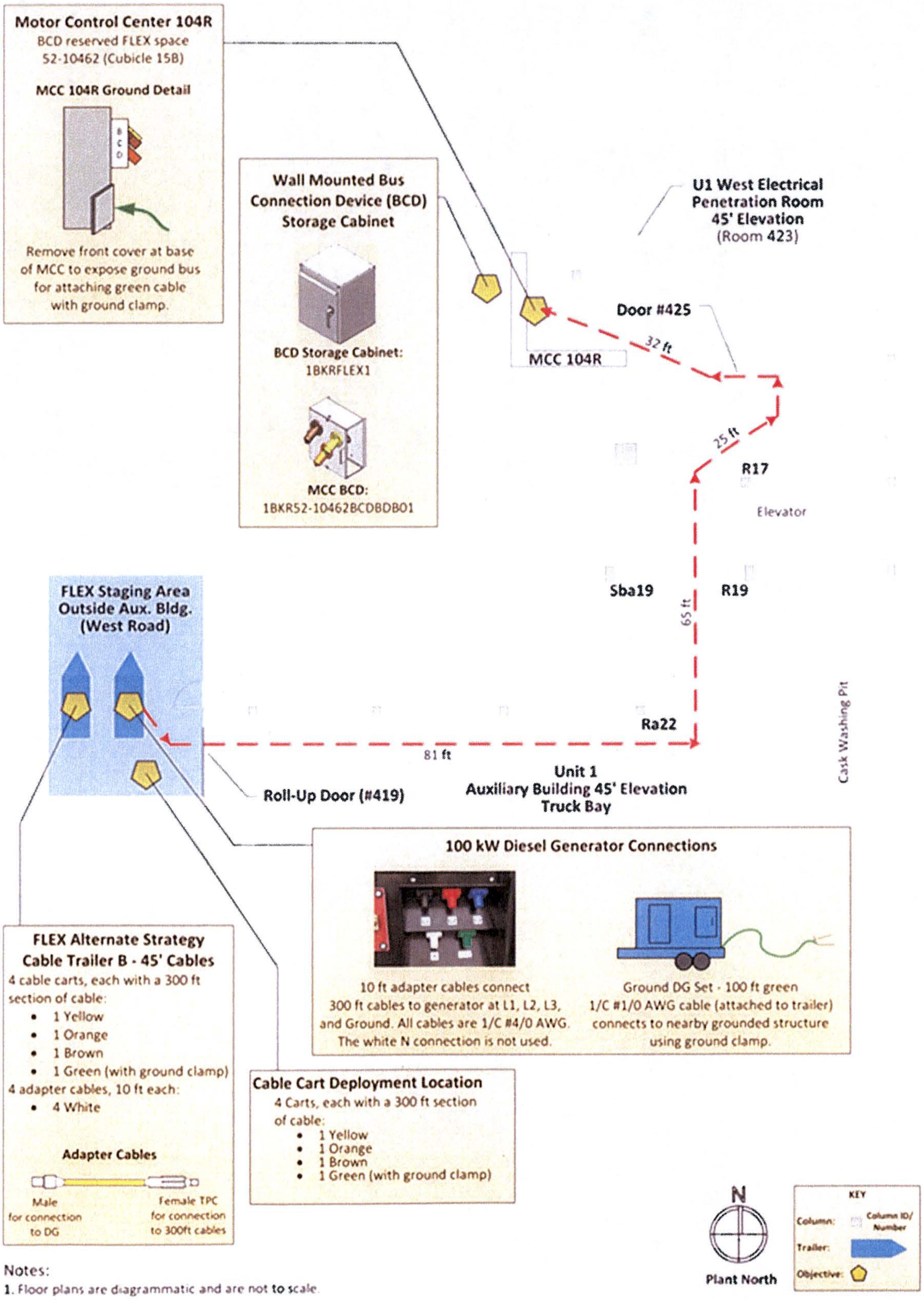
Notes:
1. Floor plans are diagrammatic and are not to scale.

Figure 14-5: Power to Unit-1 480 VAC Load Center 14A from 500kW DG Turbine Building 45' Elevation



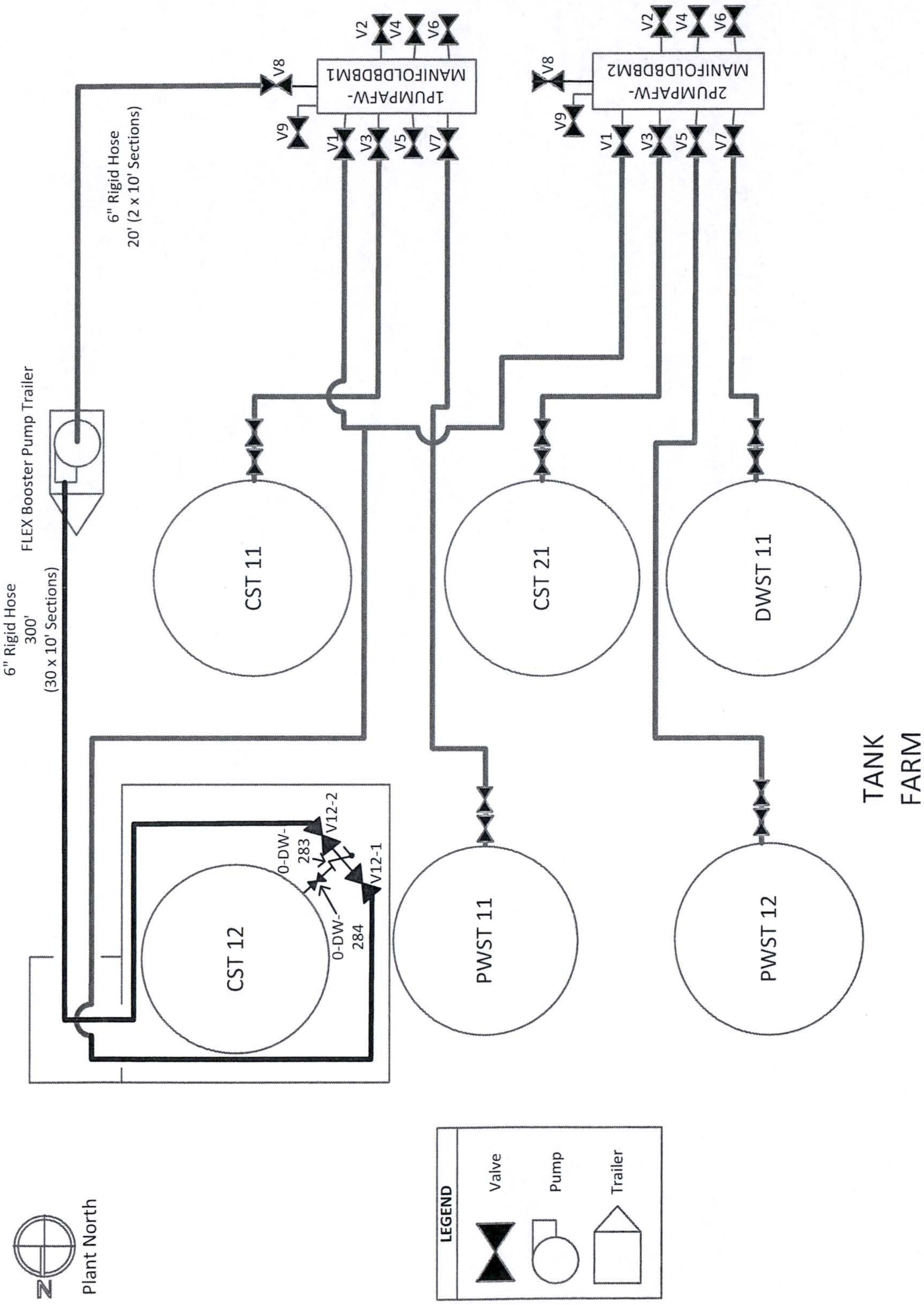
Notes:
1. Floor plans are diagrammatic and are not to scale.

Figure 14-6: Power to Unit-1 480 VAC Reactor MCC 104R from 100kW DG



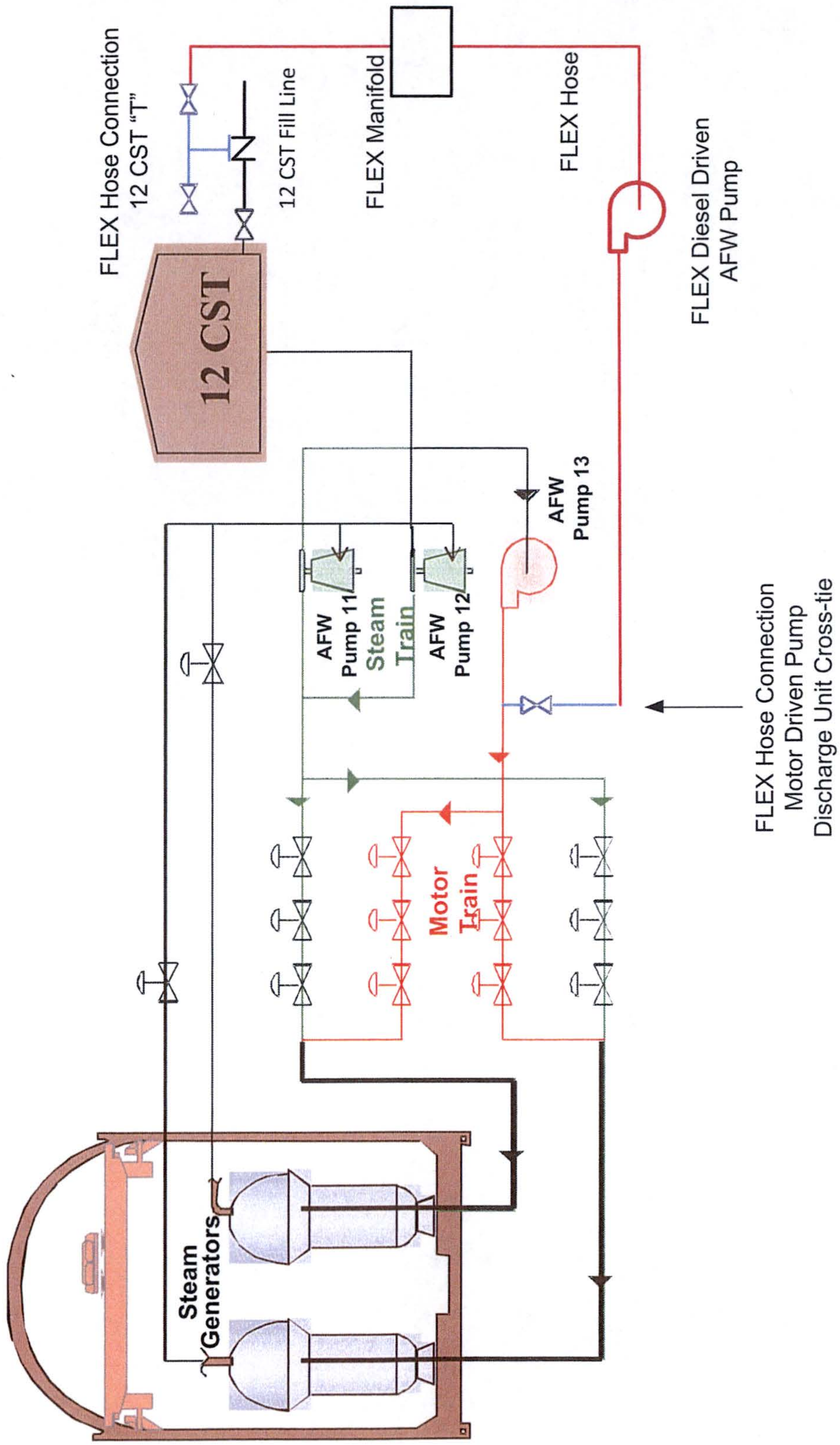
Notes:
1. Floor plans are diagrammatic and are not to scale.

Figure 14-7: Available Tank Farm Connections to 12 Condensate Storage Tank



NOTES:
1. Dimensions are not to scale
2. Floor plan is diagrammatic and not to scale

Figure 14-8: AFW System FLEX Connections



Enclosure

Calvert Cliffs Nuclear Power Plant, Units 1 and 2

Final Integrated Plan

Mitigation Strategies for a Beyond-Design-Basis External Event

(NRC Order EA-12-049)

May 2016

(134 Pages)

Figure 14-9: Unit 1 S/G Makeup from FLEX Manifold 45' Elevation

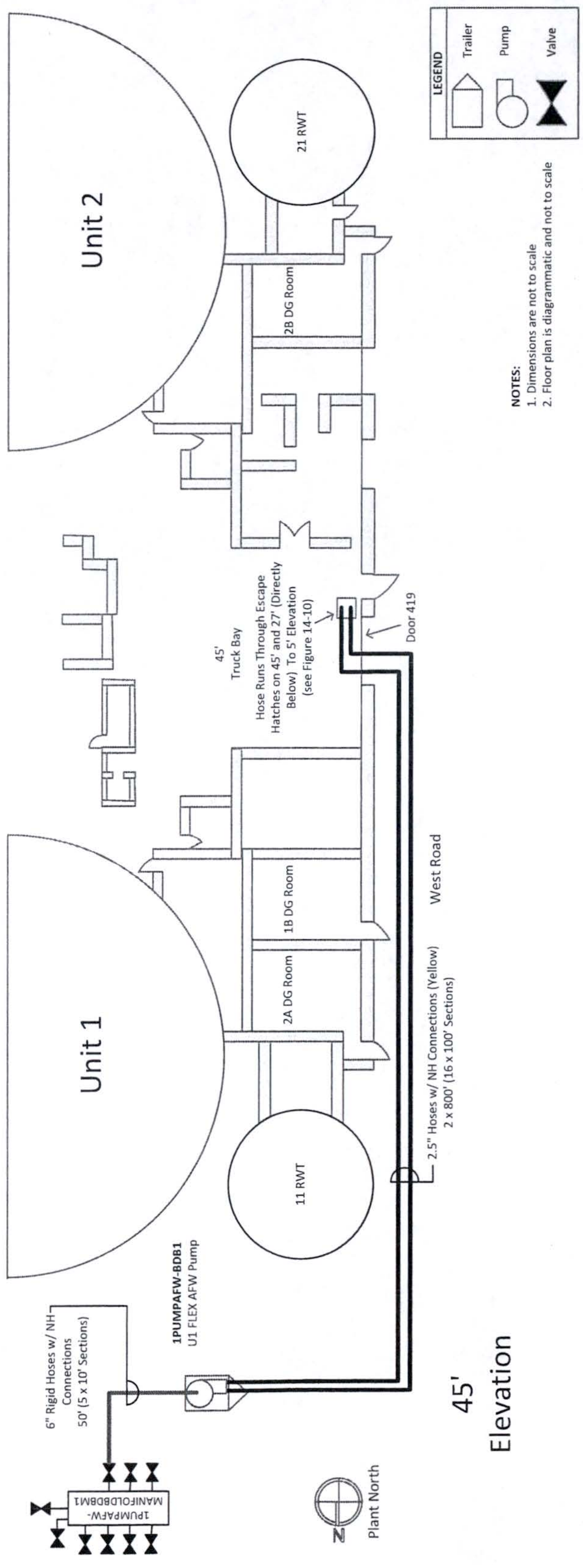


Figure 14-10: Unit 1 S/G Makeup from FLEX Manifold 5' Elevation

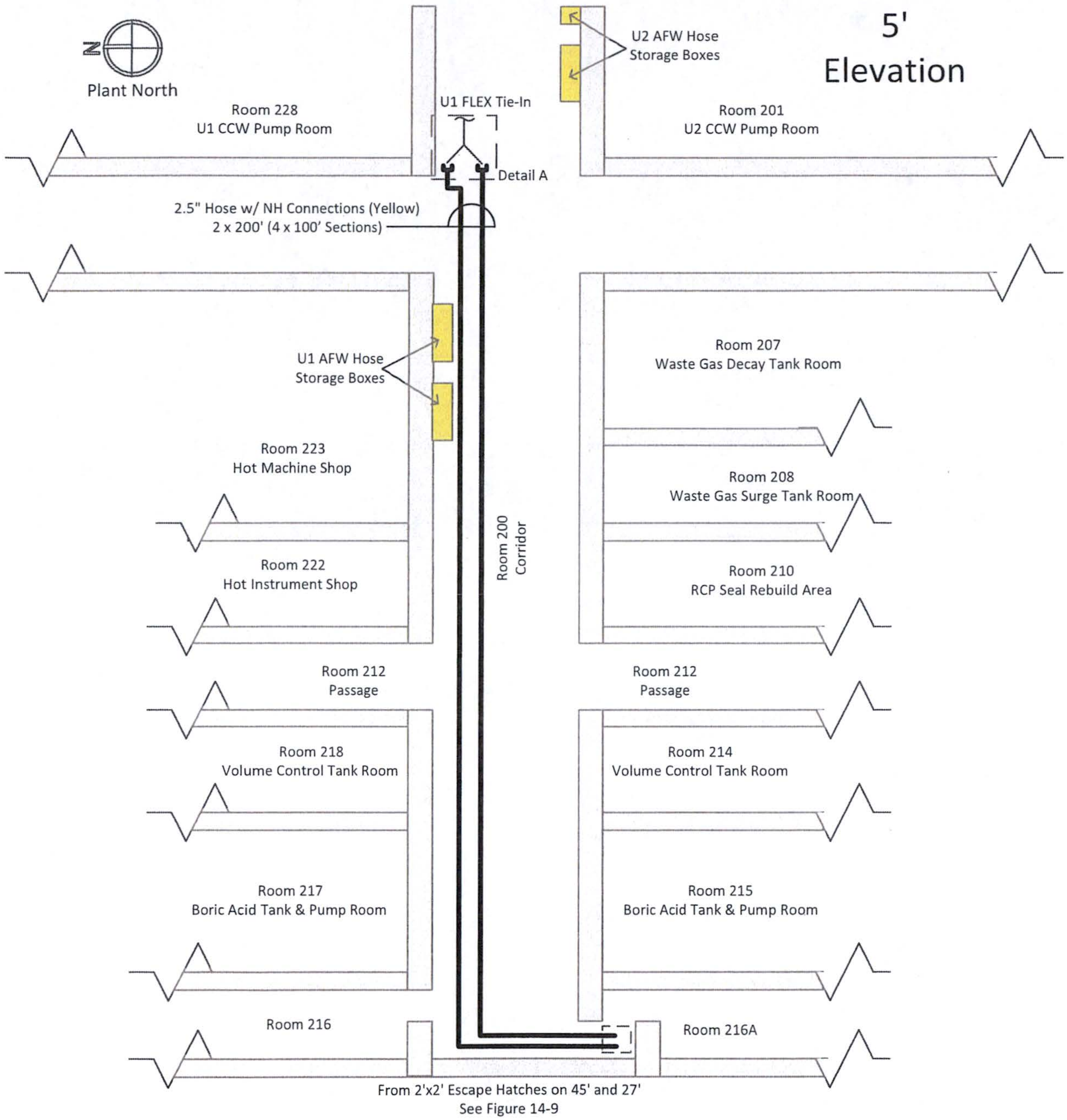
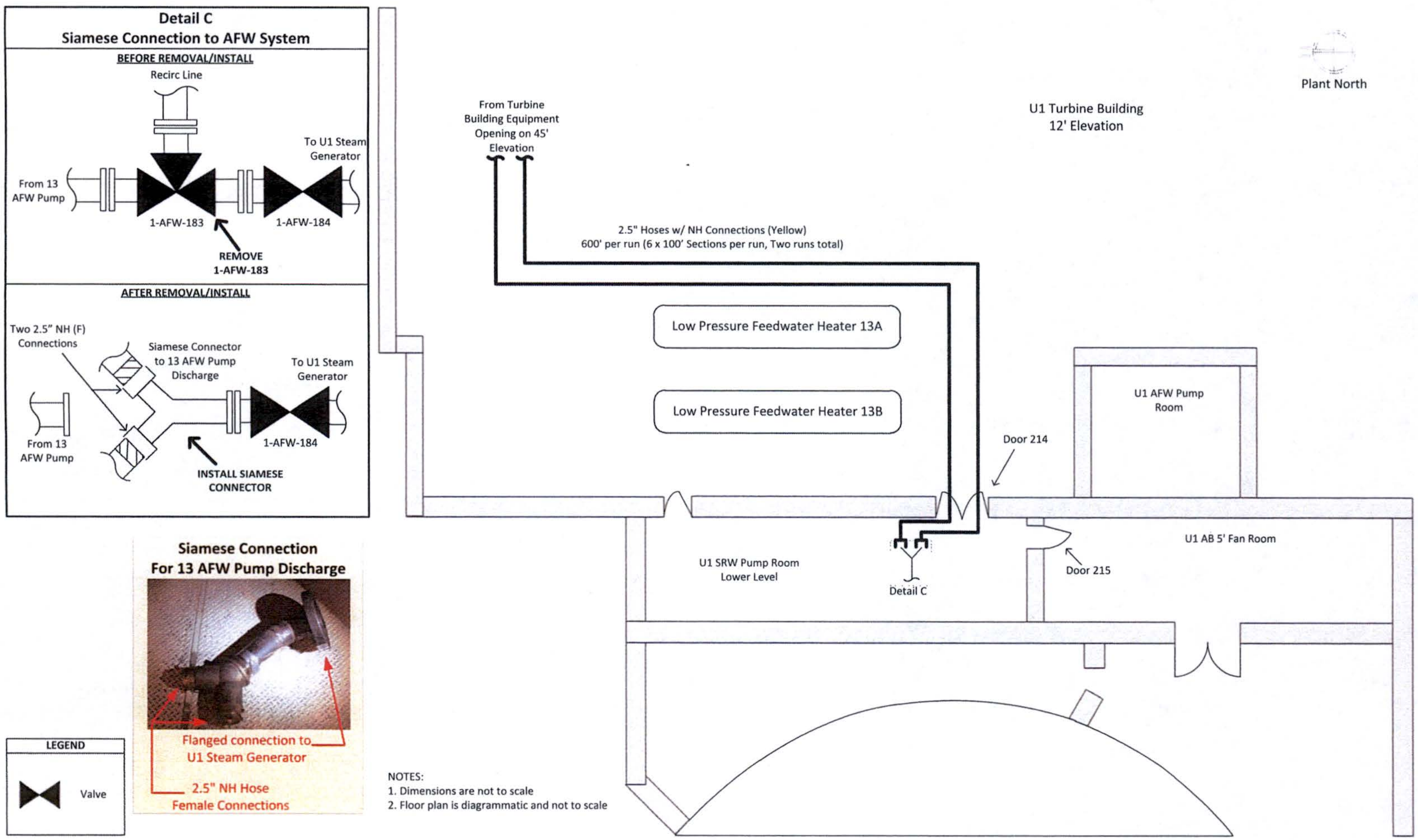


Figure 14-11: Alternate S/G Makeup Hose Connection Path



NOTES:
1. Dimensions are not to scale
2. Floor plan is diagrammatic and not to scale

Figure 14-12: Unit 1 FLEX RCS Makeup 45' Elevation

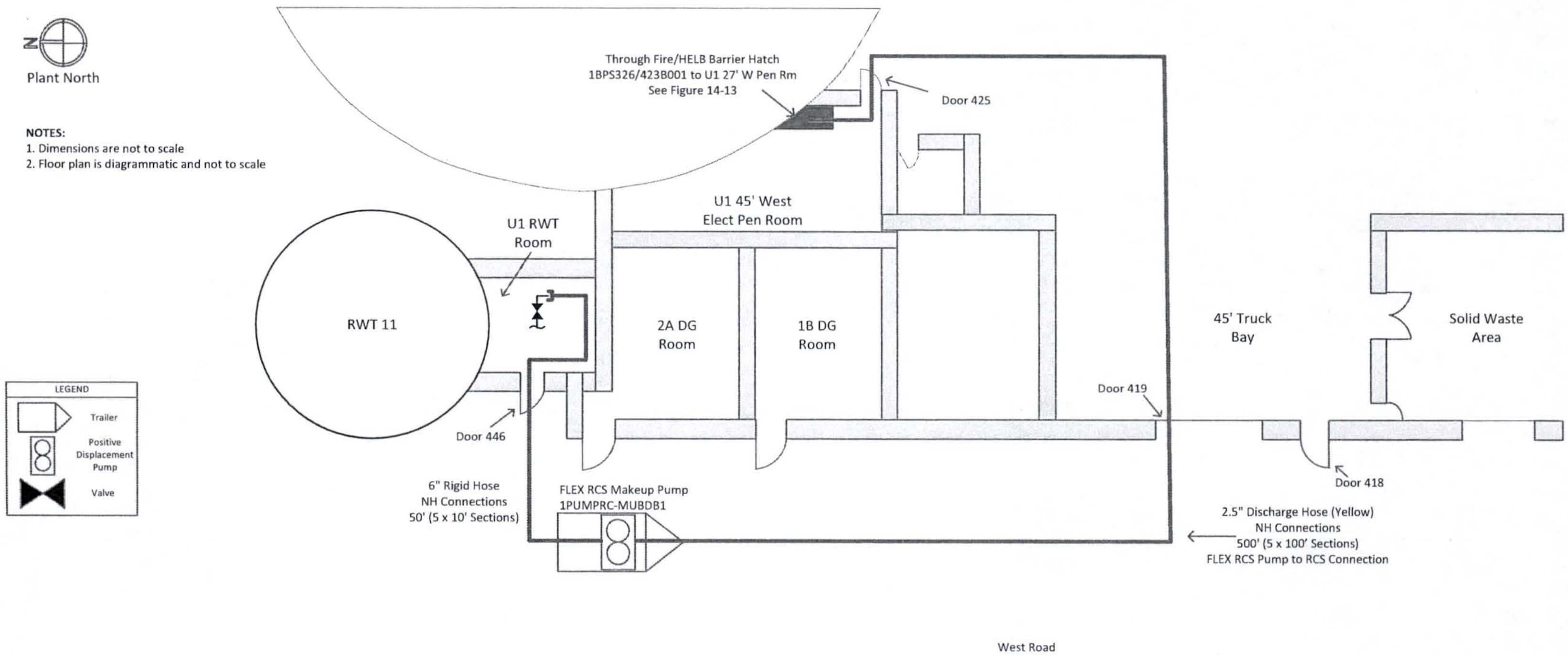


Figure 14-13: Unit 1 FLEX RCS Makeup 27' Elevation

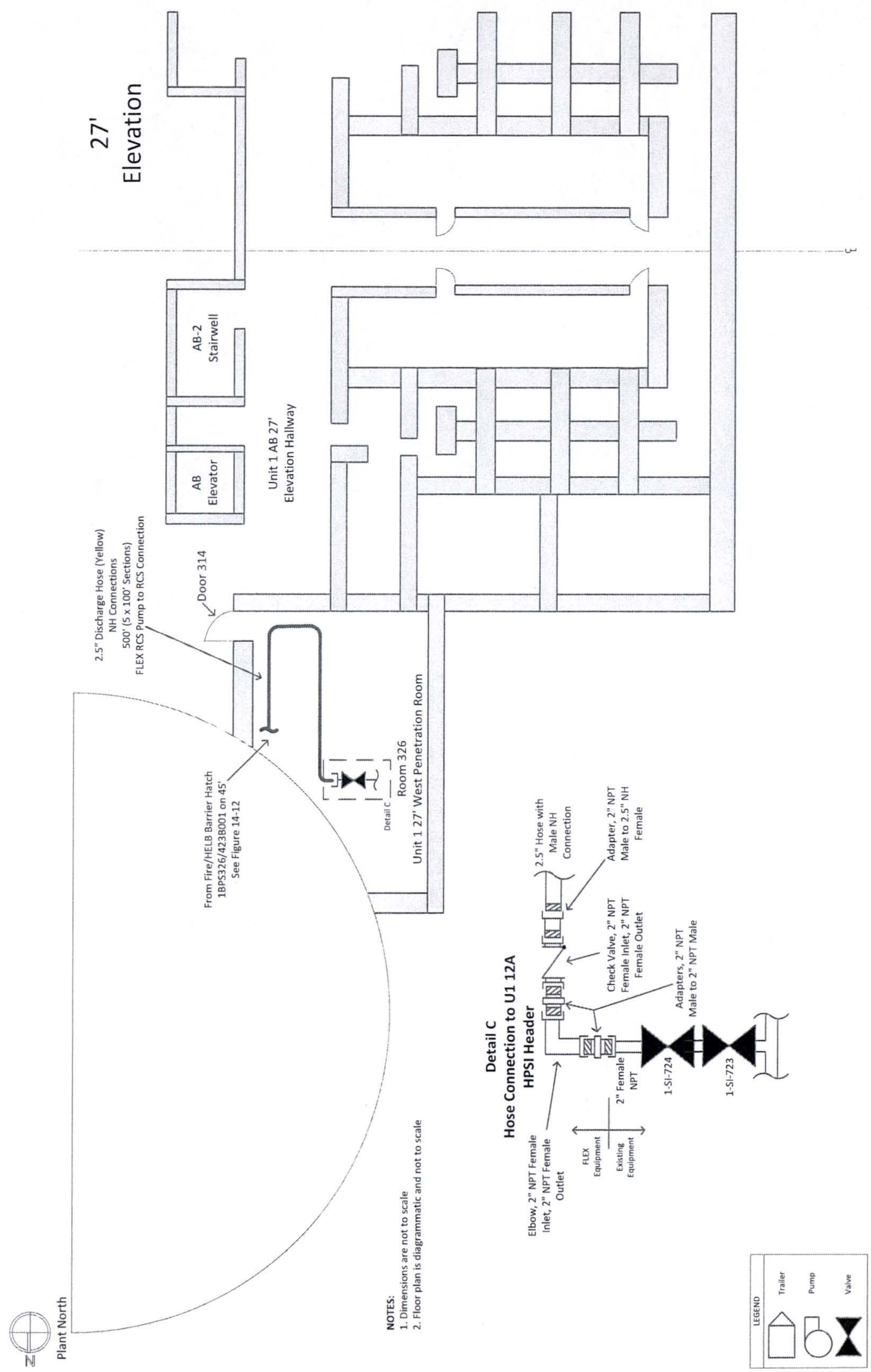
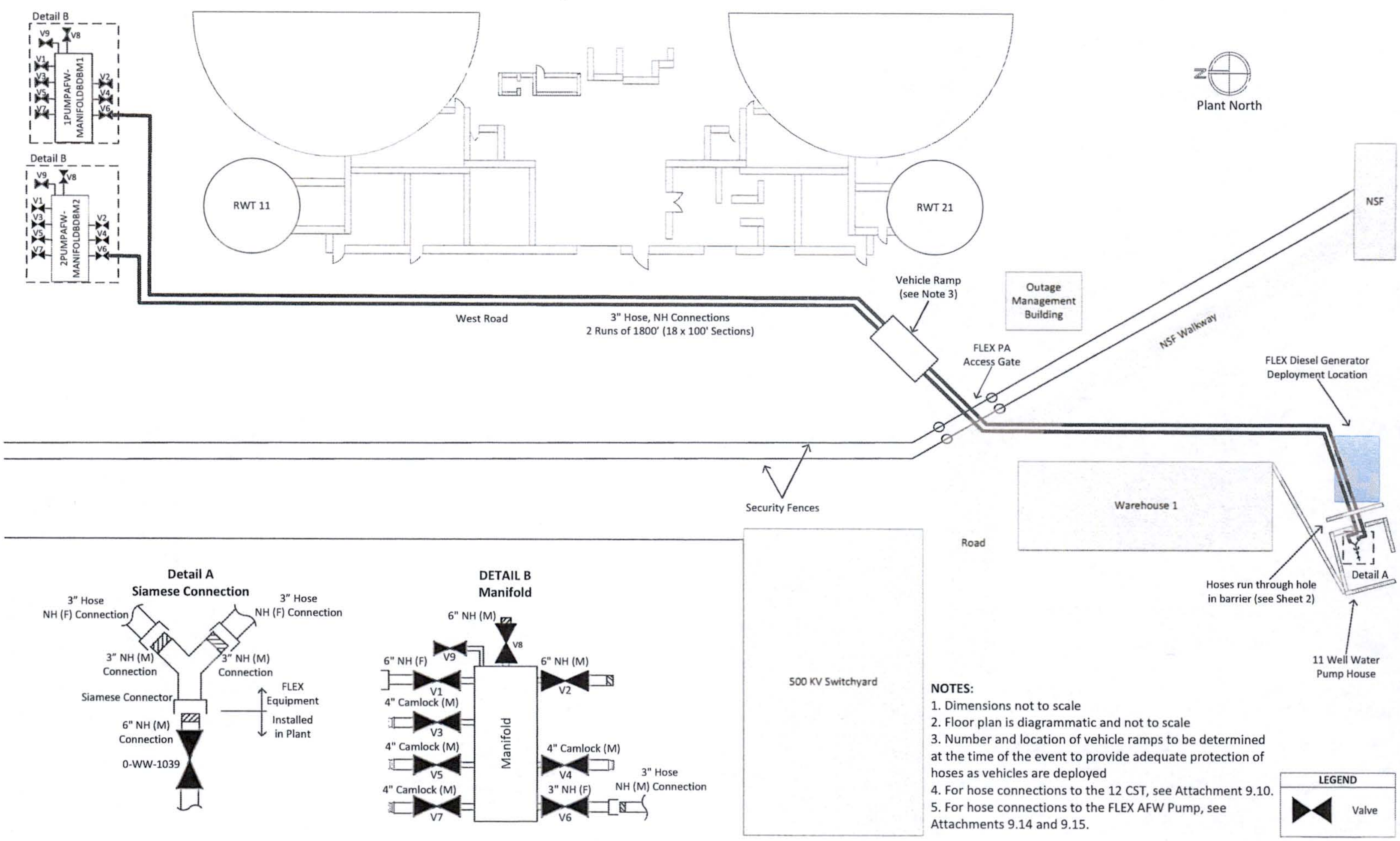


Figure 14-14: 12 CST Makeup From Well Water



NOTES:
1. Dimensions not to scale
2. Floor plan is diagrammatic and not to scale
3. Number and location of vehicle ramps to be determined at the time of the event to provide adequate protection of hoses as vehicles are deployed
4. For hose connections to the 12 CST, see Attachment 9.10.
5. For hose connections to the FLEX AFW Pump, see Attachments 9.14 and 9.15.

Figure 14-15: 12 CST Makeup From Chesapeake Bay via Intake Structure

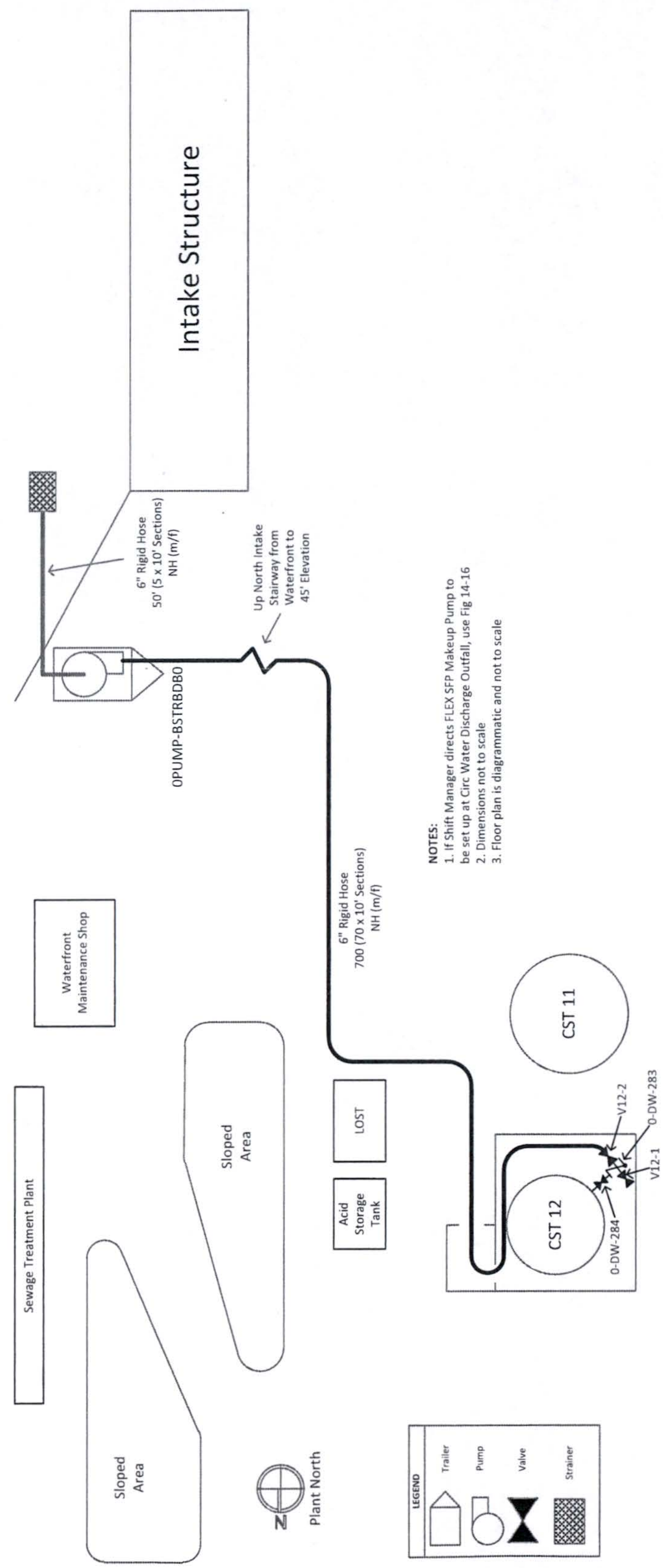
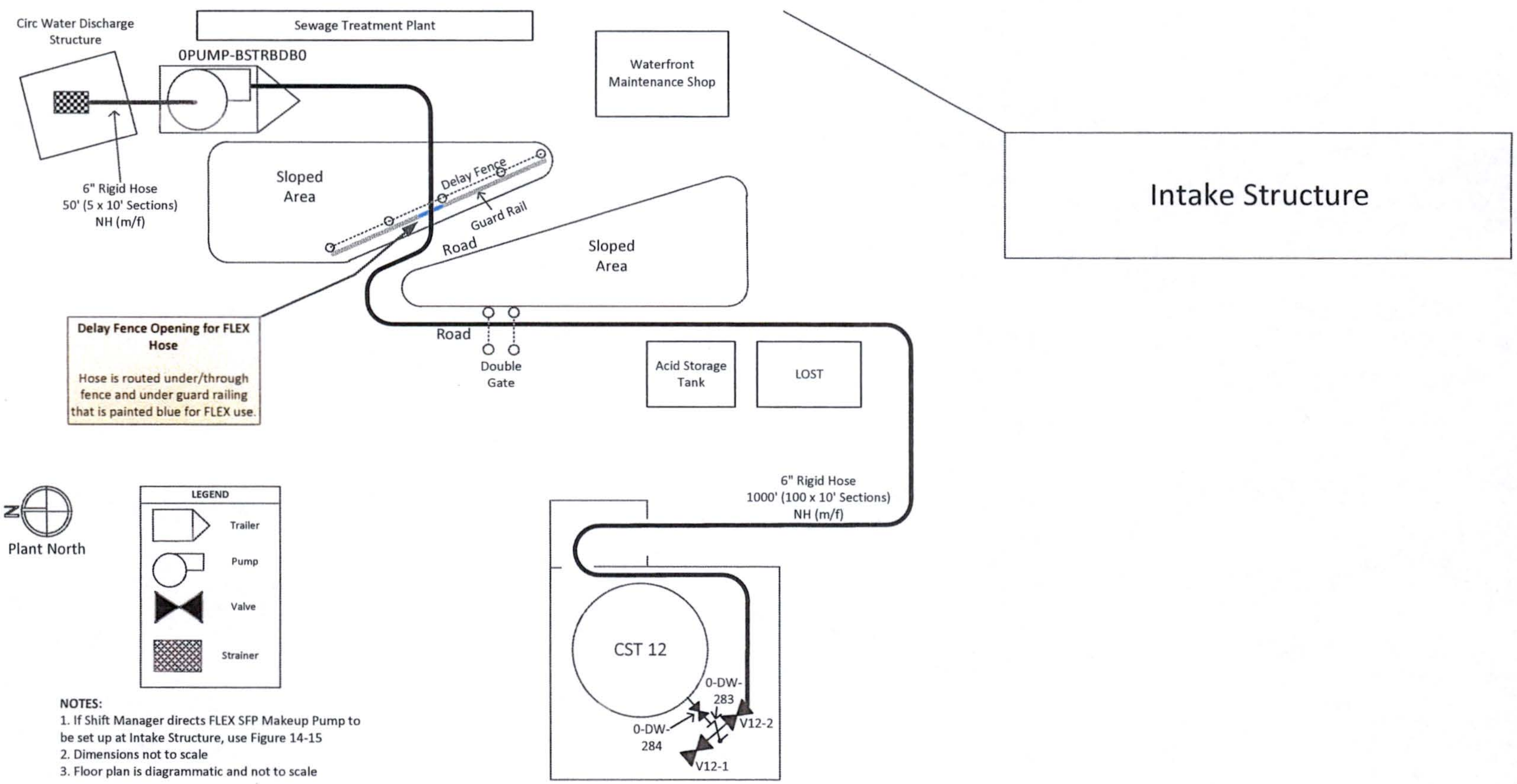


Figure 14-16: 12 CST Makeup From Chesapeake Bay via Discharge Canal



NOTES:
1. If Shift Manager directs FLEX SFP Makeup Pump to be set up at Intake Structure, use Figure 14-15
2. Dimensions not to scale
3. Floor plan is diagrammatic and not to scale

Figure 14-17: SW Makeup from Chesapeake Bay to 36" Flange

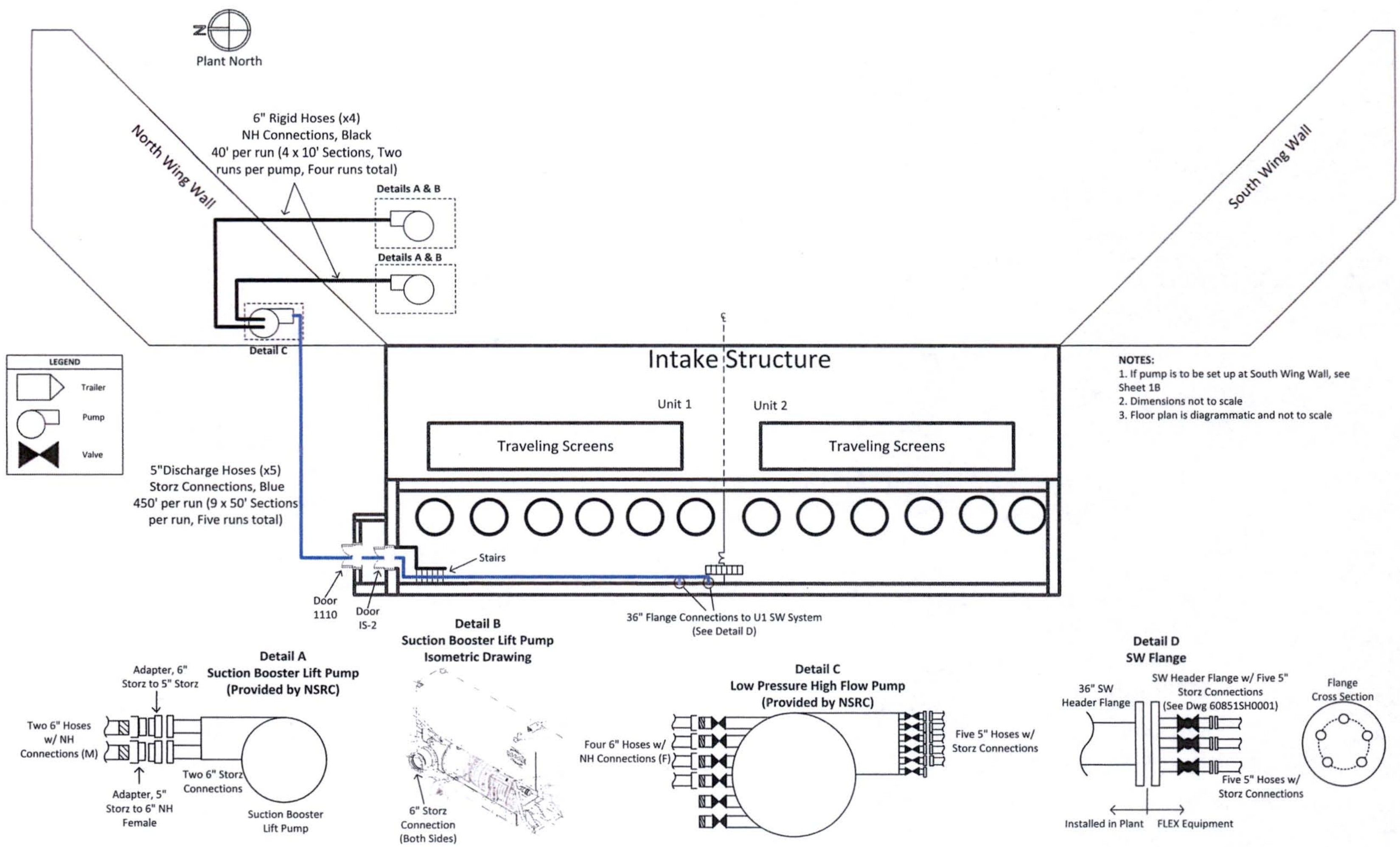
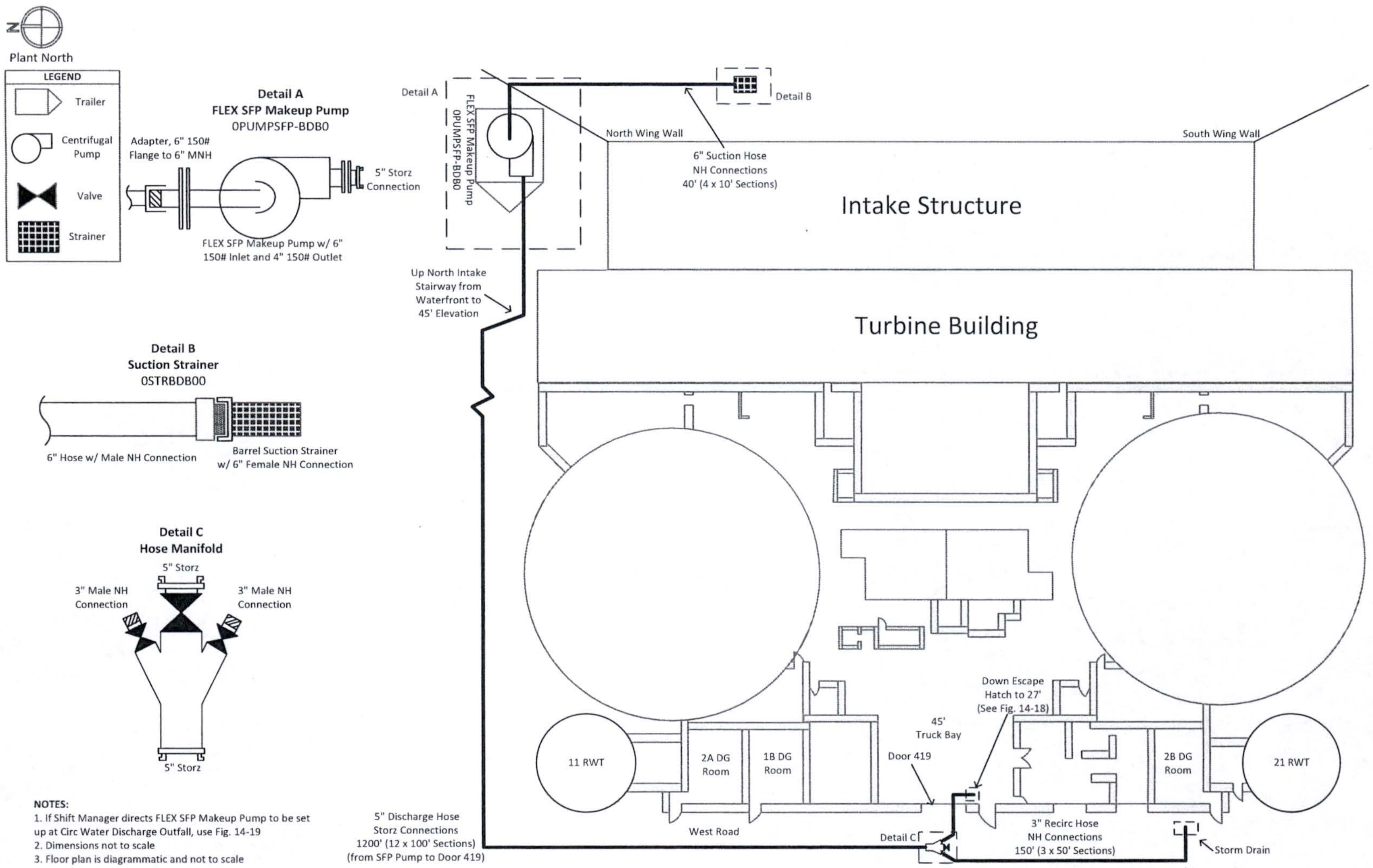


Figure 14-18: SFP Makeup from Chesapeake Bay to Spoolpiece 45' Elevation



NOTES:
1. If Shift Manager directs FLEX SFP Makeup Pump to be set up at Circ Water Discharge Outfall, use Fig. 14-19
2. Dimensions not to scale
3. Floor plan is diagrammatic and not to scale

Figure 14-19: SFP Makeup from Chesapeake Bay Direct Injection 45' Elevation

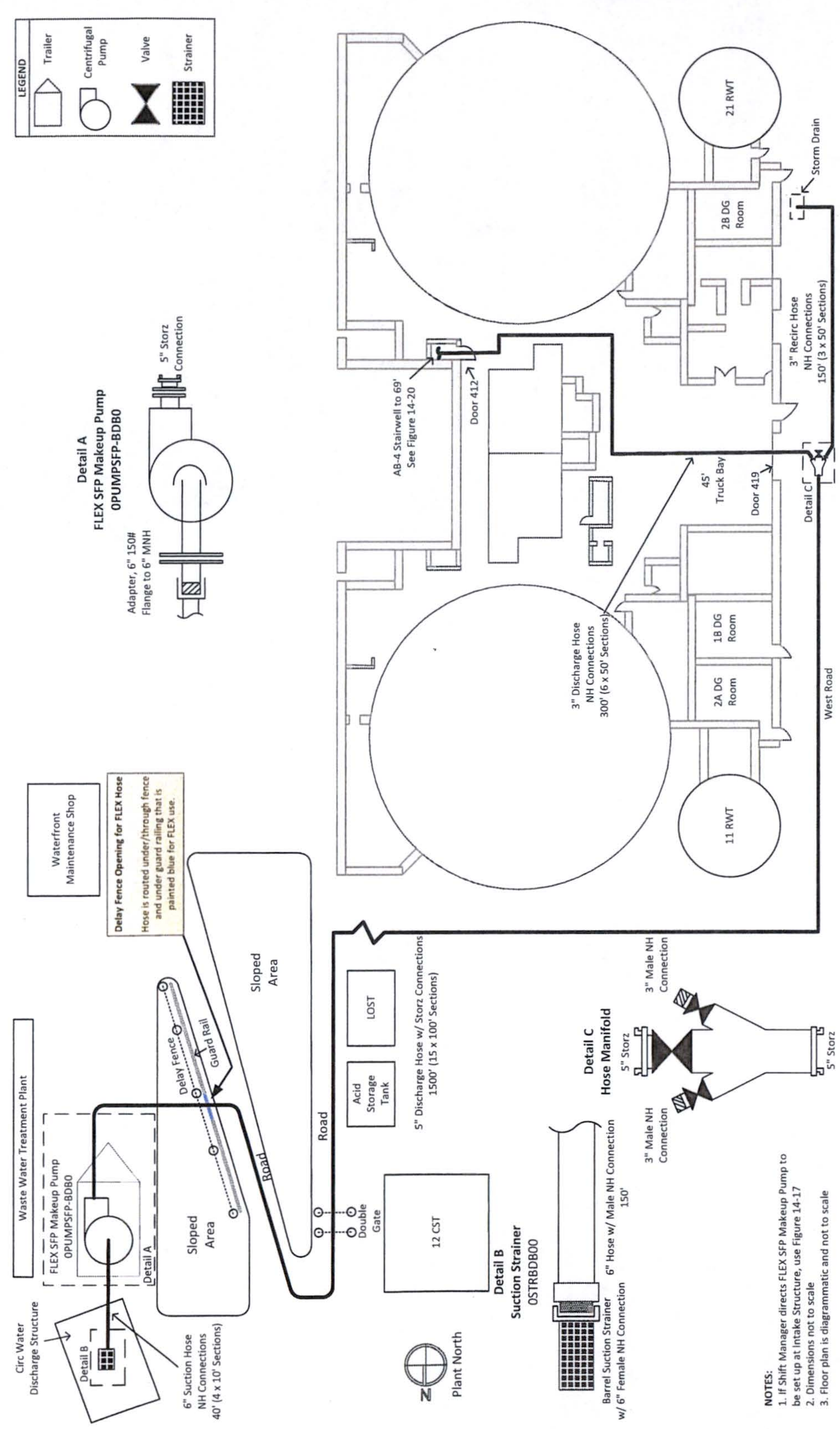


Figure 14-20: SFP Makeup from Chesapeake Bay to Spoolpiece 27' Elevation

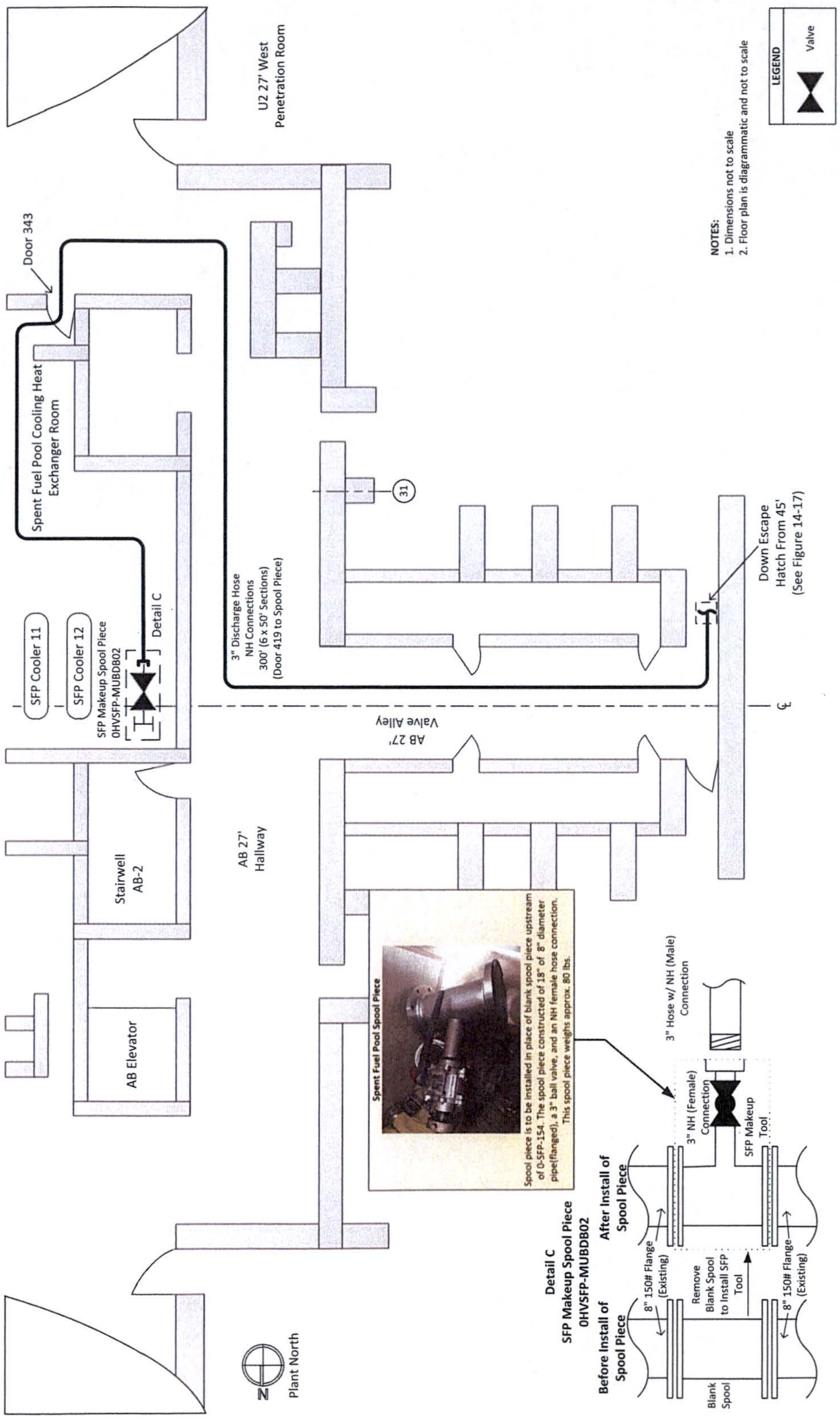


Figure 14-21: SFP Makeup from Chesapeake Bay Direct Injection 69' Elevation