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SCE&G®
A SCANA COMPANY

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RC-15-0125

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

Dear Sir / Madam:

Subject: VIRGIL C. SUMMER NUCLEAR STATION (VCSNS), UNIT 1
DOCKET NO. 50-395
OPERATING LICENSE NO. NPF-12
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)

References:

1. Nuclear Regulatory Commission (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, Agencywide Documents Access and Management System (ADAMS) Accession Number ML12054A735

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 0, dated August 29, 2012, ADAMS Accession Number ML12229A174

3. NEI 12-06, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide*, Revision 0, dated August 2012, ADAMS Accession Number ML12242A378

4. SCE&G Letter, *Virgil C. Summer Nuclear Station (VCSNS) Unit 1 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 17, 2012, ADAMS Accession Number ML12296A252

5. SCE&G Letter, *Virgil C. Summer, Unit 1, Overall Integrated Plan as Required by 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, ADAMS Accession Number ML13063A150

On March 12, 2012, the Nuclear Regulatory Commission issued Order EA-12-049 (i.e., Reference 1) to South Carolina Electric & Gas Company (SCE&G). Reference 1 was immediately effective and directed SCE&G to develop, implement, and maintain guidance and

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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 (i.e., Reference 2) and an Overall Integrated Plan (OIP) pursuant to Section IV, Condition C. Reference 2 endorses industry guidance document NEI 12-06, Revision 0 (i.e., Reference 3) with clarifications and exceptions identified in Reference 2. Reference 4 provided the initial status report regarding mitigation strategies at the Virgil C. Summer Nuclear Station (VCSNS), Unit 1. Reference 5 provided the OIP for VCSNS, Unit 1.

In addition, Reference 1 requires submission of status reports at six-month intervals following submittal of the OIP. Reference 3 provides direction regarding the content of the status reports.

The purpose of this letter is to provide the fifth six-month status report pursuant to Section IV, Condition C.2, of Reference 1, that delineates progress made in implementing the requirements of Reference 1. The enclosed report provides an update of milestone accomplishments since the last status report, including any changes to the compliance method, schedule, or need for relief and the basis, if any.

This letter contains no new regulatory commitments. If you have any questions regarding this report, please contact Bruce L. Thompson at (803) 931-5042.

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

8/24/2015
Executed on

Thomas D. Gatlin

PF/TDG/ts

Enclosure Virgil C. Summer Nuclear Station (VCSNS), Unit 1- Fifth Six-Month Status Report for the Implementation of Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order EA-12-049)

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VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1
DOCKET NO. 50-395
OPERATING LICENSE NO. NPF-12

ENCLOSURE

FIFTH SIX-MONTH STATUS REPORT FOR THE IMPLEMENTATION OF ORDER MODIFYING LICENSES WITH REGARD TO REQUIREMENTS FOR MITIGATION STRATEGIES FOR BEYOND-DESIGN-BASIS EXTERNAL EVENTS (ORDER EA-12-049)

1 Introduction

South Carolina Electric & Gas Company (SCE&G) developed an Overall Integrated Plan (i.e., Reference 1 in Section 8) for Virgil C. Summer Nuclear Station (VCSNS), Unit 1, documenting the diverse and flexible strategies (FLEX), in response to Nuclear Regulatory Commission (NRC) Order EA-12-049 (i.e., Reference 2 in Section 8). Subsequently, SCE&G provided the first, second, third, and fourth six-month status reports (i.e., References 3, 4, 6, and 7 in Section 8, respectively). This report, the fifth six-month status report, provides an update of milestone accomplishments including any changes to the compliance method, schedule, or need for relief/relaxation and the basis, if any, which occurred during the period between February 17, 2015, and August 15, 2015, hereafter referred to as the "update period."

2 Milestone Accomplishments

The following milestone(s) were completed during the update period:

- Submit 6-month update
- Perform Staffing Analysis
- Design Storage Building
- Develop Training Plan

3 Milestone Schedule Status

The following provides an update to Attachment 2 of the Overall Integrated Plan. It provides the activity status of each item, and whether the expected completion date has changed. The dates are planning dates subject to change as design and implementation details are developed.

Milestone	Target Completion Date	Activity Status	Revised Target Completion Date
Submit 60 Day Status Report	Oct 2012	Complete	
Submit Overall Integrated Plan	Feb 2013	Complete	
Submit 6 Month Updates:			
Update 1	Aug 2013	Complete	
Update 2	Feb 2014	Complete	
Update 3	Aug 2014	Complete	
Update 4	Feb 2015	Complete	
Update 5	Aug 2015	Complete	
Update 6	Feb 2016	Not Started	
FLEX Strategy Evaluation	Aug 2013	Complete	
Walk-Throughs or Demonstrations	Aug 2015	In Progress	October 2015
Perform Staffing Analysis	Jul 2014	Complete	July 2015
Modifications:			
Modifications Evaluation	Dec 2013	Complete	
Unit 1 Design Engineering Evaluation	Jan 2015	Complete	
Unit 1 Implementation Outage	Nov 2015	In Progress	

Milestone	Target Completion Date	Activity Status	Revised Target Completion Date
Storage:			
Design Storage Building	Jul 2014	Complete	March 2015
Storage Implementation	Jul 2015	In Progress	September 2015
FLEX Equipment:			
Procure On-Site Equipment	Oct 2014	In Progress	October 2015
Develop Strategies with RRC	Nov 2014	Complete	
Install Off-Site Delivery Station (if Necessary)	Aug 2013	Complete	
Procedures:			
PWROG issues NSSS-specific guidelines	May 2013	Complete	
Create Site-Specific FSGs (FSPs)	Feb 2014	In Progress	October 2015
Create Maintenance Procedures	Oct 2014	In Progress	October 2015
Training:			
Develop Training Plan	Jan 2015	Complete	March 2015
Training Complete	Jul 2015	In Progress	November 2015
Unit 1 FLEX Implementation	Nov 2015	Not Started	July 2016
Submit Completion Report	Jan 2016	Not Started	August 2016

4 Changes to Compliance Method

The following summarizes changes that were made during this update period to the compliance method as documented in the Overall Integrated Plan (i.e., Reference 1) or to the changes that were submitted in References 3, 4, 6, or 7 of this status report. These changes do not impact VCSNS's compliance with NEI 12-06.

1. Change: The Sequence of Events (SOE) and multiple time constraints related to the SOE have been changed during this update period. Section 4 of the Overall Integrated Plan, *Sequence of Events and Technical Basis*, and corresponding attachment, Attachment 1A, *Sequence of Events Timeline*, have been revised accordingly. Given that Section 4 and Attachment 1A have undergone significant changes, they are provided in their entirety within Attachment 1 to this update.

   Justification: Section 4 and Attachment 1A, of the Overall Integrated Plan, have been revised to reflect current strategies and updated information (e.g., finalized calculations, procedures, and walkthroughs).

   Documentation: The SOE and the technical basis for each time constraint is being documented in VCSNS Technical Report, TR00080-006, *FLEX Time Constraints Basis,* (DRAFT at the time of this update).

2. Change: In order to maintain core cooling during Phase 2, the primary strategy is being modified to include an alternate suction source for the Emergency Feed Water (EFW) pumps in the event the minimum Condensate Storage Tank (CST) inventory is not immediately available. A FLEX Alternate EFW Suction Pump will transfer water from the Ultimate Heat Sink (UHS) to the 'C' Service Water (SW) Pump header to allow alignment to any EFW pump via the design basis SW to EFW flow path.

   Justification: The CST does not meet the hazard protection requirements concerning high winds from tornados documented in NEI 12-06, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide*, Revision 0. Therefore, the CST is not creditable for FLEX. This change will ensure a strategy exists to cope with all applicable beyond-design-basis external events (BDBEE).

   Documentation: VCSNS Plant Modification, *FLEX Feed Connections*, ECR 51003B.

   Note: Section 5 contains information regarding the request for schedule relaxation regarding this change.

3. Change: The time constraint to refill the CST, following a BDBEE, was changed to 8.4 hours.

   Justification: Updates to the timeline, with respect to refilling the CST, are based on the minimum volume assumed to be available in the CST at T=0. This volume is the Technical Specification (T/S) minimum.

   Documentation: The SOE and the technical basis for each time constraint is being documented in VCSNS Technical Report, TR00080-006, *FLEX Time Constraints Basis,* (DRAFT at the time of this update).

4. Change: The strategy for Reactor Coolant System (RCS) inventory and reactivity control, Phase 2, included use of the station's installed Alternate Seal Injection (ASI) pump and a portable FLEX RCS Makeup Pump (FX RCS MU PUMP). The strategy has been changed to credit two FX RCS MU PUMPS.

   Justification: The additional FX RCS MU PUMP, an on-site portable diesel-driven pump, meets the requirements within NEI 12-06. The pumps will be stored in diverse locations, one in the Emergency Response Building (ERB) and one in the FLEX Storage Building (FSB). Although the ASI pump could not be credited for FLEX, if it survives the event, it will be used to provide flow to the Reactor Coolant Pump (RCP) seals.

   Documentation: Flex Support Procedures reflect the availability of two FX RCS MU Pumps to support this strategy.

5. Change: The strategy for RCS inventory and reactivity control, Phase 3, has been modified to include a mobile boration skid. The skid will be provided by the National SAFER Response Center (NSRC).

Justification: The NSRC mobile boration skid will be available, as needed, to provide long term boration needs.

Documentation: The SAFER Response Plan includes use of the mobile boration skid.

6. Change: An offsite staging area, located at the SCANA Corporate Campus in Cayce, SC, was added to the SAFER Response Plan for VCSNS.

   Justification: The interim staging area will be utilized if overland routes, from the Columbia Metropolitan Airport (CAE) to VCSNS, are not available following an event. In this case, equipment will be delivered by truck from CAE to the SCANA Corporate Campus. The equipment will then be delivered to the site by helicopter. This staging area was chosen so that the helicopter company could gain Federal Aviation Administration approval of the congested area flight plan.

   Documentation: The SAFER Response Plan identifies the additional staging area.

7. Change: Two methods for extending DC power availability, Phase 2, are being added to the Safety Function Support strategies. These methods will utilize B5b equipment. One method uses a portable 80kW generator and AC distribution panel to supply AC power to the input of the Station Battery Chargers. The second method uses a portable 80kW generator and a portable battery charger to supply DC power to the output of the station battery chargers. The equipment for one method will be stored in the ERB and the equipment for the other method will be stored in the FSB.

   Justification: The ability to provide alternate power to the Station Batteries using B5b equipment provides defense in depth.

   Documentation: A Flex Support Procedure reflects the availability of B5b equipment to support this strategy.

8. Change: The following figures have been revised to reflect current strategies. The updated figures are provided within Attachment 2 of this report.

   Figure 4 – Conceptual Strategy for Reactor Makeup and Reactivity Control

   Figure 5 – Conceptual Coping Strategies for Support Functions from EB

   Figure 7 – Conceptual Strategy for Supplying SG Makeup Using Alternate EFW Suction

   Figure 8 – Conceptual FLEX Feed Hose Layout

   Figure 11 – FLEX Strategy Conceptual Mechanical Diagram

   Figure 12 – FLEX Strategy Conceptual Electrical Diagram

   Figure 14 – FLEX Storage and Deployment Site Plan

5 Need for Relief/Relaxation and Basis for the Relief/Relaxation

SCE&G expects to be in full compliance with NRC Order EA-12-049 by the end of the upcoming outage (start date of October 3, 2015) with the exception of the core cooling mitigation strategy. The station recently determined that the CST, which was credited for providing EFW for core cooling, does not meet the hazard protection requirements regarding high winds from tornados outlined in NEI 12-06, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide*, Revision 0, without physical modification to the tank or surrounding structures. VCSNS is currently pursuing an alternate emergency feedwater suction strategy to supply water to the Turbine Driven Emergency Feedwater Pump in the event the CST is rendered unavailable. The request for relaxation is based on the time required to design and implement the new alternate EFW suction modification, update FLEX procedures, and complete operations training. The request for schedule relaxation was submitted in a separate document in August 2015 (i.e., Reference 8 in Section 8).

6 Open Items

The NRC audit team concluded the onsite portion of the Mitigating Strategies Audit on July 17th, 2015. The following table provides a summary of FLEX related items which remained open at the time of the audit's exit meeting and the status of those items at the time of this report.

Audit Item Reference	Item Description	Status
ISE CI 3.2.1.2.A (SE Tracker Audit Item 8-A)	Confirm the acceptability of the use of the non-Westinghouse RCP seals in the Westinghouse RCPs; provide justification for the RCP seal leakage rates for use in the ELAP analysis; and confirm the acceptability of O-ring performance under high temperature conditions expected during an ELAP event.	Pending NRC endorsement of white paper
ISE CI 3.2.4.8.A (SE Tracker Audit Item 20-A)	Electrical Power Sources/Isolations and Interactions - Confirm that the selected diesel generators are appropriately sized.	Closed
AQ 12 (SE Tracker Audit Item 12-B)	Provide the value of the maximum leak-off for each RCP seal in gpm assumed in the ELAP analysis.	Pending NRC endorsement of white paper

Audit Item Reference	Item Description	Status
AQ 55 (SE Tracker Audit Item 55-B, part a)	The staff has concerns on the long term reliability of the turbine/steam driven AFW pump during an ELAP event. Specifically address the following: a. Excessive moisture in the steam supply can disrupt turbine operation. Typically steam traps remove this excessive moisture. However, the condensate return lines from these traps can be isolated or crimped during an ELAP event. Provide a discussion on how the steam traps will continue to operate during an ELAP event if the condensate header is isolated or can become isolated during an ELAP. If the condensate discharges to a local sump, please address long term area temperature and humidity along with the removal of the condensate before local room flooding can occur.	Information provided on E-portal
SE Review Item (SE Tracker Audit Item 14-E)	The licensee is requested to provide a summary evaluation to confirm that temperature and pressures within containment will not exceed the equipment qualification of electrical equipment including Power Operated Relief Valves that are being relied upon as part of their FLEX strategies. The licensee needs to ensure that the qualified profile of the required electrical equipment remains bounding for the entire duration of the event.	Closed

7 Potential Draft Safety Evaluation Impacts

There are no potential impacts to the Draft Safety Evaluation identified at this time.

8 References

The following references support the information contained within this enclosure.

1. SCE&G Letter, *Virgil C. Summer, Unit 1, Overall Integrated Plan as Required by 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, Agencywide Documents Access and Management System (ADAMS) Accession Number ML13063A150
2. NRC Nuclear Regulatory Commission (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, ADAMS Accession Number ML12054A735

3. SCE&G Letter, *Virgil C. Summer, Unit 1, First Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)*, dated August 28, 2013, ADAMS Accession Number ML13242A273
4. SCE&G Letter, *Virgil C. Summer, Unit 1, Second Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049),* dated February 27, 2014, ADAMS Accession Number ML14063A203
5. NRC letter, *Virgil C. Summer Nuclear Station, Unit 1 - Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Order EA-12-049 (Mitigation Strategies)*, dated February 21, 2014, ADAMS Accession Number ML14034A339
6. SCE&G Letter, *Virgil C. Summer, Unit 1, Third Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)*, dated August 28, 2014, ADAMS Accession Number ML14245A405
7. SCE&G Letter, *Virgil C. Summer, Unit 1, Fourth Six-Month Status Report in Response to March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (Order Number EA-12-049)*, dated February 27, 2015, ADAMS Accession Number ML15062A007
8. SCE&G Letter, *Request for Schedule Relaxation from NRC Order EA-12-049, "Order Modifying Licenses With Regard To Requirements For Mitigation Strategies For Beyond-Design-Basis External Events,"* dated August 13, 2015

9 Attachments

1. Revised Section 4, *Sequence of Events and Technical Basis*, and Attachment 1A, *Sequence of Events Timeline* of the Overall Integrated Plan
2. Revised Conceptual Sketches of Strategies

VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1

RC-15-0030
ENCLOSURE ATTACHMENT 1

REVISED SECTION 4, *SEQUENCE OF EVENTS AND TECHNICAL BASIS*, AND ATTACHMENT 1A, *SEQUENCE OF EVENTS TIMELINE,* OF THE OVERALL INTEGRATED PLAN

Section 4: Sequence of Events and Technical Basis	
Provide a sequence of events and identify any time constraint required for success including the technical basis for the time constraint. ***Ref: NEI 12-06 Section 3.2.1.7*** ***JLD-ISG-2012-01 Section 2.1***	*Strategies that have a time constraint to be successful should be identified with a technical basis and a justification provided that the time can reasonably be met (for example, a walkthrough of deployment).* *Describe in detail in this section the technical basis for the time constraint identified on the sequence of events timeline Attachment 1A* *See attached sequence of events timeline (Attachment 1A).* *Technical Basis Support information, see attached NSSS Significant Reference Analysis Deviation Table (Attachment 1B)*

General :

1. FLEX Response at VC Summer is governed by EOP-6.0, ECA-0.0 Loss of All ESF AC Power and FSP-5.0, *Initial Assessment and FLEX Equipment Staging*. These two procedures are the controlling documents for Phase 1, 2 and 3 FLEX Response. The sequence of events is constructed based on assumed progression through these procedures.
2. WCAP-17601-P (Reference 7) envelops the plant for thermal hydraulic issues. This is verified per PWROG Core Cooling Position Paper Revision 0; section II (Reference 6). In order to minimize any leakage, and to lower RCS and Steam Generator feed pressures, the plant will be cooled down. Although plant cooldown is not required to be performed quickly after the event, due to the performance of low leakage Flowserve N9000 RCP seals, VCS will take prompt action to cooldown (within 2 – 4 hours). Cooldown is desirable for long term survivability of the RCP seals and to allow use of FLEX equipment at lower RCS and SG pressures. An analysis has been completed to determine the point at which two-phase natural circulation flow becomes less than single phase natural circulation flow, and the point at which reflux cooling will begin, since RCP seal leakage is 2.5gpm per pump. For VC Summer, using low leakage RCP seals, RCS makeup must occur by T=20 to meet this criteria.
3. Boration calculation (Reference 47) for the present core indicates that boration is not required for maintaining 260 psig in the steam generators for the first 28 hours. Assuming 1 hour for mixing, boration must be complete by hour 27. Based on calculated time to reach Reflux Cooling, boration will be complete well in advance. The Boration Calculation includes a 25% margin to ensure it will bound all future core designs, and therefore not require update each cycle. Steam Generator pressure and RCS Temperature will be stabilized at these conditions to complete required boration prior to subsequent RCS cooldown to 350 degF.
4. If possible, stripping of the DC buses will be avoided by powering the battery chargers from FLEX equipment within approximately 3 hours. If the batteries are not charging, then stripping

must be initiated at approximately 3 hours, and completed by 4 hours after losing charging capability (Reference 8).

5. Room temperature profiles with loss of ventilation have been calculated for the Control Room (Reference 9), Relay Room (Reference 10), and the Turbine Driven Emergency Feed Pump Room (Reference 11).
6. The TDEFW pump requires no support systems (no DC power, instrument air, or additional cooling is required (it is cooled by the pumped fluid)). The TDEFW pump operation usually requires no operator action; it starts and runs at the preset speed. The only time station procedures call for local speed control is if the flow control valves are impaired.
7. A new digital radio system will be installed in 2015, and will be tested per MTP-50856.01 to ensure adequate performance.
8. Battery room parameters, including temperature and hydrogen generation, have been evaluated per References 12 and Reference 13.
9. Condensate Storage Tank (CST) depletion times are documented in Reference 14, Reference 47, and in Technical Specification Basis.
10. Accumulator venting or isolation must be completed to perform second stage of cooldown to final long term cooling conditions.
11. Containment integrity was reviewed by Reference 15.
12. A best estimated decay heat curve was developed per Reference 16.
13. Per 10 CFR 50.63 and Regulatory Guide 1.155, VCSNS is a 4 hour coping plant, with an alternate ac capability. Applicable portions of supporting analysis have been used in ELAP evaluations.
14. The FLEX breakers for XSW1DA and XSW1DB must remain racked up on their associated switchgear to maintain the seismic qualification of the breakers. To accommodate this, Class 1E equipment will be protected from faults in FLEX equipment by administrative controls which ensure the 7.2 kV breaker can only be locally controlled, that its normal position is OPEN, the Closing and Tripping Control Power Breakers are OPEN, the associated fuses removed, and portable cables are disconnected.
15. There are no non-safety related installed mechanical components or equipment that will be credited in FLEX strategies. Newly installed non-safety related mechanical components or equipment required for FLEX-strategy implementation will be categorized as Quality Related and will be qualified to survive ELAP events.

Discussion of time constraints identified in Attachment 1A

A detailed discussion of Time Constraints is provided in VCSNS Technical Report (TR), TR00080-006, *FLEX Timeline Constraints Basis* (Reference 49). The following information provides a brief summary of that evaluation:

Table Item 7 – Assess Communication Systems and Deploy Portable Comm Tower: If onsite radio communications are degraded, use of a portable radio tower will enhance communications. Communication between the Control Room Staff and field operators should be established to conduct an effective/symmetric cooldown.

Table Item 9 – Align Alternate EFW Suction Source: If the CST is damaged, an alternate suction source must be aligned to the TDEFP to maintain SG Feed for core cooling. Assuming an instantaneous loss of feed, the time to dryout the SGs is 61 minutes. Restoration of EFW flow within one hour will ensure core uncover does not occur.

Table Item 11 – Control Emergency Feed: Simulator shows that steam generators reach above normal levels, with no throttling of the EFW flow control valves, in approximately 45 minutes at Beginning of Core Life (longer at End Of Life (EOL)). Air accumulators for the EFW flow control valves are sized to allow remote closure for up to 3 hours. Coarse SG Level control can be maintained in this manner until local control is established. Control of EFW will be a high priority for the Control Room Staff if Instrument Air is not available. If air is available, remote operation of the EFW flow control valves will be maintained, even in the event that DC load shedding is required.

Table Item 12 – Strip X-Train DC Loads: EOP-6.0, directs shedding of non-essential DC loads to prolong the life of the Station Non-1E Battery, XBA1X. Included in the loads that are shed is the Emergency Seal Oil Pump, which provides Seal Oil to the Main Generator Hydrogen Seals, to keep Hydrogen contained within the Main Generator. Controlled venting of Main Generator allows securing of the ESOP (and other DC bearing oil motors) to prolong the life of XBA1X. Without this load shedding, XBA1X will last only 2 hours, at which point Hydrogen would be released into the Turbine Building if these actions are not completed.

Table Item 13 – Establish Relay Room Cooling: Refer to TR00080-006, *FLEX Timeline Constraints Basis.*

Table Item 14 - Declare ELAP: Time period of two (2) hours is selected conservatively to ensure that ELAP entry conditions can be verified by control room staff, and it is validated that the alternate source AC (an underground line to XTF5052 fed from either the Parr 115 kV grid or the Parr Hydro plant) is not available. This is a reasonable assumption since Parr Hydro is not continuously manned and has to be manually started by local operators. Parr Hydro response time meets requirements of NUMARC 8700 Appendix B. ELAP entry conditions are:

I. Loss of Offsite Power

II. Loss of all Emergency Diesels

III. Loss of Alternate AC

IV. Any doubt exists that normal 7200 VAC power can be restored within 2 hours of event

Table Item 16, 17, 19 – Energize Station Batteries or Perform DC Load Shed: DC load shed must be complete within four hours in order to maintain consistency with assumptions for coping time evaluations (Reference 8). Reference 28 provides the load profiles for before, during, and after the initiating event and the load profile after load shedding is completed

(calculation conservatively assumes full DC load until load shedding is complete). Assuming the completion of load shedding occurs at T=4 hours results in an estimated total battery life of 15 hours (i.e. 11 additional hours of life after load shedding is completed). The calculation also lists the breakers that need to be opened. Station Operators have performed timed walk downs to confirm these actions can be completed within one hour of initiation.

Table Item 18 – Perform Cooldown: The anticipated characteristics of the Flowserve N9000 seals provide flexibility in the decision making for timing of the RCS cool down and de-pressurization. The 2-4 hour timing of the cooldown was to allow additional flexibility in manpower priorities, if required, and is supported by WCAP 17601, Section 5.7.1. The plant cooldown will be prioritized after feedwater and battery charging is assured. The cooldown will commence between 2 and 4 hours after the event and will not be purposefully delayed. The initial cooldown, directed by EOP-6.0, stops at a Steam Pressure of 260 psig, to ensure the RCS is promptly cooled. The cooldown is stopped to allow isolation of SI Accumulators (or venting) to prevent nitrogen injection into the RCS which could interrupt Natural Circulation. Local operation of SG PORVs is the credited method for performing the cooldown. However, if instrument air is available, the SG PORVs can be controlled remotely from the Control Room. The time restraint, associated with this activity, ensures the assumptions, made in Design Calculations supporting RCS boration, CST depletion, and Reactor Building heatup, are maintained and valid.

Table items 20-27, 33-35 Establish Natural Circulation or Forced Ventilation: Procedures have been developed to address ventilation requirements in various areas of the plant to support local operator actions or equipment concerns. The strategies consist of restoring forced ventilation if AC power can be restored from a FLEX source with alternatives of establishing natural circulation and portable fans. This is necessary to ensure both Equipment Reliability and Operator Habitability in some areas. Refer to TR-00080-006, *FLEX Timeline Constraints Basis.*

Table Items 29 & 31 – Refill the CST or Supply Low Pressure SG Feed: Numerous methods are available to refill the CST, which is the easiest method for assuring a continued suction supply for the TDEFP, which is assumed to survive all events. CST level will last significantly longer at normal levels. If the CST empties or is otherwise unavailable, the low pressure Flex Transfer pump(s) must be placed in service. Per WCAP-17601-P (Reference 7), steam generator dryout time will exceed two hours from the time the CST empties; this conservatism is not included in the Time Constraint. If it were, at least 10.4 hours would be available before the SG Feed Pump would be required to be placed in service. Typically the CST can be filled from onsite demineralized water or filtered water tanks or from a low pressure water source (Lake Monticello via fire service), or the Service Water Pond (ultimate heat sink) for seismic events.

Table Item 30– Isolate or Vent the SI Accumulators: This is not a Time Constraint, but more of a Progression Restraint. The Cooldown from 409 degF to 350 degF is not time critical. The initial cooldown will enable use of FLEX strategies and minimize RCS leakage. Subsequent cooldown to the minimum SG pressure to support TDEFP operation is recommended but only after Boration is complete and the SI Accumulators are isolated, to prevent nitrogen injection into the RCS.

Table Item 32 – Refuel FLEX Equipment: Lowest Fuel Capacity of FLEX equipment is Ultimate Heat Sink (UHS) System which could be deployed for CST Fill at time T+6 and would require refueling 9.4 hours later. Other large FLEX Pumps have > 12 hour onboard capacity. Each Combustion Turbine Generator (CTG) has a fuel capacity of 3 hours and only needs continuation of an already implemented fuel strategy. This fuel strategy is performed by a CTG operator already stationed at the CTG.

Table Item 36 - Boration: Boration is required for VCSNS due to cooldown. Boration will be completed in the timeframe before hour 28 (Reference 47). The volume of borated water injected is based on maintaining shutdown margin for 350 degF in the RCS, but the Time Constraint is based on achieving 409 degF because this temperature cannot be maintained indefinitely without some form of boration (though this is a smaller volume than what is required for 350 degF). Once boration is started, it should be continued until the required concentration for 350 degF is reached. Much like the plant normally borates for cold shutdown, Xenon free concentration before entering Mode 5, the same approach is used here, prior to achieving 350 degF.

Table Item 40 - Makeup to Spent Fuel Pool: Boiling will start at 20-24 hours, with a boil off rate of approximately 2 inches per hour. See Reference 18 and 49.

Attachment 1A: Sequence of Events Timeline

Action Item	Elapsed Time* (hours)	Action	Time Constraint Y/N	Time Constraint (hours)	Reference	Remarks/Applicability
	0	Event Starts	N/A	--	--	--
1	0	SBO Procedure (EOP 6.0) Entered	N	--	Reference 17	EOP-6.0 is direct entry procedure.
2	0.017	TDEFW starts, blowdown isolates	N	--	--	Automatic on Blackout, RCS temperature controlled by MS Safeties.
3	0.067	Isolate the RCS	N	--	References 17 & 51	Letdown isolates automatically if air is lost, otherwise this is performed from Control Room.

Attachment 1A: Sequence of Events Timeline

Action Item	Elapsed Time* (hours)	Action	Time Constraint Y/N	Time Constraint (hours)	Reference	Remarks/Applicability
4	0.5	Assess Status of EB Power	N	--	Reference 17	Preparatory actions to identify preferred method of re-charging Station Batteries.
5	0.5	Assess & Stage CTGs and Fuel Supply	N	--	Reference 17	Preparatory actions only, not connecting to plant equipment.
6	0.5	Assess deployment routes	N	--	Reference 17	Inside and outside protected area.
7	0.5	Assess Communication Systems, Deploy Portable Communication Tower if necessary	Y	T+4	--	Communication should be established early to coordinate FLEX response (should be performed before cooldown is commenced, at a minimum).
8	0.5	Isolate RCP Seals	N	--	Reference 17	RCP seal CBO flow cannot be isolated (fails open). CBO flow redirected to PRT instead of VCT.
9	0.5	Align Alt EFW Suction	Y	T+1	Reference 17 & 53	Required only if CST is not available.
10	0.75	Isolate CST from the Main Condenser	N	--	Reference 17	Conserves inventory in CST.
11	0.75	Control Emergency Feed	Y	T+1.5	Reference 17 & Simulator	At full TDEFP flow, SGs take approx. 45 minutes to fill to 80% NR. Each EFW FCV has an air accumulator to allow closure for up to 3 hours.

Attachment 1A: Sequence of Events Timeline

Action Item	Elapsed Time* (hours)	Action	Time Constraint Y/N	Time Constraint (hours)	Reference	Remarks/Applicability
12	1	Strip X Train DC Loads – Vent Main Generator Hydrogen	Y	T+2	Reference 17	Controlled vent allows securing ESOP and conservation of Non-1E DC Power. XBA1X Battery life is 2 hours.
13	1	Establish Relay Room Cooling (Natural Circulation)	Y	T+1	References 10 & 17	Prevent loss of control due to heatup of sensitive electronics.
14	2	Declare ELAP	Y	T+2	References 17, 21, 28	Crew is allowed two hours to determine if AC power can be recovered. By T=2 hours, decision made by SS that an ELAP exists.
15	2	Contact NSRC	N	--	Reference 21	Notify NSRC to mobilize equipment for VCS.
16	2	Energize Station Batteries from EB Battery Chargers	Y	T+15	Reference 21, 28	At least one battery charging strategy must be complete before Station Batteries are exhausted.
17	2	Energize Station Batteries from Station Battery Chargers, powered from CTGs	Y	T+15	Reference 21, 28	At least one battery charging strategy must be complete before Station Batteries are exhausted.

Attachment 1A: Sequence of Events Timeline

Action Item	Elapsed Time* (hours)	Action	Time Constraint Y/N	Time Constraint (hours)	Reference	Remarks/Applicability
18	2	Perform Cooldown ~ 75degF/hr to ~260 psig steam pressure	Y	T+6	References 7 & 17	With low leakage RCP seals, immediate cooldown is not required, but cooldown will start at 2 to 4 hours, and be accomplished within 6 hours after the event.
19	3	Perform DC load stripping.	Y	T+4	Reference 21, 28	Required to be completed within 4 hours of event start, if station batteries are not re-energized.
20	3	Establish TDEFP Room Cooling (Natural Circulation)	Y	T+4	Reference 49	To maintain equipment reliability.
21	3	Establish EFW FCV area Cooling (Natural Circulation)	Y	T+4	Reference 49	To maintain operator habitability.
22	3	Establish SG PORV Area Cooling (Natural Circulation)	Y	T+4	Reference 49	To maintain operator habitability.
23	3	Establish Battery Room Ventilation (Forced)	Y	T+77	Reference 49	77 hours after charging capability is restored, H2 concentration in battery room approaches 2%.

Attachment 1A: Sequence of Events Timeline

Action Item	Elapsed Time* (hours)	Action	Time Constraint Y/N	Time Constraint (hours)	Reference	Remarks/Applicability
24	3	Establish Battery Charger Room Cooling (Natural Circulation)	Y	T+4	Reference 49	To maintain equipment reliability. Only required if CTGs used to re-energize Station Battery Chargers.
25	3	Establish ESF Switchgear 1DA/B Room Cooling (Forced)	Y	T+12	Reference 49	To maintain equipment reliability and operator habitability. Only required if CTGs used to re-energize Station Battery Chargers.
26	3	Establish SF Pool Area Cooling (Natural Circulation)	Y	T+21	Reference 49	To maintain operator habitability.
27	3	Establish AB-463 North Area Cooling (Natural Circulation)	Y	T+14	Reference 49	To maintain equipment reliability and operator habitability.
28	6	Complete Walkdowns and Assessment of plant.	N	--	--	Assessment of plant damage should be complete by end of cooldown to prioritize subsequent actions.
29	6	Perform CST refill	Y	T+8.4	Reference 14	At T/S minimum volume, must either refill CST or go on alternate low pressure feed by T=8.4 hours. CST inventory should last 64+ hours if at normal level.

Attachment 1A: Sequence of Events Timeline

Action Item	Elapsed Time* (hours)	Action	Time Constraint Y/N	Time Constraint (hours)	Reference	Remarks/Applicability
30	6	Isolate or Vent SI Accumulators	N	--	Reference 17	Progression restraint – cannot cooldown further until isolation or venting performed.
31	6	Perform Low Pressure SG feed	Y	T+8.4	References 2 & 17	Required only if unable to fill CST, or other loss of emergency feed.
32	6	Refuel FLEX Equipment	Y	T+15.4	Reference 21	Based on UHS pump needing fuel first, if in service. All others FLEX pumps have > 12 hour fuel capacity.
33	6	Establish Control Room Cooling (Natural Circulation)	Y	T+8	Reference 49	To maintain operator habitability.
34	6	Establish Control Room Cooling (Forced)	Y	T+12	Reference 49	To maintain operator habitability.
35	6	Establish Relay Room Cooling (Forced)	Y	T+12	Reference 49	To maintain equipment reliability.

Attachment 1A: Sequence of Events Timeline

Action Item	Elapsed Time* (hours)	Action	Time Constraint Y/N	Time Constraint (hours)	Reference	Remarks/Applicability
36	10.5	Boration	Y	T+20 T+27	References 23 & 47	Longest boration option requires 17.5 hours to inject. Boration must be accomplished by T+28 hours to maintain 409 degF, assuming 1 hour for mixing. Boration must be complete by T=27 hours. Also, must be initiated by T=20 hours.
37	17.5	Establish Long Term RCS Inventory Control	Y	T+39.5	References 17, 23, 49	Continue methods of RCS makeup established during boration. Time to reflux cooling is 39.5 hours and time to uncover core is 80.7 hours if RCS makeup is not achieved.
38	17.5	Establish RCS Letdown	N	--	Reference 50	If ASI survives, it's desirable to continue to supply RCP Seal Cooling. Must establish letdown to accommodate.
39	17.5	Depressurize SGs to 170 psig for Long Term Cooling	N	--	References 17 & 23	Long Term Cooling conditions (minimum SG pressure for continued operation of TDEFP) – RCS must be borated, Accumulators must be isolated.

Attachment 1A: Sequence of Events Timeline

Action Item	Elapsed Time* (hours)	Action	Time Constraint Y/N	Time Constraint (hours)	Reference	Remarks/Applicability
40	18	Begin SF Pool makeup	Y	T+87	Reference 49	Time to boil in SFP conservatively estimated at 21 hours. At 2.06 in/hr boiloff, time to L2 (10ft above fuel) is 87 hours.
41	24+	Improve Water Quality for long term SG Feed	N	--	Ref 52	NSRC Water Treatment equipment delivered to improve water quality if source is Lake or SW Pond.
42	24+	Establish RB Cooling	N	T+30 days	Reference 49	RB cooling not required for > 30 days to prevent exceeding design temp/press limits but will be established when AC power is available.

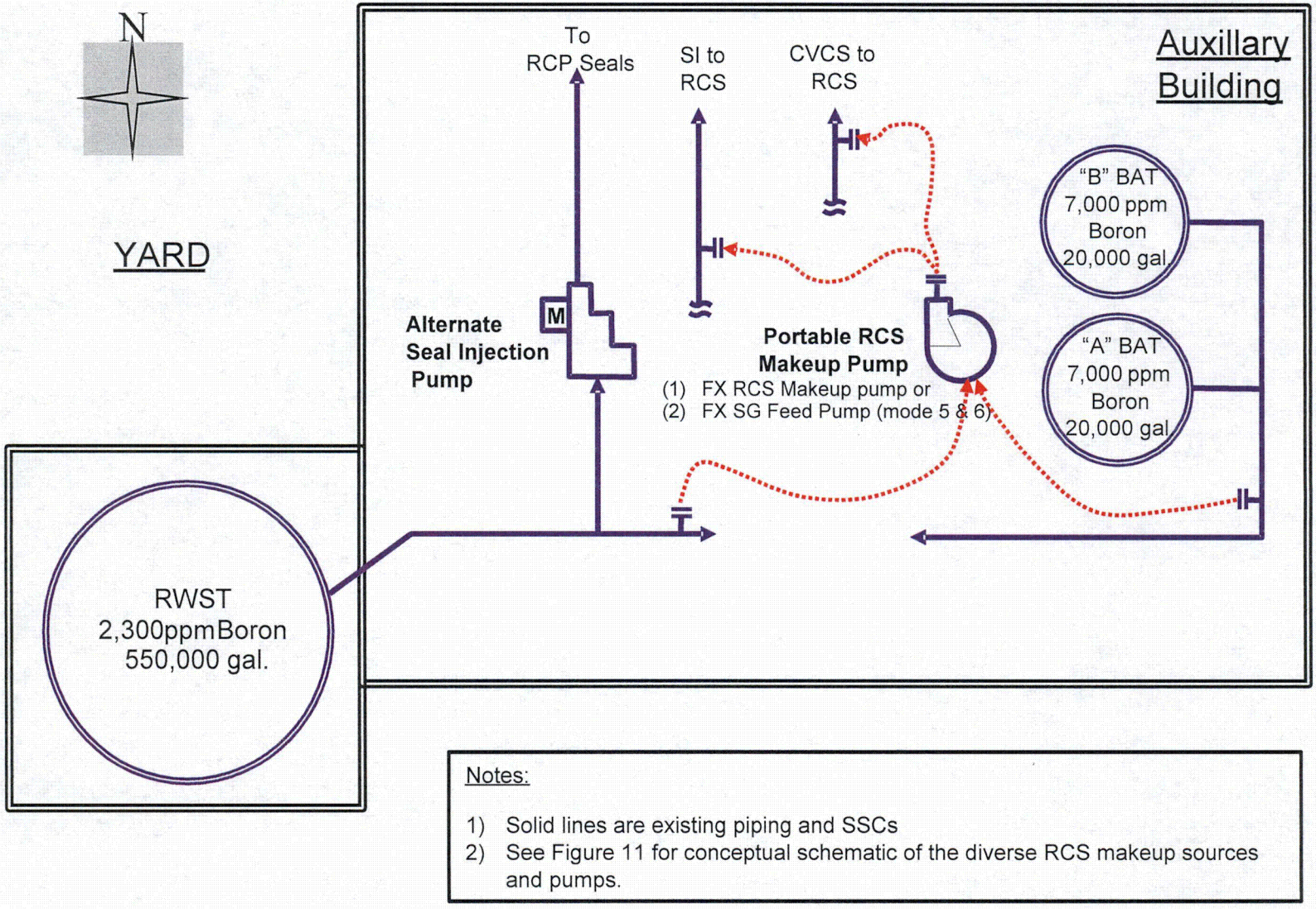
*Note – Elapsed time is an estimate only. Final disposition of the start times and margin to completion for the sequence of events will be determined after completion of Validation activities and documented in VCSNS TR00080-007, *VCS FLEX Validation Document*. The results will be included in the Final Implementation Plan.

VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1

RC-15-0125
ENCLOSURE ATTACHMENT 2

CONCEPTUAL SKETCHES OF STRATEGIES

Figure 4 – Conceptual Strategy for Reactor Makeup and Reactivity Control



Notes:

1) Solid lines are existing piping and SSCs
2) See Figure 11 for conceptual schematic of the diverse RCS makeup sources and pumps.

Figure 5 – Conceptual Coping Strategies for Support Functions from EB

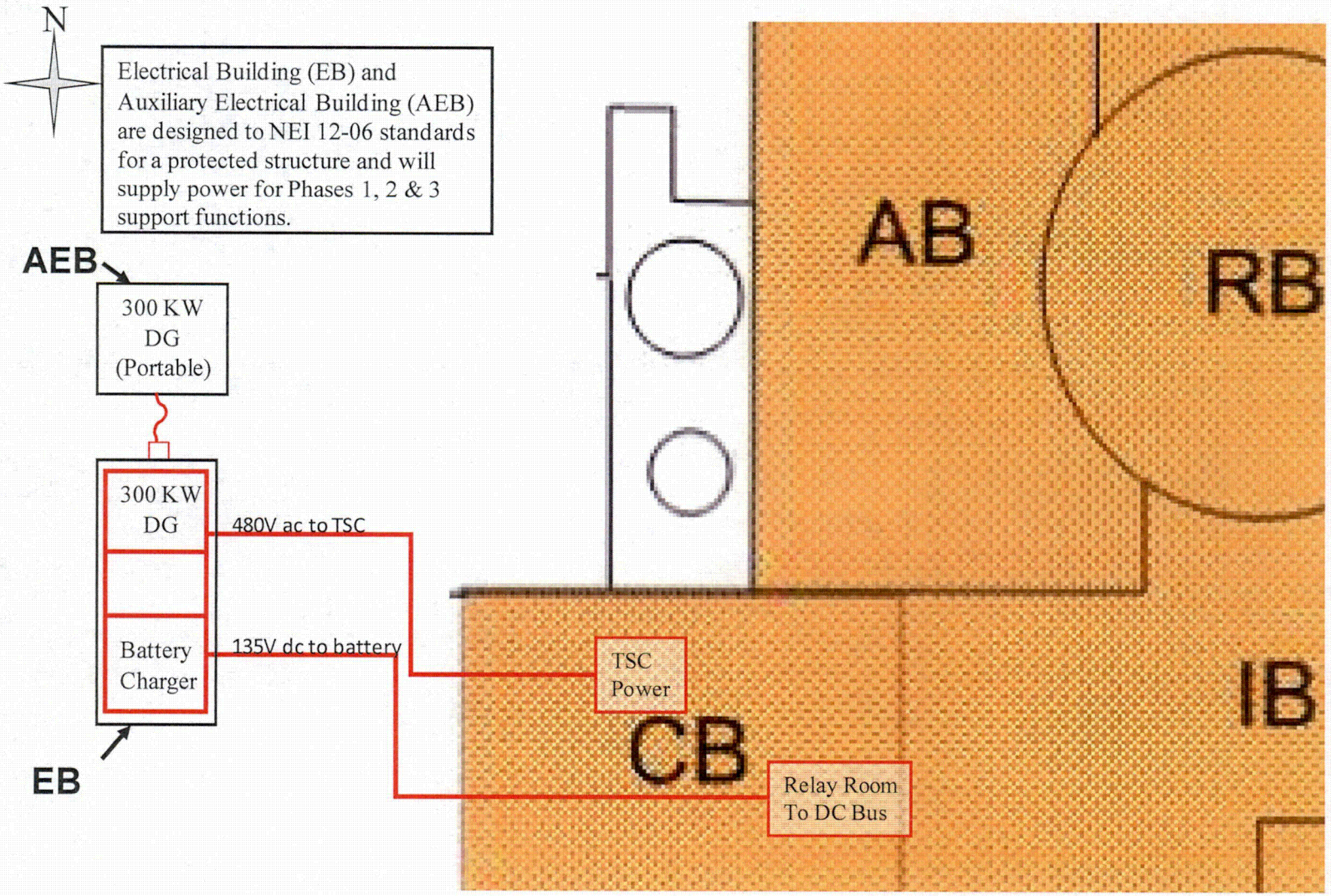


Figure 7 – Conceptual Strategy for Supplying SG Makeup Using Alternate EFW Suction

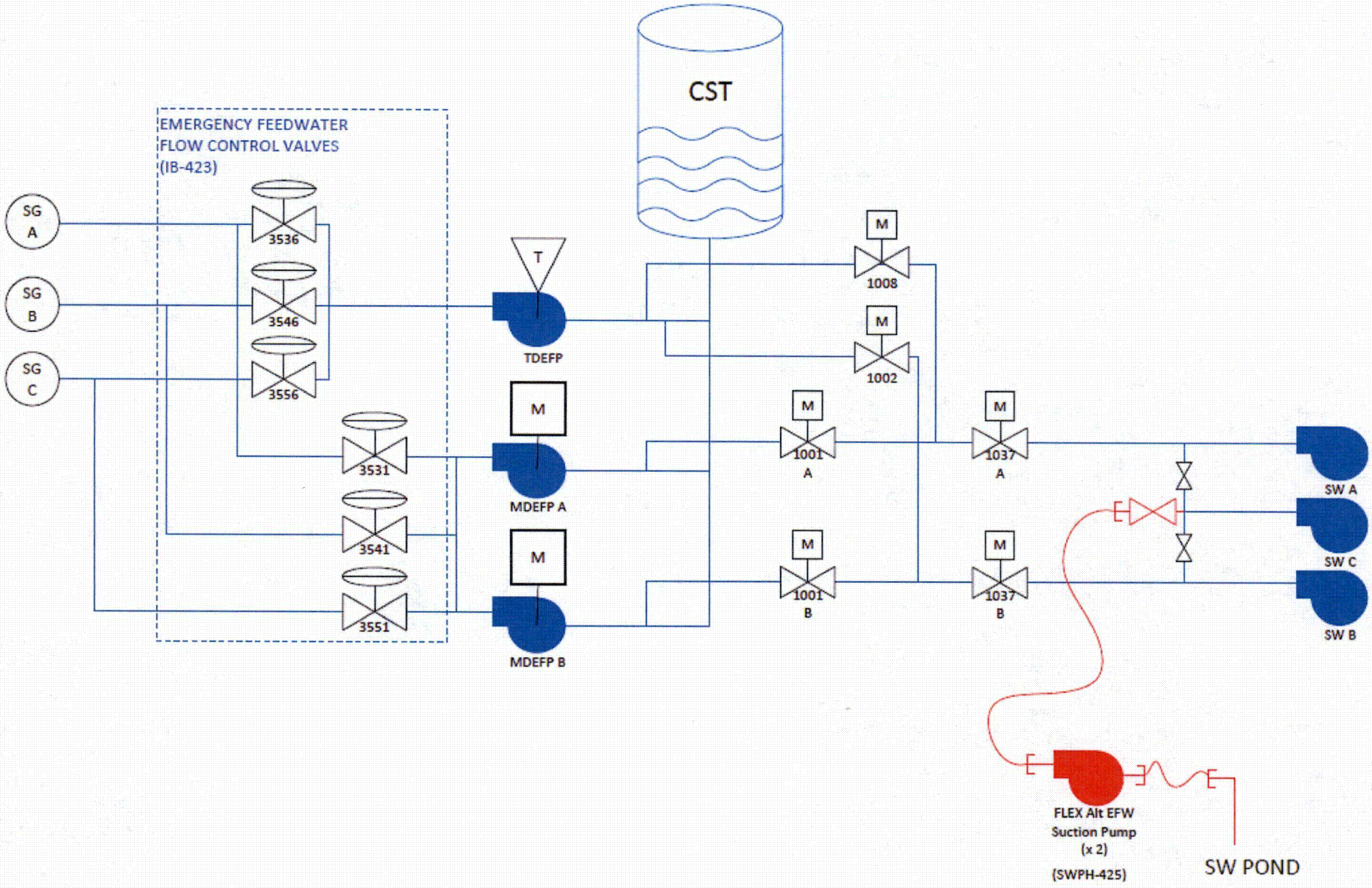


Figure 8 – Conceptual FLEX Feed Hose Layout

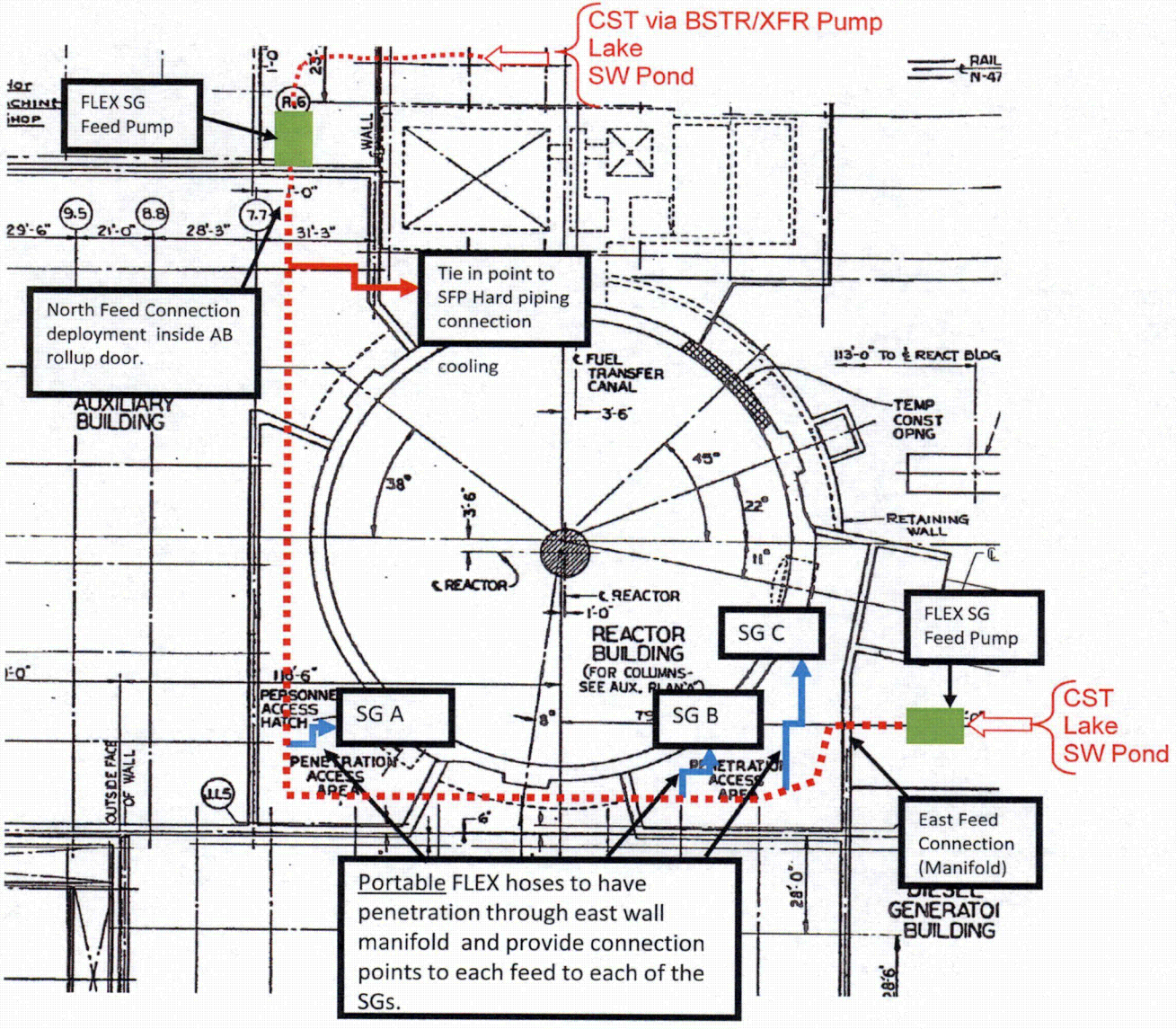


Figure 11 – FLEX Strategy Conceptual Mechanical Diagram

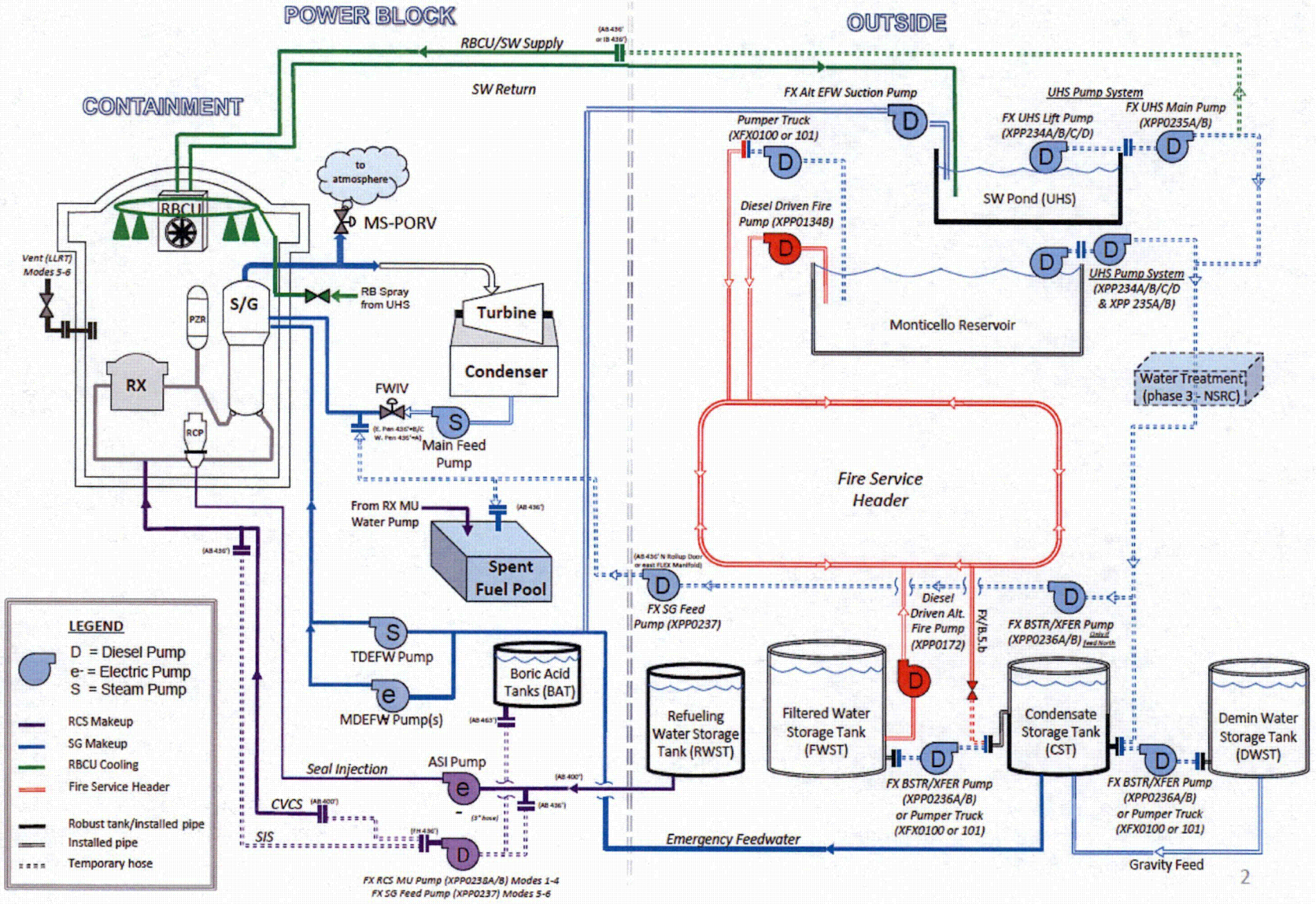


Figure 12 – FLEX Strategy Conceptual Electrical Diagram

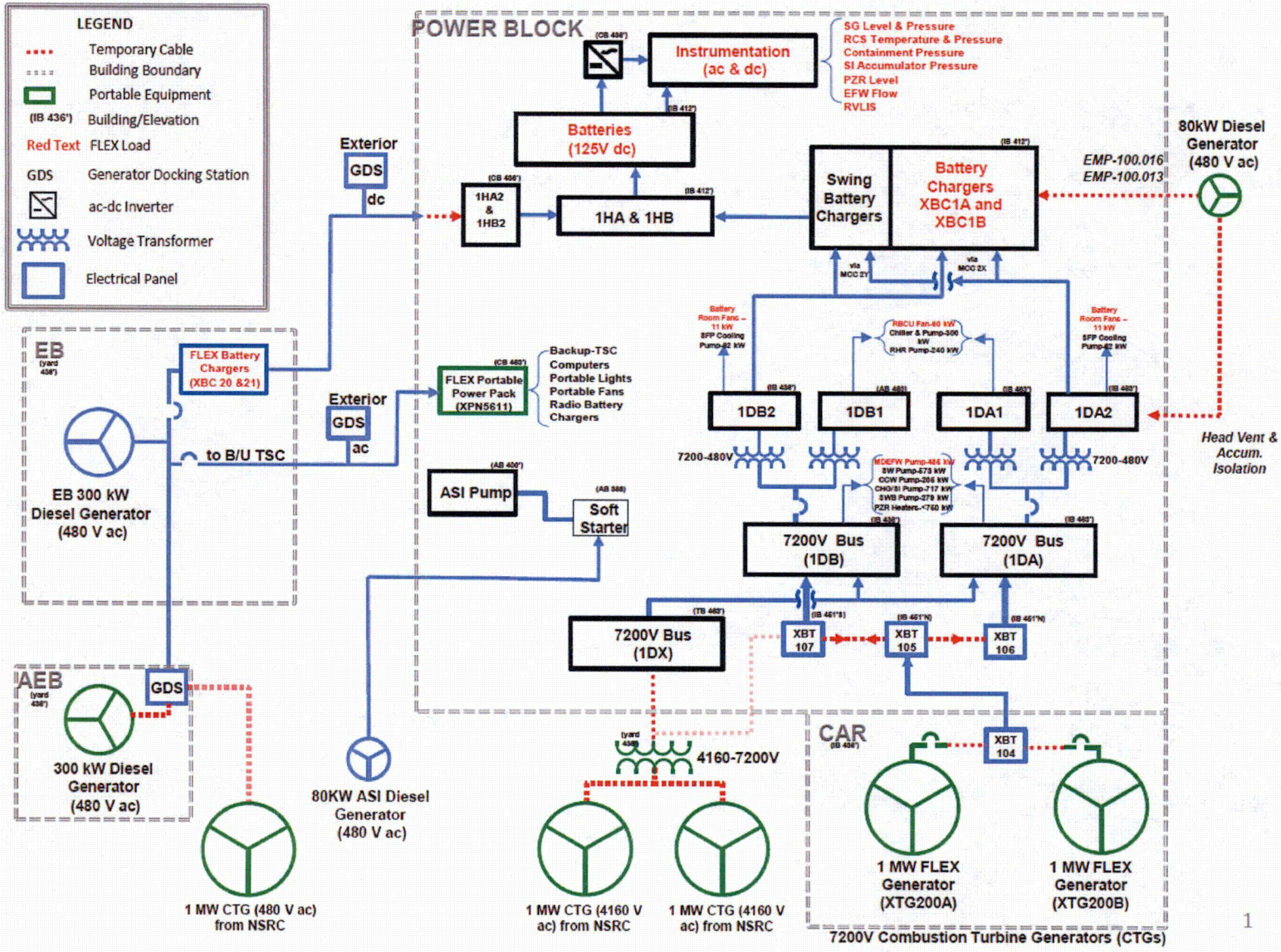
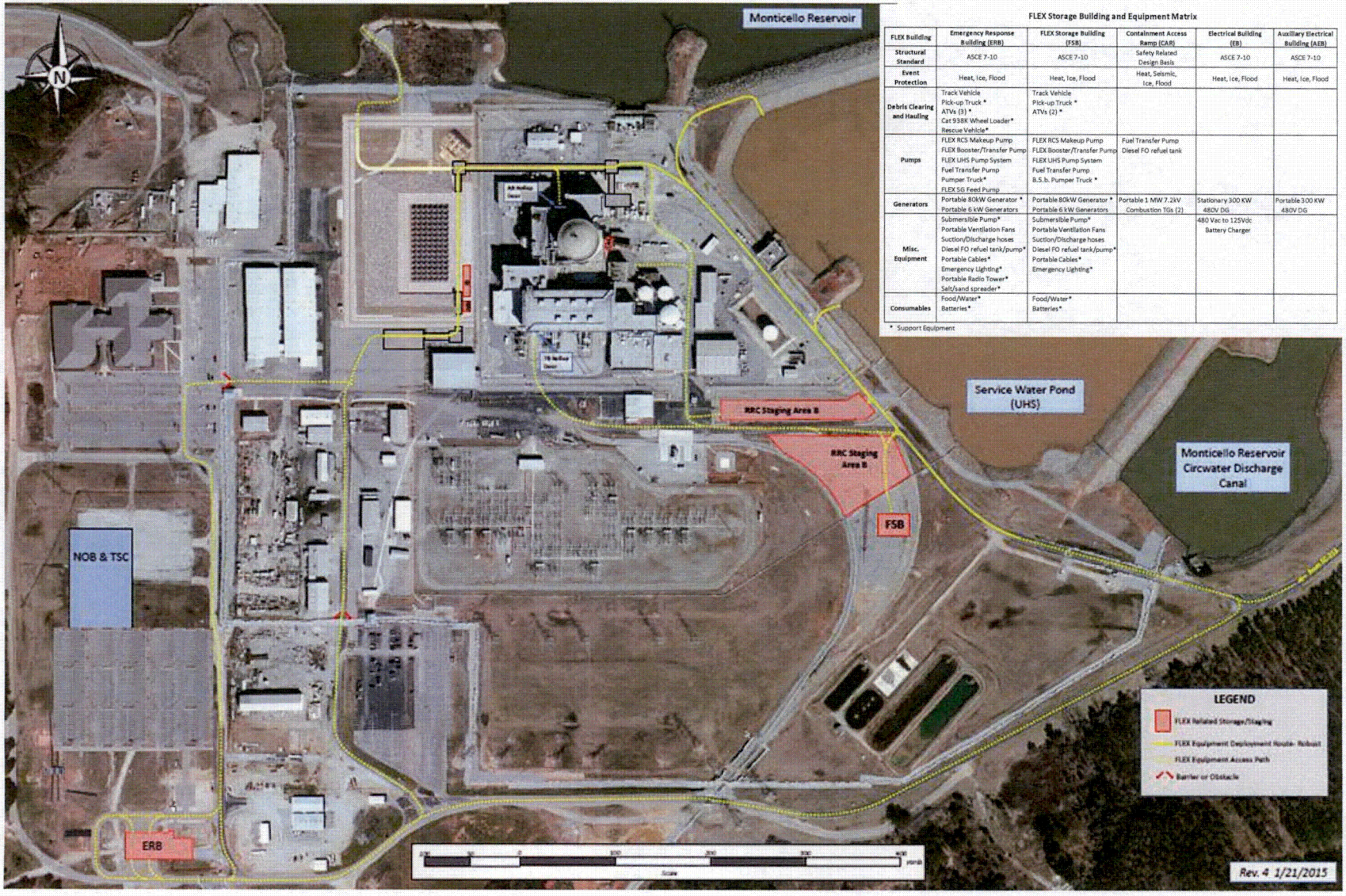


Figure 14 – FLEX Storage and Deployment Site Plan



FLEX Storage Building and Equipment Matrix

FLEX Building	Emergency Response Building (ERB)	FLEX Storage Building (FSB)	Containment Access Ramp (CAR)	Electrical Building (EB)	Auxiliary Electrical Building (AEB)
Structural Standard	ASCE 7-10	ASCE 7-10	Safety Related Design Basis	ASCE 7-10	ASCE 7-10
Event Protection	Heat, Ice, Flood	Heat, Ice, Flood	Heat, Seismic, Ice, Flood	Heat, Ice, Flood	Heat, Ice, Flood
Debris Clearing and Hauling	Track Vehicle Pick-up Truck * ATVs (3) * Cat 938K Wheel Loader* Rescue Vehicle*	Track Vehicle Pick-up Truck * ATVs (2) *			
Pumps	FLEX RCS Makeup Pump FLEX Booster/Transfer Pump FLEX UHS Pump System Fuel Transfer Pump Pumper Truck* FLEX SG Feed Pump	FLEX RCS Makeup Pump FLEX Booster/Transfer Pump FLEX UHS Pump System Fuel Transfer Pump B.5.b. Pumper Truck *	Fuel Transfer Pump Diesel FO refuel tank		
Generators	Portable 80kW Generator * Portable 6 kW Generators	Portable 80kW Generator * Portable 6 kW Generators	Portable 1 MW 7.2kV Combustion TGs (2)	Stationary 300 KW 480V DG	Portable 300 KW 480V DG
Misc. Equipment	Submersible Pump* Portable Ventilation Fans Suction/Discharge hoses Diesel FO refuel tank/pump* Portable Cables* Emergency Lighting* Portable Radio Tower* Salt/sand spreader*	Submersible Pump* Portable Ventilation Fans Suction/Discharge hoses Diesel FO refuel tank/pump* Portable Cables* Emergency Lighting*		480 Vac to 125Vdc Battery Charger	
Consumables	Food/Water* Batteries*	Food/Water* Batteries*			

* Support Equipment