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PSEG
Nuclear LLC

Order EA-13-109

LR-N18-0056
July 25, 2018

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

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

Subject: Hope Creek Generating Station's Report of Full Compliance with Phase 1 and Phase 2 of June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)

On June 6, 2013, the Nuclear Regulatory Commission (NRC) issued Order EA-13-109 to all licensees that operate boiling-water reactors (BWRs) with Mark I and Mark II containment designs. The Order was effective immediately and requires the Hope Creek Generating Station (HCGS) to install a reliable hardened venting capability for pre-core damage and severe accident conditions, including those involving a breach of the reactor vessel by molten core debris. Specific requirements are outlined in Attachment 2 of NRC Order EA-13-109. This letter and Attachment 1 provide the notification required by Item IV.D.4 of NRC Order EA-13-109 that HCGS has achieved full compliance with the requirements described in Attachment 2 of the Order. Enclosure 1 provides the HCGS Final Integrated Plan for reliable hardened containment vent strategies.

There are no regulatory commitments contained in this letter. If you have any questions or require additional information, please contact Mr. Brian J. Thomas at 856-339-2022.

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

Executed on 7/25/18
(Date)

Sincerely,

Eric Carr
Site Vice President
Hope Creek Generating Station

Attachment 1: HCGS Completion of Required Actions for NRC Order EA-13-109, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions"

Enclosure 1: Final Integrated Plan - HCVS Order EA-13-109 for Hope Creek Generating Station (HCGS)

cc: Administrator, Region I, NRC
Mr. Justin Hawkins, NRC Senior Resident Inspector, Hope Creek
Mr. James Kim, Project Manager, NRC/NRR/DORL
Mr. Raj Auluck, NRC/NRR/JLD
Mr. Brian Lee, NRC/NRR/JLD
Mr. Patrick Mulligan, Chief, NJBNE
Mr. Thomas MacEwen, Hope Creek Commitment Tracking Coordinator
Mr. Lee Marabella, PSEG Corporate Commitment Coordinator

ATTACHMENT 1

HCGS Completion of Required Actions for NRC Order EA-13-109, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions"

HCGS Completion of Required Actions for NRC Order EA-13-109, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions"

1 Background

On June 6, 2013, the Nuclear Regulatory Commission (NRC) issued Order EA-13-109, *Order Modifying Licenses with Regard to Requirements for Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions* (Reference 1), to PSEG Nuclear LLC (PSEG). This Order was immediately effective and directs the Hope Creek Generating Station (HCGS) to install a reliable hardened venting capability for pre-core damage and severe accident conditions, including those involving a breach of the reactor vessel by molten core debris. In response to NRC Order EA-13-109, PSEG developed an Overall Integrated Plan (OIP) (Reference 2) to address the requirements of Phase 1 of the Order, which requires a Hardened Containment Vent System (HCVS) that provides reliable hardened torus venting capability. PSEG provided six-month status reports of Order implementation for HCGS via References 3 through 9. Reference 5 submitted an updated OIP to describe a Severe Accident Water Addition / Severe Accident Water Management (SAWA/SAWM) strategy that makes it unlikely that a drywell vent is needed to protect the containment from overpressure-related failure under severe accident conditions, including those that involve a breach of the reactor vessel by molten core debris, in response to Phase 2 of the Order.

The information provided below documents full compliance of HCGS with the NRC Order EA-13-109 requirements.

2 Open Item Resolution

The tables below provide a status of the open items from Revision 1 of the HCGS OIP (Reference 5) and the NRC Interim Staff Evaluations (ISEs) for Phase 1 and Phase 2 (References 10 and 11, respectively). Reference 12 provides the results of the NRC staff audit of ISE Open Item closure information provided in References 3 through 9 and supporting documentation provided during the audit process. All Phase 1 and Phase 2 ISE Open Items are closed as indicated in Reference 12.

Phase 1 Open Items		
Item Ref.	**Action**	**Comment**
ISE #1 OIP #1	Finalize time constraints and their bases. Make available for NRC staff audit the finalized time constraints for remote manual operations and their bases.	Closed per Reference 12. Anticipatory venting time constraints are included in the FLEX strategy timeline which assumes torus venting is initiated approximately four hours following an Extended Loss of AC Power (ELAP) event, based on torus water temperature of 200 degrees F. MAAP analyses (HC-MISC-005) have been revised to reflect the modified vent design. NRC review of the OIP (Reference 5) timeline for HCVS is documented in Section 3.3.1 of the Phase 2 ISE (Reference 11).

Phase 1 Open Items		
Item Ref.	**Action**	**Comment**
ISE #2 OIP #2	Make available for NRC staff audit analyses demonstrating that HCVS has the capacity to vent the steam/energy equivalent of one percent of licensed/rated thermal power (unless a lower value is justified), and that the suppression pool and the HCVS together are able to absorb and reject decay heat, such that following a reactor shutdown from full power containment pressure is restored and then maintained below the primary containment design pressure and the primary containment pressure limit.	Closed per Reference 12. Calculation GS-0026, *Hardened Containment Vent Capacity*, shows that the HCVS 12-inch vent can accommodate the required steam/energy equivalent of one percent of licensed/rated thermal power flow. GS-0026 uses 3917 MWt reactor power (1.02 x 3840 rated thermal power), vs current licensed rated thermal power of 3902 MWt. Calculation GS-0027, *Disc Rupture Fluid Transient Analysis in Hardened Containment Vent Piping,* shows that the piping can accommodate the fluid dynamics of the steam/energy equivalent of one percent of rated thermal power flow. Vendor Technical Document (VTD) 432633, *Suppression Pool Energy Capacity*, used 3900 MWt, and evaluated zero to three hours from an ELAP based on Revision 0 of the OIP (Reference 2). VTD 432633 shows that the suppression pool has sufficient capacity to absorb the energy released into the torus for the first three hours following an ELAP event, with approximately 60% margin. MAAP analyses (HC-MISC-005, including cases run using 3902 MWt) support anticipatory venting at four hours based on torus water temperature of 200 degrees F and acceptable containment response thereafter.
ISE #3 OIP #6	Provide the seismic and tornado missile final design criteria for the HCVS stack.	Closed per Reference 12. Design Change Package (DCP) 80115583, *Hardened Containment Vent Modification*, addresses the seismic design of the HCVS stack and includes a Technical Evaluation of tornado missile protection following NEI white paper HCVS-WP-04 as endorsed by NRC letter to NEI dated September 14, 2015 (ADAMS Accession No. ML15240A072).

Phase 1 Open Items		
Item Ref.	**Action**	**Comment**
ISE #4	Make available for NRC staff audit documentation that demonstrates adequate communication between the remote HCVS operation locations and HCVS decision makers during ELAP and severe accident conditions.	Closed per Reference 12. The HCVS Primary Operating Station (POS) is at the Remote Shutdown Panel in Room 3576 at 137 ft. elevation in the Auxiliary Building and the Remote Operating Station (ROS) in the electrical chase (Room 5301) is located at 102 ft. elevation of the Control/Diesel Building (also part of the Auxiliary Building). The POS is on the same elevation as the Main Control Room (MCR) and the ROS is two levels below the MCR. They are accessible from the MCR via pathways within the power block. Accessibility under postulated temperature and radiological conditions is addressed via ISE Open Item #5. PSEG has implemented communications enhancements including radio upgrades to support diverse and flexible (FLEX) mitigating strategies for beyond-design-basis external events. These enhancements include the addition of a remote desk set in the MCR which is provided with FLEX-backed uninterruptible power supplies and direct connections to repeaters for reliable radio communication within the power block, including the MCR and the Operations Support Center. Communication between HCVS operators and decision makers would be maintained to support HCVS operation based on the proximity of the POS and ROS to the emergency response facilities, and radio communications capability.

Phase 1 Open Items		
Item Ref.	**Action**	**Comment**
ISE #5 OIP #4	Perform dose evaluation for venting actions (OIP #4). Make available for NRC staff audit an evaluation of temperature and radiological conditions to ensure that operating personnel can safely access and operate controls and support equipment.	Closed per Reference 12. The GOTHIC model Vendor Technical Documents (VTDs) 432340 (001) (Auxiliary Building GOTHIC model) and 432611 (001) (Room 5301 and TSC areas GOTHIC model) as well as HCVS Dose Evaluation VTD 432634 (001), show that the temperatures and radiation levels are acceptable for personnel ingress/egress. A dose evaluation (VTD 432902) and summary of the HCVS temperature and radiological evaluations (VTD 432889) were performed as part of Order Phase 2 completion and address accessibility of controls and equipment for locations required for torus venting and SAWA/SAWM. PSEG Emergency Plan Section 12, Radiological Exposure Control, provides measures for radiological monitoring, assessment, and personnel protection during accident response.

Phase 1 Open Items		
Item Ref.	**Action**	**Comment**
ISE #6	Make available for NRC staff audit descriptions of all instrumentation and controls (existing and planned) necessary to implement this order including qualification methods.	Closed per Reference 12. Parameters of drywell pressure, torus pressure, torus level, torus water temperature, and reactor pressure on Main Control Room (MCR) instrumentation allow monitoring effectiveness of torus venting actions. For these parameters, HCGS uses existing instrumentation and MCR displays qualified to Regulatory Guide 1.97 and provided with Class 1E electrical power (HCGS Updated Final Safety Analysis Report, Table 7.5-1). HCVS operation is monitored by vent valve position, vent flow, and effluent radiation levels. DCP 80113942, *Hardened Containment Vent Electrical*, provided instrumentation and controls at the Primary Operating Station (POS) at the Remote Shutdown Panel in Room 3576 at 137 ft. elevation in the Auxiliary Building, and at the Remote Operating Station (ROS) in the Electrical Chase Area (Room 5301) on 102 ft. elevation of the Auxiliary Building. HCVS flow rate and dose rate are displayed via a recorder in the POS and by indicators in the ROS. The HCVS instruments are qualified by using one or more of the three methods described in JLD-ISG-2013-02 (Reference 17).
ISE #7	Make available for NRC staff audit the final sizing evaluation for HCVS batteries/battery charger including incorporation into FLEX DG loading calculation.	Closed per Reference 12. Details are provided in Section 4.3 of Reference 7 (5^{th} six-month update, ML16358A254).

Phase 1 Open Items		
Item Ref.	**Action**	**Comment**
ISE #8	Make available for NRC staff audit documentation of the HCVS nitrogen pneumatic system design including sizing and location.	Closed per Reference 12. DCP 80113941, *Hardened Containment Vent Mechanical*, provided a permanently installed nitrogen supply at the ROS in the Electrical Chase Area (Room 5301) on 102 ft. elevation of the Auxiliary Building. The ROS is protected from all external hazards. VTD 432632, *Backup Nitrogen Supply for Hardened Vent*, shows that the system possesses enough volume for 8 cycles of the HCVS valves, at a minimum bottle pressure of 1800 psig. DCP 80113941 also installed the capability to manually breach the HCVS rupture disk from the ROS using a separate nitrogen source, which is evaluated in VTD 432631, *Compressed Gas Purge System for Containment Hardened Vent*. One nitrogen bottle at a minimum pressure of 1600 psig can breach the rupture disk in ten minutes. Drawing M-57-1 sheet 2 shows the N2 bottle which ties in to the Argon purge system. Operators check bottle pressure using the Auxiliary Building log (HC.OP-DL.ZZ-0006-F1).
ISE #9	Make available for NRC staff audit the descriptions of local conditions (temperature, radiation, and humidity) anticipated during ELAP and severe accident for the components (valves, instrumentation, sensors, transmitters, indicators, electronics, control devices, etc.) required for HCVS venting including confirmation that the components are capable of performing their functions during ELAP and severe accident conditions.	Closed per Reference 12. Functionality of HCVS components during ELAP and severe accident conditions is supported by the documents referenced in response to ISE #5, combined with DCPs 80113941, 80113942 and 80115583. This includes the vendor-supplied Digital Technology Systems Quality Assurance (DTSQA) documentation for the radiation monitoring modifications in DCP 80113942.

Phase 1 Open Items		
Item Ref.	**Action**	**Comment**
ISE #10	Make available for NRC staff audit an evaluation verifying the existing containment isolation valves, relied upon for the HCVS, will open under the maximum expected differential pressure during BDBEE and severe accident wetwell venting.	Closed per Reference 12. The HCVS containment isolation valves 1GSV-201 (actuator 1GSHV-11541) and 1GSV-028 (actuator 1GSHV-4964) are shown to have a disc design differential pressure of 65 psig per VTDs 315211 and 315212, respectively. The Primary Containment Pressure Limit is 65 psig. Air-operated valve (AOV) capability evaluations 1GSHV-4964 and 1GSHV-11541 address the ability to open the hardened torus vent (HTV) valves with high containment pressure. For the 24-inch inboard valve (1GSHV-4964) the evaluation shows negative margin when opening against a differential pressure of 65 psi. The 12-inch outboard valve (1GSHV-11541) is capable of opening against the full differential pressure of 65 psi. The inboard valve is opened first using HC.OP-EO.ZZ-0318, *Containment Venting* (EOP-0318), allowing pressure across the inboard valve to equalize as it fully opens.

Phase 1 Open Items		
Item Ref.	**Action**	**Comment**
ISE #11	Provide a description of the strategies for hydrogen control that minimizes the potential for hydrogen gas migration and ingress into the reactor building or other buildings.	Closed per Reference 12. The release point elevation and plume rise during venting (described in References 13 and 14) will minimize migration and ingress of hydrogen into buildings. Vendor Technical Document (VTD) 432628 Volume 2, *Hydrogen Leakage from the CIVs [containment isolation valves] of HCVS into the Enclosed CPCS Duct Return Line*, shows that the in-leakage of hydrogen into the vent is minimal in the time between venting operations. When the HTV valves are closed, the vent piping will be purged with Argon gas using EOP-318, *Containment Venting,* if hydrogen is expected.

Phase 1 Open Items		
Item Ref.	**Action**	**Comment**
ISE #12 OIP #5	Provide a description of the final design of the HCVS to address hydrogen detonation and deflagration.	Closed per Reference 12. Vendor Technical Document (VTD) 432631, *Compressed Gas Purge System for Containment Hardened Vent,* demonstrates that the volume of argon gas used to purge the HCVS is sufficient in order to prevent hydrogen detonation/deflagration by completely filling the HCV downstream of 1GSHV-11541. The compressed gas purge system uses argon gas to fill the HCVS piping from valve 1GSHV-11541 (V-201) to the release point to prevent oxygen from entering the vent piping after a vent cycle. VTD 432733, *Time Requirement for Operation of the Compressed Gas Purge System for the Hardened Containment Vent,* recommends initiation of argon purging within 90 seconds of vent closure and operating procedure changes to maintain the vent path open in order to reduce hydrogen concentrations in containment because of the potential for oxygen ingress into the vent pipe. Measures to prevent hydrogen deflagration and detonation have been established by EOP-318, *Containment Venting,* and the argon purge system installed via DCP 80113941, *Hardened Containment Vent System Mechanical*. EOP-0318 has been revised in order to require an argon purge of the HCVS prior to opening the containment isolation valves in an accident scenario where hydrogen generation is expected, and to keep the vent path open for as long as possible, unless containment pressure approaches zero psig. The strategy to maintain the vent path open for as long as possible reduces or eliminates hydrogen in containment during long term HCVS cycling, thereby reducing the potential for oxygen ingress into the vent pipe to produce a detonable mixture between cycles.

Phase 1 Open Items		
Item Ref.	**Action**	**Comment**
ISE #13 OIP #3	Finalize χ/Q analysis (OIP #3). Submit a relaxation request as stated in the Order for the deviation from Order EA-13-109 provision 1.2.2, "The HCVS shall discharge the effluent to a release point above the main plant structures," which includes a technical justification for the deviation.	Closed per Reference 12 based on the approved relaxation of the release point requirement (References 13, 14 and 15).

Phase 2 Open Items		
Item Ref.	**Action**	**Comment**
ISE #1	Licensee shall provide the finalized design of HCVS discharge location.	Closed per Reference 12. Design Change Package (DCP) 80115583, *Hardened Containment Vent Modification*, provides the final discharge location design consistent with relaxation of the release point height requirement (Reference 15).
ISE #2	Licensee shall provide the finalized design, which demonstrates the capability to inject the necessary Severe Accident Water Addition (SAWA) flow rate and the ability to control that flow under a flooded condition.	Closed per Reference 12. DCP 80118721, *HC Severe Accident Water Addition,* provides the SAWA design to inject the required flow rate and to control flow under a flooded condition, as described in Section IV.C of the enclosed FIP.
ISE #3	Licensee to confirm through analysis the temperature and radiological conditions to ensure that operating personnel can safely access and operate controls and support equipment.	Closed per Reference 12. Vendor Technical Document 432889, *Severe Accident Water Addition Personnel and Equipment Environmental Qualification Report*, summarizes the results of temperature and radiological analyses and their impact on equipment and personnel access to SAWA equipment.

Phase 2 Open Items		
Item Ref.	**Action**	**Comment**
ISE #4	Licensee to demonstrate how instrumentation and equipment being used for SAWA and supporting equipment is capable to perform for the sustained operating period under the expected temperature and radiological conditions.	Same response as for Phase 2 ISE # 3.
ISE #5	Licensee to demonstrate that containment failure as a result of overpressure can be prevented without a drywell vent during severe accident conditions.	Closed per Reference 12. ISE #5 and ISE #6 are addressed in Technical Evaluation 80115232-0380, *SAWA ISE Items 5 and 6,* which shows that the reference plant analyses are applicable to Hope Creek and that the SAWA/SAWM strategy can prevent containment failure due to overpressure without the use of a drywell vent. The torus freeboard diagram from OIP Revision 1 (Reference 5) has been updated and provided as Attachment 1 of the enclosed FIP.
ISE #6	Licensee shall demonstrate how the plant is bounded by the reference plant analysis that shows the SAWM strategy is successful in making it unlikely that a drywell vent is needed.	Same response as for Phase 2 ISE #5.

Phase 2 Open Items		
Item Ref.	**Action**	**Comment**
ISE #7	Licensee to demonstrate that there is adequate communication between the MCR and the operator at the FLEX manual valve during severe accident conditions.	Closed per Reference 12. The SAWA design includes mechanical flow indicator (1BCFI-0100) in the Control/Diesel area of the Auxiliary Building at 102 ft. elevation, near the manual flow control valve 1BC-V643, which is used to control SAWA flowrate during non-flooded conditions. Flow indicator 1APFI-0100 and a reach rod for flow control valve 1AP-V200 are provided in Room 3197 on 75 ft. elevation of the Auxiliary Building for SAWA flow control during flooded conditions. Communication between the operator locally controlling SAWA flow and the MCR is via UHF radio or Plant Page, and is similar to communications capability available during FLEX strategy implementation.
OIP #7	Finalize design of SAWA flow control and indication for flooded condition.	Complete via Phase 2 ISE item 2.
OIP #8	Evaluate Control/Diesel Building temperature, humidity, and radiological conditions during a non-flooding event.	Complete via Phase 2 ISE items 3 and 4.
OIP #9	Evaluate Turbine and Auxiliary Building temperature, humidity, and radiological conditions during a flooding event.	Complete via Phase 2 ISE items 3 and 4.
OIP #10	Evaluate SAWA equipment and connections external to protected buildings.	Complete. SAWA uses FLEX equipment and connections and additional equipment and connections installed by DCP 80118721. Equipment and connections are protected from the applicable hazards (non-flood and flood scenarios). Equipment used for the flood scenario is either protected from flooded conditions in a flood-protected building or has the ability to operate submerged in water.
OIP #11	Procedures for Phase 2 SAWA/SAWM.	Complete as described in Section V of the enclosed FIP.

3 Milestone Schedule – Items Complete

NRC Order EA-13-109 Milestones		
Milestone	**Completion Date**	**Comments**
Overall Integrated Plan and Six-Month Updates		
Submit OIP – Phase 1	Jun 2014	Reference 2
Update 1	Dec 2014	Reference 3
Update 2	Jun 2015	Reference 4
Update 3 and Phase 2 OIP	Dec 2015	Reference 5
Update 4	Jun 2016	Reference 6
Update 5	Dec 2016	Reference 7
Update 6	Jun 2017	Reference 8
Update 7	Dec 2017	Reference 9
Phase 1 Implementation		
Hold preliminary/conceptual design meeting	Jun 2014	
Design Engineering On-site/Complete	Nov 2016	
Implementation Outage	Oct 2016	Completed Nov 2016
Walk-Through Demonstration/ Functional Test	Nov 2016	
Operations Procedure Changes Developed	Jun 2016	Completed to support Nov 2016 implementation
Site-Specific Maintenance Procedures Developed	May 2018	Periodic maintenance and testing is being addressed by the Preventive Maintenance (PM) process.

NRC Order EA-13-109 Milestones		
Milestone	**Completion Date**	**Comments**
Phase 1 Implementation (continued)		
Procedure Changes Active	Nov 2016	Procedure changes to support implementation were issued in Nov 2016
Training Complete	Jun 2016	Initial / Just-in-time training complete Nov 2016
Submit Completion Report – Phase 1	Dec 2016	Reference 7
Phase 2 Implementation		
Hold preliminary/conceptual design meeting	Dec 2015	
Submit Overall Integrated Implementation Plan	Dec 2015	
Design Engineering On-site/Complete	April 2017	Design Change Package 80118721, Revision 0 issued in April 2017 and revised May 2018
Operations Procedure Changes Developed	Dec 2017	
Site-Specific Maintenance Procedures Developed	May 2018	Periodic maintenance and testing is being addressed by the PM process.
Training Complete	May 2018	
Implementation Outage	May 2018	
Operations Procedure Changes Active	May 2018	
Walk Through Demonstration/Functional Test	May 2018	
Submit Completion Report	July 2018	Complete via this report.

4 NRC Order EA-13-109 Compliance Elements Summary

The elements identified below for HCGS as well as the HCVS Phase 1 and Phase 2 OIP (Reference 5), subsequent six-month status reports (References 6 through 9), and additional docketed correspondence demonstrate compliance with Order EA-13-109. The basis for HCGS compliance includes NRC-approved relaxation of the torus vent release point height (References 13, 14 and 15). The HCGS Final Integrated plan (FIP) for reliable hardened containment vent Phase 1 and Phase 2 strategies is provided in Enclosure 1.

4.1 HCVS Phase 1 and Phase 2 Functional Requirements and Design Features - Complete

The HCGS Phase 1 HCVS provides a vent path from the wetwell (torus) to remove decay heat, vent the containment atmosphere, and control containment pressure within acceptable limits. The Phase 1 HCVS will function for those accident conditions for which containment venting is relied upon to reduce the probability of containment failure, including accident sequences that result in the loss of active containment heat removal capability during an Extended Loss of AC Power (ELAP).

The HCGS Phase 2 HCVS provides a reliable containment venting strategy that makes it unlikely that the plant would need to vent from the containment drywell before alternative reliable containment heat removal and pressure control is reestablished. The HCGS Phase 2 HCVS strategies implement Severe Accident Water Addition (SAWA) with Severe Accident Water Management (SAWM) as an alternative venting strategy. This strategy consists of the use of the Phase 1 wetwell vent and SAWA hardware to implement a water management strategy that will preserve the wetwell vent path until alternate reliable containment heat removal can be established.

The HCGS Phase 1 and Phase 2 HCVS strategies are in compliance with NRC Order EA-13-109. The modifications required to support the HCVS strategies for HCGS have been fully implemented in accordance with the station processes.

4.2 HCVS Phase 1 and Phase 2 Quality Standards - Complete

The design and operational considerations of the Phase 1 and Phase 2 HCVS installed at HCGS comply with the requirements specified in the Order and described in NEI 13-02, Revision 1 (Reference 16), with alternatives for release point height (Reference 15), vent system status monitoring using vent flow rate instead of vent line temperature and pressure (Enclosure 1, FIP Section III.B, Order Element 1.2.8), and leak testing of the HCVS outboard of the containment isolation valves (Enclosure 1, FIP Section III.B, Order Element 1.2.13).

The Phase 1 and Phase 2 HCVS has been installed in accordance with the station design control process.

The Phase 1 and Phase 2 HCVS components including piping, piping supports, containment isolation valves, containment isolation valve actuators and containment isolation valve position indication have been designed consistent with the design basis of the plant. Other Phase 1 and Phase 2 HCVS components including electrical power supply, valve actuator pneumatic supply and instrumentation have been designed for reliable and rugged performance that is capable of ensuring Phase 1 and Phase 2 HCVS functionality following a seismic event. As described in the FIP (Enclosure 1), the Phase 2 SAWA design includes equipment that is specifically credited with mitigating an external flooding event and is therefore not relied upon for operation following a seismic event.

4.3 HCVS Phase 1 and Phase 2 Programmatic Features - Complete

Storage of portable equipment for HCGS Phase 1 and Phase 2 HCVS use provides adequate protection from applicable site hazards, and identified paths and deployment areas will be accessible during all modes of operation and during severe accidents, as recommended in NEI 13-02, Revision 1, Section 6.1.2.

Training in the use of the Phase 1 and Phase 2 HCVS for HCGS has been completed in accordance with an accepted training process as recommended in NEI 13-02, Revision 1, Section 6.1.3.

Procedures for HCGS have been developed and integrated with existing procedures to ensure safe operation of the Phase 1 and Phase 2 HCVS. Operating procedures have been verified and are available for use in accordance with the site procedure control program. Maintenance and testing for HCVS utilizes the Preventive Maintenance (PM) process.

Site processes have been established to ensure the Phase 1 and Phase 2 HCVS is tested and maintained as recommended in NEI 13-02, Revision 1, Sections 5.4 and 6.2.

HCGS has completed validation in accordance with industry developed guidance to assure required tasks, manual actions and decisions for HCVS strategies are feasible and may be executed within the constraints identified in the HCVS Phase 1 and 2 OIP for Order EA-13-109 (Reference 5).

HCGS has completed evaluations to confirm accessibility, habitability, staffing sufficiency, and communication capability in accordance with NEI 13-02, Sections 4.2.2 and 4.2.3

5 References

1. NRC Order EA-13-109, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions," dated June 6, 2013 (ADAMS Accession No. ML13143A321)
2. PSEG letter LR-N14-0155, "PSEG Nuclear LLC's Phase 1 Overall Integrated Plan in Response to June 6, 2013, Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated June 25, 2014 (ADAMS Accession No. ML14177A508)
3. PSEG Letter LR-N14-0258, "Hope Creek Generating Station's First Six-Month Status Report in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated December 19, 2014 (ADAMS Accession No. ML14353A076)
4. PSEG Letter LR-N15-0129, "Hope Creek Generating Station's Second Six-Month Status Report in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated June 18, 2015 (ADAMS Accession No. ML15173A026)
5. PSEG Letter LR-N15-0257, "Hope Creek Generating Station's Phase 1 and Phase 2 Overall Integrated Plan and Third Six-Month Status Report (Phase 1) in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated December 28, 2015 (ADAMS Accession No. ML15362A580)
6. PSEG Letter LR-N16-0118, "Hope Creek Generating Station's Fourth Six-Month Status Report in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated June 29, 2016 (ADAMS Accession No. ML16181A210)
7. PSEG Letter LR-N16-0218, "Hope Creek Generating Station's Fifth Six-Month Status Report in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated December 22, 2016 (ADAMS Accession No. ML16358A254)
8. PSEG Letter LR-N17-0075, "Hope Creek Generating Station's Sixth Six-Month Status Report in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated June 27, 2017 (ADAMS Accession No. ML17178A300)
9. PSEG Letter LR-N17-0162, "Hope Creek Generating Station's Seventh Six-Month Status Report in Response to June 6, 2013 Commission Order Modifying

Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109),” dated December 19, 2017 (ADAMS Accession No. ML17354A772)

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

11. NRC Letter to PSEG, “Hope Creek Generating Station – Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Phase 2 of Order EA-13-109 (Severe Accident Capable Hardened Vents) (CAC NO. MF4458),” dated August 2, 2016 (ADAMS Accession No. ML16103A320)

12. NRC letter to PSEG, “Hope Creek Generating Station - Report for the Audit of Licensee Responses to Interim Staff Evaluations Open Items Related to NRC Order EA-13-109 to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions,” dated May 4, 2018 (ADAMS Accession No. ML18120A165)

13. PSEG Letter LR-N16-0041, "Hope Creek Generating Station’s Request for Relaxation from the Hardened Containment Vent Release Point Height Requirement of NRC Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated June 21, 2016 (ADAMS Accession No. ML16174A086)

14. PSEG Letter LR-N16-0148, "Supplemental Information Regarding Hope Creek Generating Station’s Request for Relaxation from the Hardened Containment Vent Release Point Height Requirement of NRC Order EA-13-109," dated September 7, 2016 (ADAMS Accession No. ML16251A309)

15. NRC Letter to PSEG, “Hope Creek Generating Station – Request for Relaxation of the Release Point Height Requirement of NRC Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions (CAC No. MF4458),” dated September 30, 2016 (ADAMS Accession No. ML16256A655)

16. NEI 13-02, “Industry Guidance for Compliance with Order EA-13-109,” Revision 1, dated April 2015 (ADAMS Accession No. ML15113B318)

17. NRC Interim Staff Guidance JLD-ISG-2013-02, “Compliance with Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions,” dated November 14, 2013 (ADAMS Accession No. ML13304B836)

18. NRC Interim Staff Guidance JLD-ISG-2015-01, “Compliance with Phase 2 of Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions,” Revision 0, dated April 2015 (ADAMS Accession No. ML15104A118)

ENCLOSURE 1

Final Integrated Plan
HCVS Order EA-13-109
for
Hope Creek Generating Station

Final Integrated Plan

HCVS Order EA-13-109

for

Hope Creek Generating Station (HCGS)

July 23, 2018

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Section I: Introduction

In 1989, the NRC issued Generic Letter (GL) 89-16, “Installation of a Hardened Wetwell Vent,” (Reference 1) to all licensees of BWRs with Mark I containments to encourage licensees to voluntarily install a hardened wetwell vent. In response, licensees installed a hardened vent pipe from the wetwell to some point outside the secondary containment envelope (usually outside the Reactor Building). Some licensees also installed a hardened vent branch line from the drywell.

On March 19, 2013, the Nuclear Regulatory Commission (NRC) Commissioners directed the staff per Staff Requirements Memorandum (SRM) for SECY-12-0157, Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments (References 2 and 3) to require licensees with Mark I and Mark II containments to "upgrade or replace the reliable hardened vents required by Order EA-12-050, Order to Modify Licenses with Regard to Reliable Hardened Containment Vents (Reference 4) with a containment venting system designed and installed to remain functional during severe accident conditions." In response, the NRC issued Order EA-13-109, Issuance of Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions, June 6, 2013 (Reference 5). Reference 5 requires that licensees of BWR facilities with Mark I and Mark II containment designs ensure that these facilities have a reliable hardened vent to remove decay heat from the containment, and to maintain control of containment pressure within acceptable limits following events that result in the loss of active containment heat removal capability while maintaining the capability to operate under severe accident (SA) conditions resulting from an Extended Loss of AC Power (ELAP).

Hope Creek Generating Station (HCGS) is required by Reference 5 to have a reliable, severe accident capable hardened containment venting system (HCVS). Reference 5 allows implementation of the HCVS Order in two phases:

- Phase 1 upgraded the venting capabilities from the containment wetwell to provide a reliable, severe accident capable hardened vent to assist in preventing core damage and, if necessary, to provide venting capability during severe accident conditions. HCGS achieved Phase 1 compliance on November 9, 2016.

- Phase 2 provided additional protections for severe accident conditions through the development of a reliable containment venting strategy that makes it unlikely that HCGS would need to vent from the containment drywell during severe accident conditions. HCGS achieved Phase 2 compliance on May 9, 2018.

NEI developed guidance for complying with Reference 5 in NEI 13-02, Industry Guidance for Compliance with Order EA-13-109, BWR Mark I & II Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions, Revision 0 (Reference 6), with significant interaction with the NRC and licensees. NEI issued

Revision 1 to NEI 13-02 in April 2015 (Reference 7) which contains guidance for compliance with both Phase 1 and Phase 2 of the Order. Reference 7 also includes HCVS- Frequently Asked Questions (FAQs) 01 through 09 and reference to white papers (HCVS-WP-01 through 03 (References 8 through 10)). The NRC endorsed NEI 13-02, Revision 0 as an acceptable approach for complying with Order EA-13-109 through Interim Staff Guidance JLD-ISG-2013-02, *Compliance with Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions*, issued in November 2013 (Reference 12) and JLD-ISG-2015-01, *Compliance with Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions*, issued in April 2015 (Reference 13) for NEI 13-02, Revision 1 with some clarifications and exceptions. NEI 13-02, Revision 1 provides an acceptable method of compliance for both phases of Order EA-13-109.

In addition to the endorsed guidance in NEI 13-02, the NRC staff endorsed several other documents that provide guidance for specific areas. HCVS-FAQs 10 through 13 (References 14 through 17) were endorsed by the NRC after Reference 7 was issued on October 8, 2015. NRC staff also endorsed four White Papers, HCVS-WP-01 through 04 (References 8 through 11), which cover broader or more complex topics than the FAQs.

As required by Reference 5, HCGS submitted a Phase 1 Overall Integrated Plan (OIP) in June of 2014 (Reference 18) and subsequently submitted a combined Phase 1 and 2 OIP in December 2015 (Reference 24). These OIPs followed the guidance of NEI 13-02, Revision 0 and 1, respectively. The NRC staff used the methods described in the ISGs to evaluate licensee compliance as presented in the Order EA-13-109 OIPs. While the Phase 1 and combined Phase 1 and 2 OIPs were written to different revisions of NEI 13-02, HCGS conforms to NEI 13-02, Revision 1 for both phases of Order EA-13-109, with alternatives for the following:

- Release point height (FIP Section III.B, Order Element 1.2.2)
- Vent system status monitoring using vent flow rate instead of vent line temperature and pressure (FIP Section III.B, Order Element 1.2.8)
- Leak rate testing of the HTV outboard of the containment isolation valves (FIP Section III.B, Order Element 1.2.13).

The NRC performed a review of each OIP submittal and provided HCGS with Interim Staff Evaluations (ISEs) (References 20 and 21) assessing the site's compliance methods. In the ISEs the NRC identified open items which the site needed to address before that phase of compliance was reached. Six-month status reports (References 22 through 28) were provided consistent with the requirements of Order EA-13-109. These status reports were used to close many of the ISE open items. In addition, the site participated in NRC ISE open item audit calls where the information provided in the six-month updates and on an e-portal were used by the NRC staff to determine whether the ISE Open Item appeared to be addressed.

By submittal of this Final Integrated Plan (FIP), HCGS has addressed all the elements of NRC Order EA-13-109 utilizing the endorsed guidance in NEI 13-02, Rev 1 and the related HCVS-FAQ and HCVS-WP documents. In addition, the site has addressed the NRC Phase 1 and Phase 2 ISE Open Items as documented in previous six-month updates and in the NRC staff's Order EA-13-109 audit report (Reference 29). Section III contains the HCGS Final Integrated Plan details for Phase 1 of the Order. Section IV contains the Final Integrated Plan details for Phase 2 of the Order. Section V details the programmatic elements of compliance.

<u>Section I.A</u>: Summary of Compliance

<u>Section I.A.1</u>: Summary of Phase 1 Compliance

The plant venting actions for the EA-13-109, Phase 1, severe accident capable venting scenario can be summarized by the following**:**

The HCVS is initiated via manual action from the Main Control Room (MCR) until power is transferred to the Primary Operating Station (POS) as part of ELAP load shedding. The POS at HCGS is at the Remote Shutdown Panel (RSP) that will be treated as the main operating location for Order EA-13-109. The RSP is in Room 3576 at the 137 ft. elevation of the Auxiliary Building (AB). The HCVS may also be operated from the Remote Operating Station (ROS) at the appropriate time based on procedural guidance in response to plant conditions from observed or derived symptoms. The ROS is in Room 5301 of the AB at 102 ft. elevation.

- The vent utilizes containment parameters of pressure, temperature and level from the MCR instrumentation to monitor effectiveness of the venting actions.
- The vent operation is monitored by HCVS valve position, flow rate, and effluent radiation levels.
- The HCVS motive force (DC power and N2 supply) is monitored and has the capacity to operate for 24 hours with installed equipment. Replenishment of the motive force will be by use of portable equipment once the installed motive force is exhausted.
- Venting actions are capable of being maintained for a sustained period of at least seven days.

The operation of the HCVS is designed to minimize the reliance on operator actions in response to external hazards. The screened in external hazards for HCGS are seismic, external flooding, severe storms with high winds, extreme high temperatures, and ice, snow and extreme cold temperatures. Initial operator actions are completed by plant personnel and include the capability for remote-manual initiation from the HCVS control station. Attachment 2 contains a piping and instrumentation diagram (P&ID) of the HCVS vent flow path.

Section I.A.2: Summary of Phase 2 Compliance

The Phase 2 actions can be summarized as follows:

- Utilization of Severe Accident Water Addition (SAWA) to initially inject water into the Reactor Pressure Vessel (RPV)

- Utilization of Severe Accident Water Management (SAWM) to control injection and Suppression Pool level to ensure the HCVS Phase 1 wetwell vent will remain functional for the removal of heat from the containment.

- Heat can be removed from the containment for at least seven (7) days using the HCVS or until alternate means of heat removal are established that make it unlikely the drywell vent will be required for containment pressure control.

- The SAWA and SAWM actions can be manually activated and controlled from areas that are accessible during severe accident conditions.

- Parameters measured are Drywell pressure, Suppression Pool water level, SAWA flowrate and the HCVS Phase 1 vent path parameters.

The locations of the SAWA equipment and controls, as well as ingress and egress paths have been evaluated for the expected severe accident conditions (temperature, humidity, radiation) for the sustained operating period. Equipment has been evaluated to remain operational throughout the sustained operating period. Personnel radiological exposure, temperature and humidity conditions for operation of SAWA equipment will not exceed the authorized emergency exposure dose limits or plant safety guidelines for temperature and humidity.

The HCGS SAWA strategy uses separate flow paths depending on whether an ELAP results from external flooding or some other external hazard. The FLEX hydraulic analysis (Reference 30) has been revised to include the SAWA flow cases for the flooded and non-flooded conditions. Attachment 4 contains a one-line diagram of the SAWA flow paths.

The SAWA flow path for the non-flooded scenario uses the portable diesel FLEX pump deployed at the Service Water Intake Structure (SWIS) with a flow path, hose routing and connection points that differ from FLEX. The flow path is from the Delaware River to a new manifold at the Auxiliary Building truck bay at 102 ft. elevation. The flow path continues from the pump manifold through new piping that ties into the existing 'B' RHR / SW cross-tie on 77 ft. elevation of the Reactor Building (RB) in Room 4209, and then to the RPV. The new piping includes a flow control valve and flow meter at the truck bay to enable flow monitoring and control. There are two check valves in series upstream of the tie-in to the 'B' RHR / SW cross-tie. The flow path to the RPV is through normally closed RHR system motor-operated valves (MOVs) and check valves. Communication is established between the MCR and the pump manifold location. Flow can be controlled within the range of 100 gpm to 500 gpm, consistent with the BWROG reference plant analyses described in NEI 13-02, Revision 1 (Reference 7).

The SAWA flow path for the flooded condition uses three new skid-mounted, motor-driven submersible SAWA pumps of equal capacity of approximately 250 gpm, installed at Turbine Building (TB) 54 ft elevation. The main condenser condensate header was modified with a 6-inch tie-in connection to provide water from the condensers to the SAWA pumps, utilizing a hard suction hose. The pump skid has two pumps normally aligned to the condenser that can provide the initial required flow rate of 500 gpm. The pump skid also has one pump that is normally aligned to take suction from the floor of the TB at 54 ft. elevation when flooded, for prolonged injection at lower flow rates. The pumps are controlled from a motor control center on elevation 153 ft of the flood protected radwaste area of the AB. The discharge piping from the pump skid extends to the 77 ft. elevation of the Turbine Building and ties into the Condensate Transfer and Storage System. Downstream of this connection on 75 ft. elevation of the radwaste area of the Auxiliary Building, in Room 3187, a flow control valve and flow instrument are installed for controlling and monitoring flow. The flow indicator and manual valve operator are mounted in Room 3197, which is a mild environment in the flood-protected Auxiliary Building. The new manual valve is equipped with a reach rod to extend through the wall between Room 3187 and Room 3197. The flow path continues through the Condensate Transfer System, into the 'A' RHR loop and then to the RPV. The flow rate can be reduced to approximately 100 gpm for long term operation by operating one pump and adjusting the manual flow control valve.

The SAWA electrical loads are included in the FLEX DG loading calculation (Reference 31) for NRC Order EA-12-049 (Reference 41) compliance. Two pre-staged 480 VAC FLEX DGs (N and N+1) are located north of HCGS Unit 1 on the Unit 2 (cancelled plant) RB roof. The FLEX DGs are a significant distance and on the opposite side of the power block from the discharge of the HCVS on the south side of the Unit 1 RB. In the event that both FLEX DGs on the Unit 2 RB roof are unavailable, one of two additional 480 VAC FLEX DGs may be deployed from its respective Outdoor FLEX Storage Area (OFSA 1 or OFSA 2) to the Unit 1 diesel truck bay using SH.OP-AM.FLX-0051, *Salem/Hope Creek Shared FLEX Equipment Phase 2 Deployment* (Reference 61). Refueling of the FLEX DG is accomplished from the Emergency Diesel Generator (EDG) fuel oil tanks using HC.OP-EO.ZZ-0408, *FLEX Fuel Supply* (Reference 57), as described in the EA-12-049 FLEX FIP (Reference 32).

Evaluations for projected SA conditions (radiation / temperature) indicate that personnel can complete the initial and support activities without exceeding the authorized emergency exposure dose limits for equipment operation or site safety standards (Reference 33).

Electrical equipment and instrumentation is powered from the existing station batteries, and from AC distribution systems that are powered from the FLEX DG. The “B” 125 VDC battery charger is also powered from the FLEX DG to maintain the battery capacities during the sustained operating period.

Section II: List of Acronyms

AB	Auxiliary Building
AC	Alternating Current
AOV	Air Operated Valve
Ar	Argon
BDBEE	Beyond Design Basis External Event
BWROG	Boiling Water Reactor Owners’ Group
CAP	Containment Accident Pressure
CPCS	Containment Pre-purge Cleanup System
DBA	Design Basis Accident
DC	Direct Current
DCP	Design Change Package
DG	Diesel Generator
ECCS	Emergency Core Cooling System
EDG	Emergency Diesel Generator
ELAP	Extended Loss of AC Power
EOP	Emergency Operating Procedure

EPG/SAG	Emergency Procedure and Severe Accident Guidelines
EPRI	Electric Power Research Institute
ERO	Emergency Response Organization
FAQ	Frequently Asked Question
FIP	Final Integrated Plan
FLEX	Diverse & Flexible Coping Strategy
GPM	Gallons per Minute
HCVS	Hardened Containment Vent System
HTV	Hardened Torus Vent
IAW	In Accordance With
ISE	Interim Staff Evaluation
ISG	Interim Staff Guidance
JLD	Japan Lessons Learned Project Directorate
LOCA	Loss of Coolant Accident
MAAP	Modular Accident Analysis Program
MCR	Main Control Room
MWt	Megawatts Thermal
N2	Nitrogen
N/A	Not Applicable
NEI	Nuclear Energy Institute
NPSH	Net Positive Suction Head
NRC	Nuclear Regulatory Commission

OFSA	Outdoor FLEX Storage Area
OIP	Overall Integrated Plan
P&ID	Piping and Instrumentation Diagram
PCPL	Primary Containment Pressure Limit
PIV	Pressure Isolation Valve
PM	Preventive Maintenance
POS	Primary Operating Station
psig	Pounds per Square Inch, Gauge
RB	Reactor Building
RCIC	Reactor Core Isolation Cooling System
RCS	Reactor Coolant System
RHR	Residual Heat Removal
RM	Radiation Monitor
ROS	Remote Operating Station
RPV	Reactor Pressure Vessel
RSP	Remote Shutdown Panel
RW	Radwaste
RWCU	Reactor Water Cleanup
SA	Severe Accident
SAMG	Severe Accident Management Guidelines
SAWA	Severe Accident Water Addition
SAWM	Severe Accident Water Management
SFP	Spent Fuel Pool

SRM	Staff Requirements Memorandum
SRV	Safety-Relief Valve
SWIS	Service Water Intake Structure
TB	Turbine Building
TID	Total Integrated Dose
UFSAR	Updated Final Safety Analysis Report
VAC	Volts AC
VDC	Volts DC
VTD	Vendor Technical Document

Section III: Phase 1 Final Integrated Plan Details

Section III.A: HCVS Phase 1 Compliance Overview

HCGS modified the existing hardened wetwell (i.e., torus for HCGS) vent path installed in response to NRC Generic Letter (GL) 89-16 (Reference 1) to comply with NRC Order EA-13-109 (Reference 5).

Section III.A.1: Generic Letter 89-16 Vent System

HCGS installed a Hardened Torus Vent (HTV) in response to NRC GL 89-16, via Design Change Package (DCP) 4EC-3121 (Reference 34). The original NRC GL 89-16 HTV provided a direct path from the torus air space to a horizontal release point outside of the Reactor Building (RB) at approximately 250 ft. elevation (plant grade elevation is approximately 102 ft.). The release point of the vent piping is approximately 50 feet below the top of the RB Dome. A 12-inch pipe connects to the 24-inch Containment Atmosphere Control System piping between containment isolation inboard and outboard valves, 1GSV-028 and 1GSV-027. HTV valves 1GSV-201 and 1GSV-028 are normally closed and remotely operated butterfly valves, which are opened from the Main Control Room (MCR) to initiate venting. Valve 1GSV-201 is located on the 12-inch pipe and valve 1GSV-028 is located on the 24-inch pipe. The motive force for operating valve 1GSV-028 (using pneumatic actuator 1GSHV-4964) and valve 1GSV-201 (using pneumatic actuator 1GSHV-11541) is provided by the instrument air system or the backup nitrogen system located near the vent piping on 102 ft. elevation of the RB. The original design (Reference 34) included rupture disk 1GSPSE-11554, which is set to burst at approximately 35 psig when valves 1GSV-028 and 1GSV-201 are opened.

<u>Section III.A.2</u>: EA-13-109 Hardened Containment Vent System (HCVS)

The NRC Order EA-13-109-compliant HCVS system utilizes the GL 89-16 HTV with modifications via the following Design Change Packages (DCPs):

- DCP 80113941, *Hardened Containment Vent Mechanical* (Reference 35)
- DCP 80113942, *Hardened Containment Vent Electrical* (Reference 36)
- DCP 80115583, *Hope Creek Hardened Torus Vent Modification* (Reference 37)

Design changes include establishing the Primary Operating Station (POS) at the Remote Shutdown Panel (Panel 10-C-399 in Room 3576), which is located near the MCR at 137 ft. elevation of the Auxiliary Building (AB) (Reference 36). The Remote Operating Station (ROS) has been installed in the electrical chase (Room 5301) located at 102 ft. elevation of the AB. The ROS includes a nitrogen (N2) system to provide motive force for operation of the air-operated HTV valves, and a separate N2 bottle to manually breach rupture disk 1GSPSE-11554. The ROS includes an argon (Ar) system for purging the vent line if hydrogen is present in the containment (Reference 35). Ar purging is performed prior to the initial venting under severe accident conditions, and after the HTV valve 1GSV-201 is closed if hydrogen is present.

The POS and ROS are protected from all external hazards and remain accessible during a range of plant conditions, including severe accident conditions. Protection from external hazards is provided by the POS and ROS being located in the safety-related AB. Design and installation of new HCVS equipment is in accordance with HCGS design processes and seismic criteria (References 35, 36 and 37). Table 2 contains the evaluation of the acceptability of the POS and ROS locations with respect to severe accident temperature and radiological conditions.

During an ELAP, the operation of the HTV valves from the POS will be available for at least 24 hours without FLEX power via the Class 1E “D” 125 VDC battery and vital instrument bus inverter. FLEX power is provided to the POS via the Class 1E “B” battery, battery charger, and vital instrument bus inverter before the “D” battery is depleted (Reference 38).

The ROS is designated as the alternate control location and method. The backup N2 system at the ROS supplies pressurized N2 gas to actuators 1GSHV-4964 (for valve 1GSV-028) and 1GSHV-11541 (for valve 1GSV-201) so that these valves can be actuated from a remote but easily accessible location. The second function of the N2 system at the ROS is to create an exhaust path from the vent ports of solenoid valves 1GSSV-4964 and 1GSSV-11541 to Room 5301 in the AB, to enable closing of HTV valves 1GSV-028 and 1GSV-201 without electrical control power (Reference 35). Two

N2 bottles are maintained at the ROS to provide at least 24 hours of HTV operation without replenishment. The two N2 bottles are arranged in parallel with each bottle capable of supplying both HTV valves, which facilitates bottle replacement if necessary. A separate N2 bottle is maintained at the ROS to manually breach rupture disk 1GSPSE-11554. Since the ROS does not require any electrical power to operate the HTV valves, the valve solenoids do not need any additional backup electrical power. Within 24 hours of an ELAP, personnel will be available to support compressed gas bottle replacement with portable on-site supplies as needed.

In order to control the open stroke time of the air-to-open, fail-closed, outboard HTV valve 1GSV-201 and reduce dynamic loading on the piping system, Reference 37 added a needle valve upstream of actuator 1GSHV-11541. The needle valve enables adjustment of the open stroke time but it does not affect valve 1GSV-201 closure for containment isolation because it is not on the exhaust path for 1GSHV-11541.

The HTV release point was modified via Reference 37 to remove the elbow at the original release point via a miter cut of the vent pipe. A pipe end cover is installed for foreign material exclusion. This change provides a vertically oriented release for improved atmospheric dispersion, and is part of the basis for NRC relaxation of Requirement 1.2.2 in Attachment 2 of NRC Order EA-13-109, which requires the release point to be above main plant structures. Details of the relaxation are provided in References 44, 45 and 46.

Following an ELAP load shed, the HTV valve control and position indication are transferred to the POS using key-lock switches located at the POS. The key-lock switches transfer control of the HTV valves and indicating lights for valve position indication, as well as a graphic recorder displaying the process flow rate and radiation dose rate. Transferring control from the MCR to the POS bypasses the Bailey control logic system and associated containment isolation interlocks that provide the interface to the valve control switches and indicating lights in the MCR.

HTV controls and displays at the POS panel 10-C-399 are as follows (Reference 36):

- Key-lock switch controls for solenoid valves 1GSSV-4964 and 1GSSV-11541 to transfer control from the MCR to the POS and remotely operate HTV valves 1GSV-028 (actuator 1GSHV-4964) and 1GSV-201 (actuator 1GSHV-11541)

- Valve position indicating lights for HTV valves 1GSV-028 and 1GSV-201

- HTV radiation dose rate and vent flow rate recorder from radiation monitor 1SPRY-11542A

The ROS includes new process indicator panel 1GS-10-C-101, which displays HTV flow rate and dose rate. These displays are powered from new panel 1MC267A for the high range radiation monitor 1SPRY-11542A, which uses a 24 VDC power supply that is backed up by the Class 1E “D” and “B” batteries and inverters.

The ELAP load shed using HC.OP-AB.ZZ-0135 *(*AB-135), *Station Blackout / Loss of Offsite Power / Diesel Generator Malfunction* (Reference 50), maintains power to 120 VAC distribution panels 1BJ481 and 1DJ481, which are fed from their respective “B” and “D” Class 1E 125 VDC batteries and inverters. These distribution panels provide power to the POS and ROS for HTV operation. The “D” battery ELAP load shed ensures sufficient capacity to support operation for the first 24 hours of the ELAP event without battery charging. The “B” battery charger is provided with FLEX power to support HTV operation for the sustained operating period of seven days. The “B” channel is the credited power source after 24 hours of event initiation, although it is expected that the FLEX power to “B” channel will be established well before 24 hours.

The HCVS high range radiation monitor with an ion chamber detector is qualified for the ELAP and external event conditions. In addition to the radiation monitor, a flow element is installed on the vent line to allow the operators to monitor operation of the HCVS. Electrical and controls components are seismically qualified and include the ability to handle severe accident environmental conditions although they are not considered part of the site Environmental Qualification program.

Table 1 contains a complete list of instruments available to the operators for operating and monitoring the HCVS. Attachment 3 contains diagrams of the HTV electrical distribution system.

The torus vent up to and including the second containment isolation barrier is designed consistent with the design basis of the plant. These items include piping, piping supports, containment isolation valves, containment isolation valve actuators and containment isolation valve position indication components.

NEI 13-02, Revision 1 suggests a 350°F value for HCVS design temperature based on the highest Primary Containment Pressure Limit (PCPL) among the Mark I and II plants. The HCGS HTV piping design conservatively uses 350°F and 65 psig (References 35 and 37). The HCGS PCPL is 65 psig, which corresponds to a temperature of 312°F.

<u>Section III.B</u>: HCVS Phase 1 Evaluation Against Requirements

The functional requirements of Phase 1 of NRC Order EA-13-109 are outlined below along with an evaluation of the HCGS response to maintain compliance with the Order and guidance from JLD-ISG-2015-01 (Reference 13). Due to the difference between NEI 13-02, Revision 0 and Revision 1, only Revision 1 (Reference 7) will be evaluated. Per Reference 13, this is acceptable as Reference 7 provides acceptable guidance for compliance with Phase 1 and Phase 2 of the Order.

1. HCVS Functional Requirements

1.1 The design of the HCVS shall consider the following performance objectives:

1.1.1 The HCVS shall be designed to minimize the reliance on operator actions.

<u>Evaluation:</u>

The operation of the HCVS was designed to minimize the reliance on operator actions in response to hazards identified in NEI 12-06, *Diverse and Flexible Coping Strategies (FLEX) Implementation Guide* (Reference 40), which are applicable to the plant site. Operator actions to initiate the HCVS vent path can be completed by plant personnel and include the capability for remote-manual initiation from the HCVS control station. A list of the actions performed by plant personnel to open the HCVS vent path is in Table 3-1:

Table 3-1: HCVS Operator Actions

Primary Action	Primary Location/ Component	Notes
1. Transfer HTV electrical loads to Class 1E 125 VDC “D” battery power.	Key-locked transfer switches 1GSHS-4964B and 1GSHS-11541B located at the POS.	Performed using EOP-318 (Reference 51) after ELAP load shed for FLEX and before HTV operation from the POS.
2. Manually breach rupture disk PSE-11554.	N2 hand valves 1KBV-316 and 1KBV-326 at the ROS.	
3. Align N2 supply from the ROS if normal service air supply is not available.	One of two N2 bottles and hand valves (1KBV-302 or 1KBV-303) at the ROS.	
4. Open 1GSV-028 (actuator 1GSHV-4964), Torus Vent Inboard Isolation Valve.	Key-locked control switch 1GSHS-4964A at the POS, or manual actions to unlock and close N2 valve 1KBV-323, and unlock and open N2 valve 1KBV-321 at the ROS.	
5. Purge with Ar if venting during a severe accident with hydrogen in containment.	Open isolation valve for one of eight Ar bottles then open hand valve 1KBV-326.	
6. Open 1GSV-201 (actuator 1GS-HV-11541), Torus Vent Outboard Isolation Valve.	Key-locked control switch 1GSHS-11541A at the POS, or manual actions to unlock and close N2 valve 1KBV-322, and unlock and open N2 valve 1KBV-319 at the ROS.	Torus venting is initiated.

Permanently installed electrical power and pneumatic supplies are available to support operation and monitoring of the HCVS for a minimum of 24 hours. No portable equipment needs to be moved in the first 24 hours.

After 24 hours, available personnel will be able to connect supplemental electric power and pneumatic supplies for sustained operation of the HCVS for a minimum of 7 days. The FLEX generators and portable N2 bottles provide this motive force. In all likelihood, these actions will be completed in less than 24 hours. However the HCVS can be operated for at least 24 hours without any supplementation.

The above set of actions conform to the guidance in NEI 13-02, Revision 1, Section 4.2.6 for minimizing reliance on operator actions and are acceptable for compliance with Order Element A.1.1.1. Table 3-2 provides an evaluation of potential HCVS failures and alternate actions.

Table 3-2: Failure Evaluation

Functional Failure Mode	Failure Cause	Alternate Action	Failure with Alternate Action Impact on Containment Venting?
Failure of Vent to Open on Demand	Valves fail to open/close due to loss of normal AC power.	Transfer control to POS, which is initially supplied by Class 1E "D" battery and inverter.	No
Failure of Vent to Open on Demand	Valves fail to open/close due to complete loss of batteries (long term).	Recharge Class 1E "B" battery with FLEX diesel generator, considering severe accident conditions.	No
Failure of Vent to Open on Demand	Valves fail to open/close due to loss of normal pneumatic air supply.	Align N2 bottle at the ROS to supply HTV valve operators.	No
Failure of Vent to Open on Demand	Valves fail to open/close due to loss of alternate pneumatic air supply (long term).	Replace nitrogen cylinders supporting HTV valves as needed.	No
Failure of Vent to Open on Demand	Valves fail to open/close due to SOV failure.	Use manual N2 valves at ROS to open/close HTV valves.	No

1.1.2 The HCVS shall be designed to minimize plant operators' exposure to occupational hazards, such as extreme heat stress, while operating the HCVS system.

Evaluation:

Primary control of the HCVS is accomplished from the POS, which is the Remote Shutdown Panel (Panel 10-C-399 in Room 3576), located near the MCR (Room 5510) at 137 ft. elevation of the Auxiliary Building (AB). Alternate control of the HCVS is accomplished from the ROS in the Electrical Chase Area (Room 5301) on 102 ft. elevation of the AB. FLEX actions that will maintain habitability of the MCR, POS and ROS were implemented in response to NRC Orders EA-12-049 (Reference 41) and EA-13-109 (Reference 5). These actions are implemented via AB-135 (Reference 50) and include the following:

1. Removing ceiling tiles and opening doors in the MCR area.
2. Opening AB stairwell doors to the outside.
3. Using a FLEX-powered portable ventilation fan to provide air to the MCR from a stairwell open to the outside. This action is not considered time critical in the EA-12-049 FIP (Reference 32) but is performed as needed once FLEX power is available.

Table 2 contains a thermal evaluation of all the operator actions that may be required to support HCVS operation. GOTHIC analyses of critical room temperatures which are referenced in a summary report of temperature and radiological dose considerations (Reference 33) demonstrate that the final design meets the Order requirements to minimize the plant operators' exposure to occupational hazards.

1.1.3 The HCVS shall also be designed to minimize radiological consequences that would impede personnel actions needed for event response.

Evaluation:

Primary control of the HCVS is accomplished from the POS (Room 3576). Under the postulated scenarios of Order EA-13-109, the MCR (Room 5510) is adequately protected from excessive radiation dose and no further evaluation of its use is required (HCVS-FAQ-06 in Reference 7). The POS is also adequately protected from radiation dose and has negligible dose rates and integrated dose during severe accident conditions (Reference 33).

Alternate control of the HCVS is accomplished from the ROS, which is located in a low dose area on 102 ft. elevation of the AB (Room 5301).

The ROS was evaluated for radiation effects due to a severe accident and determined to have negligible dose rates and integrated dose during severe accident conditions (Reference 33).

Table 2 contains a radiological evaluation of the operator actions that may be required to support HCVS operation in a severe accident. There are no abnormal radiological conditions present for HCVS operation without core damage. The evaluation of radiological hazards demonstrates that the final design meets the Order requirements to minimize the plant operators' exposure to radiological hazards.

The HCVS vent is routed away from the MCR such that building structures provide shielding, thus per HCVS-FAQ-01 the MCR is the preferred control location. The POS and ROS are similarly acceptable with respect to radiation dose during normal and severe accident conditions. If venting operations create the potential for airborne contamination in these locations, the Emergency Response Organization (ERO) will provide personal protective equipment to minimize any operator exposure.

1.1.4 The HCVS controls and indications shall be accessible and functional under a range of plant conditions, including severe accident conditions, extended loss of AC power (ELAP), and inadequate containment cooling.

Evaluation:

Primary control of the HCVS is accomplished from the POS (Room 3576). Under the postulated scenarios of Order EA-13-109 the MCR (Room 5510) is adequately protected from excessive radiation dose and no further evaluation of its use is required (HCVS-FAQ-06 in Reference 7). The POS is also adequately protected from radiation dose and has negligible dose rates and integrated dose during severe accident conditions (Reference 33).

Alternate control of the HCVS is accomplished from the ROS, which is located in a low dose area on 102 ft. elevation of the AB (Room 5301). The ROS was evaluated for radiation effects due to a severe accident and determined to have negligible dose rates and integrated dose during severe accident conditions (Reference 33).

For ELAP with injection, the HTV valves will be opened to protect the containment from overpressure and provide a means of heat rejection. The operator actions and timing of those actions to perform this function under ELAP conditions were evaluated as part of HCGS response to NRC Order EA-12-049 as stated in the HCGS FLEX FIP (Reference 32).

Table 2 contains a thermal and radiological evaluation of all the operator actions at the MCR or alternate location that may be required to support HCVS operation during a severe accident. The relevant radiological dose and temperature calculations that are inputs to the summary report in Reference 33 demonstrate that the final design meets the Order requirements to minimize the plant operators' exposure to occupational and radiological hazards.

Table 1 contains an evaluation of the controls and indications that are or may be required to operate the HCVS during a severe accident. The evaluation demonstrates that the controls and indications are accessible and functional during a severe accident with a loss of AC power and inadequate containment cooling.

1.2 The HCVS shall include the following design features:

1.2.1 The HCVS shall have the capacity to vent the steam/energy equivalent of 1 percent of licensed /rated thermal power (unless a lower value is justified by analysis), and be able to maintain containment pressure below the primary containment design pressure.

Evaluation

PSEG Calculation GS-0026, *Hardened Containment Vent Capacity*, (Reference 52) contains the verification of 1% power flow capacity using a RELAP5 model of the HCGS HTV piping and fittings. The reactor power used in the analysis (3917 MWt) exceeds the current licensed Rated Thermal Power (RTP) of 3902 MWt. The analysis uses the lower of the containment design pressure (62 psig) and the PCPL (65 psig). In order to account for the static head of water in the downcomers, a torus vapor space pressure of 54.4 psig is used to determine vent capacity. Reference 52 shows that the HCVS vent capacity exceeds 1% of RTP at a torus vapor pressure of 54.4 psig.

The decay heat absorbing capacity of the suppression pool and the HTV capacity are such that the HCVS has the capability to maintain containment pressure at or below the lower of the containment design pressure (62 psig) or the PCPL (65 psig). PSEG VTD 432633, Volume 1, *Suppression Pool Energy Capacity* (Reference 53), shows that the suppression pool has sufficient capacity to absorb the energy released into the torus for the first three hours following an ELAP event, with approximately 60% margin, using 3900 MWt reactor power (vs 3902 MWt current RTP). MAAP analyses for FLEX (HC-MISC-005, Reference 54) include cases run using 3902 MWt reactor power and support anticipatory venting at four hours based on torus water temperature of 200°F, and demonstrate acceptable containment response (i.e., containment design pressure is not exceeded). For the severe accident case, HCGS is bounded by the BWROG reference plant analyses described in References 42 and 43 such that the HTV, in conjunction with SAWA/SAWM flow rates and timing, reduce the risk of containment failure to a negligible level.

1.2.2 The HCVS shall discharge the effluent to a release point above main plant structures.

Evaluation

The HCGS HTV release point is located above main plant structures with the exception of the Reactor Building (RB) dome. The HTV piping was modified via DCP 80115583 (Reference 37) to remove the piping elbow at the release point in order to provide a vertically oriented release, without extending the height. Via references 44 and 45, PSEG requested relaxation from compliance with Order EA-13-109 Phase 1 Requirement 1.2.2 and associated guidance in NEI 13-02, Revision 1 (Reference 7), based on the adequate atmospheric dispersion that would be achieved while venting at the current release point height, and disadvantages of modifying the vent piping to achieve compliance (e.g., increased line resistance would reduce the capacity of the vent flow path). The relaxation was approved by the NRC staff in Reference 46.

HCVS-WP-04 (Reference 11) provides criteria that demonstrate robustness of the HCVS pipe. Technical Evaluation 80115583-0860 (Reference 47) addresses all the requirements of this white paper. The HCVS pipe is adequately protected from all external events and no further protection is required (Reference 37).

In Reference 47, HCGS evaluated the vent pipe robustness with respect to wind-borne missiles against the requirements contained in HCVS-WP-04. This evaluation demonstrates that the pipe was robust with respect to external missiles per HCVS-WP-04 in that:

1. HCGS HTV piping that is less than 30 feet above grade is protected by the walls of the Reactor Building (RB). The RB is a Seismic Category I structure and is designed to provide protection from the design basis tornado wind and missiles.
2. The exposed piping greater than 30 feet above grade has the following characteristics:
    a. The total vent pipe exposed area is 129 square feet which is less than the 300 square feet criterion.
    b. The pipe is made of schedule 40 steel and is not plastic, and the pipe components have no small tubing susceptible to missiles
    c. There are sources of missiles located in the proximity of the exposed HCVS components. There is an unrestrained material

laydown and storage space for the maintenance shop containing potential missiles, located immediately south of the RB. Therefore, a PRA-based evaluation has been utilized to justify that the HCGS site specific target area coupled with HCGS site specific quantity of missiles, when combined together into a probabilistic value, show a probability which is less than the probabilities used as the basis for formulating Assumption 2C in white paper HCVS-WP-04. This methodology is acceptable due to an overall negligible change in the calculated probabilities in white paper HCVS-WP-04. Reference 47 provides additional details of this evaluation.

3. HCGS maintains a large cutoff saw as part of the FLEX equipment. This saw is capable of cutting the vent pipe should it become damaged such that it restricts flow to an unacceptable level.

4. HCGS maintains severe weather preparedness procedures that would require the plant be shut down prior to the arrival of sustained hurricane force winds on site.

Based on the above description of the vent pipe design, the HCGS HCVS vent pipe design meets the Order requirement to be robust with respect to all external hazards including wind-borne missiles.

1.2.3 The HCVS shall include design features to minimize unintended cross flow of vented fluids within a unit and between units on the site.

Evaluation

HCGS is a single unit plant and cross flow between units is not applicable.

HCGS uses the Containment Pre-purge Cleanup System (CPCS) outboard containment isolation valves 1GSHV-4962 and 1GSHV-4963 for isolation between the HTV and CPCS to prevent unintended cross flow of vented fluids (Figure 1). These containment isolation valves are AOVs and they are normally closed, air-to-open and spring-to-close. 1GSHV-4962 and 1GSHV-4963 are not operated during HTV operation under ELAP or severe accident conditions. These valves are leak tested in accordance with 10CFR50, Appendix J. This is acceptable for prevention of inadvertent cross-flow of vented fluids per HCVS-FAQ-05 in Reference 7.

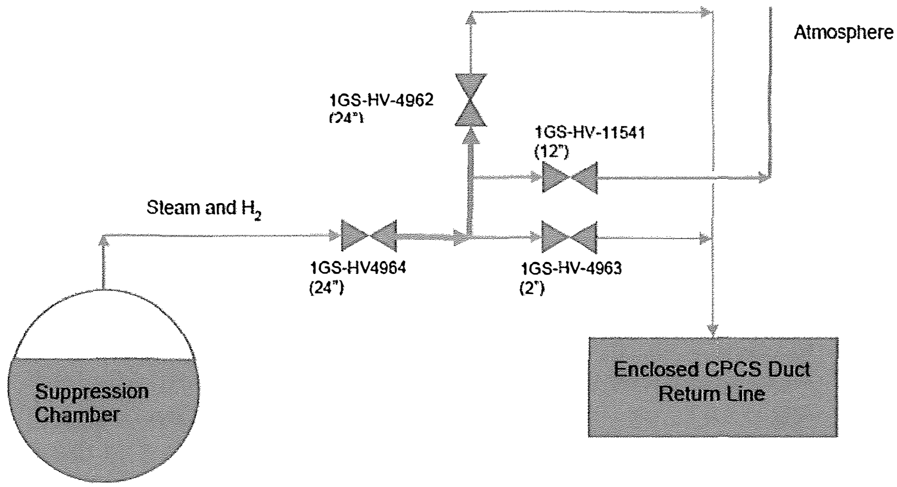

Figure 1, HTV Boundary with CPCS

Based on the above description, the HCGS design meets the requirements to minimize unintended cross-flow of vented fluids.

1.2.4 The HCVS shall be designed to be manually operated during sustained operations from a control panel located in the MCR or a remote but readily accessible location.

Evaluation

The HCGS POS is at the RSP (Panel 10-C-399 in Room 3576), which is located near the MCR on 137 ft. elevation of the AB (Reference 36). The POS and MCR are shielded from the HCVS vent line by portions of the RB structures. Attachment 6f shows the location of the POS relative to other critical areas including the HCVS vent line and the MCR.
The POS provides HTV valve key-lock switches, position indicating lights, and vent dose rate and flow recorders to control and monitor system status during sustained operations. The POS is protected from all external hazards and remains accessible during a range of plant conditions, including severe accident conditions, with due consideration to source term and dose impact on operator exposure, ELAP, inadequate containment cooling, and loss of ventilation. Table 1 contains an evaluation of the controls and instruments that are required for severe accident response and demonstrates that these controls and instruments will be functional during a loss of AC power and severe accident. Table 2 contains a thermal and radiological evaluation of the operator actions that may be required to support HCVS operation during a loss of AC power and severe accident, and demonstrates that these actions will be possible without undue hazard to the operators. Attachment 6 contains plant layout drawings showing the location of these HCVS actions.

1.2.5 The HCVS shall be capable of manual operation (e.g., reach-rod with hand wheel or manual operation of pneumatic supply valves from a shielded location), which is accessible to plant operators during sustained operations.

Evaluation

To meet the requirement for an alternate means of operation in a remote but readily accessible location, HCGS installed a ROS in the electrical chase (Room 5301) which is located at the 102 ft. elevation of the AB, and is two levels below the MCR. The ROS is located near the northeast corner of the RB and is adjacent to a stairwell for access to the MCR. The ROS and stairwell are shielded from the HCVS vent line by portions of the RB structures. Attachment 6d shows the location of the ROS relative to the HCVS vent line and other critical areas.

The ROS includes an N2 system to provide motive force for operation of the air operated HTV valves via operation of manual valves, and a separate N2 bottle with manual valves to breach rupture disk PSE-11554. The ROS includes an Ar system for purging the vent line if hydrogen is present in the containment. The ROS also includes a panel which displays HTV radiation dose rate and flow indication to monitor system status. The ROS is protected from all external hazards and remains accessible during a range of plant conditions, including severe accident conditions, with due consideration to source term and dose impact on operator exposure, ELAP, inadequate containment cooling, and loss of ventilation. Table 1 contains an evaluation of the controls and instruments that are required for severe accident response and demonstrates that all these controls and instruments will be functional during a loss of AC power and severe accident. Table 2 contains a thermal and radiological evaluation of the operator actions that may be required to support HCVS operation during a loss of AC power and severe accident, and demonstrates that these actions will be possible without undue hazard to the operators. Attachment 6 contains plant layout drawings showing the location of these HCVS actions.

1.2.6 The HCVS shall be capable of operating with dedicated and permanently installed equipment for at least 24 hours following the loss of normal power or loss of normal pneumatic supplies to air operated components during an extended loss of AC power.

Evaluation

HCVS-WP-01 (Reference 8) contains clarification on the definition of “dedicated and permanently installed” with respect to the Order. In summary, it is acceptable to use plant equipment that is used for other functions, but it is not acceptable to credit portable equipment that must be moved and connected for the first 24-hour period of the ELAP.

One of the HCGS 480 VAC FLEX DGs will be started, loaded, and will provide power to the “B” 125 VDC battery charger, among other loads. Thus there will be no need to use other electric power sources for HCVS torus venting components during the first 24 hours. However, this order element does not allow crediting the FLEX DGs for HCVS torus venting components until after 24 hours. Therefore, backup electrical power required for operation of HCVS torus venting components in the first 24 hours will come from Class 1E “D” battery 1DD411. The battery is part of the safety-related HCGS 125 VDC system and is permanently installed in the AB, where it is protected from all external hazards. Calculation E-4.6 (Reference 38) demonstrates that the 125 VDC battery 1DD411 capacity is sufficient to supply HCVS torus venting components for the first 24 hours of an ELAP without recharging. At 24 hours, FLEX generators can be credited to repower the station instrument buses and/or the battery charger to recharge the Class 1E "B" 125 VDC battery 1BD411. Gas control during recharging and room temperature control is per the response to Order EA-12-049. HCVS torus venting electrical loads are powered by either the "D" battery via inverter 1DD481, or by the "B" battery via inverter 1BD481. The FLEX diesel generator supplies power to the "B" channel to support sustained operations. Calculation E-15.16 (Reference 31) includes "B" battery charger 1BD413 and inverter 1BD481 in the FLEX DG loading calculation, so there is no additional load on the FLEX DG and FLEX power is capable of carrying HCVS torus venting components' electrical loads. Class 1E 125 VDC battery and inverter status indications are provided in the MCR. Attachment 3 contains diagrams of the HCVS electrical distribution system.

Pneumatic power for the HCVS valve actuators is normally provided by the HCGS control air system. The original HTV design includes N2 bottle backup at 102 ft. elevation of the RB (Room 4317), which may become inaccessible due to radiation dose rate during a severe accident scenario. Following an ELAP event and the loss of the normal control air, the permanently installed N2 system at the ROS provides operating pneumatics to the HTV valves. Therefore, for the first 24 hours post-ELAP initiation, pneumatic force will be supplied from the two permanently installed N2 bottles at the ROS. PSEG Vendor Technical Document (VTD) 432632, *Backup Nitrogen Supply for Hardened Vent,* (Reference 55) demonstrates that these installed bottles have the capacity to supply the required motive force to those HTV valves needed to maintain flow through the HCVS effluent piping for 24 hours without replenishment. The calculation of N2 capacity in Reference 55 conservatively assumes 8 cycles of operation for both HTV valves (1GSV-028 and 1GSV-201) during 24 hours. This assumption is very conservative because the venting strategy using EOP-318 (Reference 51) is to maintain the HTV valves open as long as possible and to only close the 12-inch valve (1GSV-201) to stop venting, with the 24-inch valve (1GSV-028) maintained open. Backup N2 pressure indication is provided locally at the ROS. The two N2 bottles are arranged in parallel, with each bottle capable of supplying motive force to both valves.

1.2.7 The HCVS shall include a means to prevent inadvertent actuation.

Evaluation

Emergency Operating Procedures (EOPs) provide clear guidance that the HCVS is not to be used to defeat containment integrity during any design basis transients and accidents. In addition, the HCVS was designed to provide features to prevent inadvertent actuation due to equipment malfunction or operator error. Also, these protections are designed such that any credited containment accident pressure (CAP) that would provide net positive suction head to the emergency core cooling system (ECCS) pumps will be available (inclusive of a design basis loss-of-coolant accident). However, the ECCS pumps will not have normal power available because of the ELAP. HCGS does not credit CAP for its design basis LOCA.

The containment isolation valves must be open to permit vent flow. HCVS features to prevent inadvertent actuation include key lock switches at the POS and locked closed valves at the ROS, which are acceptable methods of preventing inadvertent actuation per NEI 13-02. The physical features that prevent inadvertent actuation are summarized below.

At the POS, key-lock control switches prevent inadvertent actuation of HTV valves 1GSV-028 and 1GSV-201. Turning one key-lock switch per HTV valve at the POS control panel activates the transfer relays in the POS panel, opening the control circuits connecting to the MCR and closing the control circuits at the POS. A second key-lock switch per HTV valve is used to operate the valve.

At the ROS, inadvertent actuation is prevented by locking closed nitrogen system hand valves 1KBV-319 and 1KBV-321, which are used to operate the HTV valves by remote-manual action if control power at the POS is lost.

1.2.8 The HCVS shall include a means to monitor the status of the vent system (e.g., valve position indication) from the control panel required by 1.2.4. The monitoring system shall be designed for sustained operation during an extended loss of AC power.

Evaluation

The HCVS includes indications for HTV valve position, vent pipe flow and effluent radiation levels in the POS. The use of vent flow instead of vent line temperature and pressure to monitor system status is an alternative to NEI 13-02 (Reference 7) as documented in the NRC Phase 1 ISE (Reference 20).

This monitoring instrumentation provides the indication from the POS per Requirement 1.2.4. In the event that the FLEX DGs do not initially energize the emergency buses, the HTV and required containment instrumentation will be supplied by the 125 VDC batteries and are designed for sustained operation during an ELAP event using the FLEX equipment. Status of the 125 VDC system is displayed in the MCR.

HCVS instrumentation performance (e.g., accuracy and range) need not exceed that of similar plant installed equipment. Additionally, radiation monitoring instrumentation accuracy and range is sufficient to confirm flow of radionuclides through the HCVS.

The HCVS instruments, including valve position indication, vent flow rate, radiation monitoring, and support system monitoring, are seismically qualified as indicated on Table 1 and they include the ability to handle severe accident environmental conditions, although they may not be considered part of the site Environmental Qualification program.

1.2.9 The HCVS shall include a means to monitor the effluent discharge for radioactivity that may be released from operation of the HCVS. The monitoring system shall provide indication from the control panel required by 1.2.4 and shall be designed for sustained operation during an extended loss of AC power.

Evaluation

The HCVS radiation monitoring system consists of a new high range ion chamber detector RD-2B adjacent to the HTV pipe, and radiation monitor 1SPRY-11542A, which is installed in new panel 1MC267A in Room 5335 at 102 ft. elevation of the AB. The radiation monitor provides input to recorder 1SPRR-11542A in panel 10-C-399 at the POS. Although it is not required by this order element, high range radiation indicator 1SPRI-

11542A-2 is provided in panel 10-C-101 at the ROS.

The RD-2B detector is fully qualified for the expected environment at the vent pipe during accident conditions, and the process instrumentation and displays are qualified for their mild environmental conditions. The radiation monitoring equipment is qualified for the seismic requirements. Table 1 includes a description and qualification information on the radiation monitoring equipment.

1.2.10 The HCVS shall be designed to withstand and remain functional during severe accident conditions, including containment pressure, temperature, and radiation, while venting steam, hydrogen, and other non-condensable gases and aerosols. The design is not required to exceed the current capability of the limiting containment components.

Evaluation

The torus vent up to and including the second containment isolation valve is designed consistent with the design basis of the plant. These items include piping, piping supports, containment isolation valves, containment isolation valve actuators and containment isolation valve position indication components.

The existing hardened vent piping, between the torus and the containment isolation boundary including valves 1GSV-028 and 1GSV-201 are designed to at least 62 psig and 312°F.

HCVS piping and components have been analyzed and shown to perform under severe accident conditions using the guidance provided in HCVS-FAQ-08 and HCVS-WP-02 (References 7 and 9). DCPs 80113941 and 80115583 (References 35 and 37) include evaluations of HCVS piping and components for severe accident conditions.

Refer to order element 1.2.11 below for a discussion on designing for combustible gas.

1.2.11 The HCVS shall be designed and operated to ensure the flammability limits of gases passing through the system are not reached; otherwise, the system shall be designed to withstand dynamic loading resulting from hydrogen deflagration and detonation.

Evaluation

In order to prevent a detonable mixture from developing in the pipe, a manually operated purge system is installed to purge oxygen from the vent pipe with argon (Ar) prior to initial venting during severe accident conditions. The Ar purge is also used to purge hydrogen from the pipe after a period of venting if hydrogen is suspected to be in the containment, but the potential for air ingress due to steam condensation in between venting cycles creates the potential for a flammable mixture in the HTV piping. Therefore, during an accident scenario where hydrogen is expected the first time that the HTV path is opened, the venting strategy per EOP-318 (Reference 51) is to keep the vent path open for as long as possible, which reduces hydrogen concentration in containment during subsequent vent cycles. The use of the Ar purge system in conjunction with the HCVS venting strategy meets the requirement to prevent a detonable mixture from developing in the pipe.

1.2.12 The HCVS shall be designed to minimize the potential for hydrogen gas migration and ingress into the reactor building or other buildings.

Evaluation

The response under order element 1.2.3 explains how the potential for hydrogen migration into other systems, the RB or other buildings is minimized.

1.2.13 The HCVS shall include features and provisions for the operation, testing, inspection and maintenance adequate to ensure that reliable function and capability are maintained.

Evaluation:

As endorsed in the ISG, sections 5.4 and 6.2 of NEI 13-02, Revision 1 (Reference 7) provide acceptable methods for satisfying the requirements for operation, testing, inspection, and maintenance of the HCVS.

Primary and secondary containment required leakage testing is covered under existing design basis testing programs.

Reference 7, Section 6.3.2 states the following:

"The HCVS outboard of the containment boundary shall be tested to ensure that vent flow is released to the outside with minimal leakage, if any, through the interfacing boundaries with other systems or units."

As shown Attachment 2a, the connections to the HTV piping downstream of outboard containment isolation valve 1GSV-201 consist of instrument lines for flow and radiation measurement, the compressed gas system tie-in for breaching the rupture disk with N2 and purging with Ar, and a drain line downstream of rupture disk 1GSPSE-11554. The HCGS response to Order Element 1.2.3, above, addresses the interface of the HTV and CPCS, which is within the containment isolation boundary and addressed by 10 CFR 50, Appendix J leak rate testing. The HCGS design differs from the arrangement illustrated in HCVS-FAQ-05 (Reference 7, Appendix J), in that there are no major system interfaces with HTV downstream of the containment isolation valves. Therefore, PSEG considers the leak rate test outboard of the containment boundary to be impractical and unnecessary based on the HCGS design and existing containment isolation valve leak rate testing.

HCGS is implementing the following operation, testing and inspection requirements for the HCVS to ensure reliable operation of the system. These are from Section 6 of Reference 7. The implementing modification packages and associated preventive maintenance (PM) activities contain these as well as additional testing required for post-modification testing.

Table 3-3: Testing and Inspection Requirements

Description	Frequency
Cycle the HCVS valves[1] and the interfacing system valves not used to maintain containment integrity during operations.	Once per every[2] operating cycle.
Cycle the HCVS check valves not used to maintain containment integrity during unit operations.[3]	Once per every other[4] operating cycle.
Perform visual inspections and a walk down of HCVS components.	Once per operating cycle.
Functionally test the HCVS radiation monitors.	Once per operating cycle.
Leak test the HCVS.	Addressed by 10 CFR 50, Appendix J leak rate testing of containment isolation valves, and by post-maintenance testing as necessary. Testing outboard of the containment isolation valves is not applicable based on the HCGS design (FIP Section III.B, Order Element 1.2.13).
Validate the HCVS operating procedures by conducting an open/close test of the HCVS control logic from its control panel (primary and alternate) and ensuring that all interfacing system boundary[5] move to their proper (intended) positions.	Once per every other operating cycle.

[1] Not required for HCVS check valves.
[2] After two consecutive successful performances, the test frequency may be reduced to a maximum of once per every other operating cycle.
[3] Not required if integrity of check function (open and closed) is demonstrated by other plant testing requirements.
[4] After two consecutive successful performances, the test frequency may be reduced by one operating cycle to a maximum of once per every fourth operating cycle.
[5] Interfacing system boundary valves that are normally closed and fail closed under ELAP conditions (loss of power and/or air) do not require control function testing under this section. Performing existing plant design basis function testing or system operation that reposition the valve(s) to the HCVS required position will meet this requirement without the need for additional testing.

2. HCVS Quality Standards:

2.1 The HCVS vent path up to and including the second containment isolation barrier shall be designed consistent with the design basis of the plant. Items in this path include piping, piping supports, containment isolation valves, containment isolation valve actuators, and containment isolation valve position indication components.

Evaluation:

The HCVS upstream of and including the second containment isolation valve (1GSV-201) and penetrations continue to be designed consistent with the design basis of primary containment including pressure, temperature, radiation, and seismic loads.

2.2. All other HCVS components shall be designed for reliable and rugged performance that is capable of ensuring HCVS functionality following a seismic event. These items include electrical power supply, valve actuator pneumatic supply, and instrumentation (local and remote) components.

Evaluation:

The HCVS components downstream of the outboard containment isolation valve and components that interface with the HCVS are routed in seismically qualified structures or supported from seismically qualified structures.

The HCVS downstream of the outboard containment isolation valve, including piping and supports, electrical power supply, valve actuator pneumatic supply, and instrumentation (local and remote) components, have been designed and analyzed to conform to the requirements consistent with the applicable design codes for the plant and to ensure functionality following a design basis earthquake. This includes environmental qualification consistent with expected conditions at the equipment location.

Table 1 contains a list of components, controls and instruments required to operate HCVS, their qualification and evaluation against the expected conditions. All instruments are fully qualified for the expected seismic conditions so that they will remain functional following a seismic event.

<u>Section IV</u>: HCVS Phase 2 Final Integrated Plan

<u>Section IV.A</u>: The requirements of EA-13-109, Attachment 2, Section B for Phase 2

Licensees with BWRs Mark 1 and Mark II containments shall either:

(1) Design and install a HCVS, using a vent path from the containment drywell, that meets the requirements in section B.1 below, or

(2) Develop and implement a reliable containment venting strategy that makes it unlikely that a licensee would need to vent from the containment drywell before alternate reliable containment heat removal and pressure control is reestablished and meets the requirements in Section B.2 below.

1. HCVS Drywell Vent Functional Requirements

1.1 The drywell venting system shall be designed to vent the containment atmosphere (including steam, hydrogen, non-condensable gases, aerosols, and fission products), and control containment pressure within acceptable limits during severe accident conditions.

1.2 The same functional requirements (reflecting accident conditions in the drywell), quality requirements, and programmatic requirements defined in Section A of this Attachment (i.e., Attachment 2 of Reference 5) for the wetwell venting system shall also apply to the drywell venting system.

2. Containment Venting Strategy Requirements

Licensees choosing to develop and implement a reliable containment venting strategy that does not require a reliable, severe accident capable drywell venting system shall meet the following requirements:

2.1 The strategy making it unlikely that a licensee would need to vent from the containment drywell during severe accident conditions shall be part of the overall accident management plan for Mark I and Mark II containments.

2.2 The licensee shall provide supporting documentation demonstrating that containment failure as a result of overpressure can be prevented without a drywell vent during severe accident conditions.

2.3 Implementation of the strategy shall include licensees preparing the necessary procedures, defining and fulfilling functional requirements for installed or portable equipment (e.g., pumps and valves), and installing needed instrumentation.

Because the Order contains just three requirements for the containment venting strategy, the compliance elements are in NEI 13-02, Revision 1 (Reference 7). Reference 7, endorsed by NRC in Reference 13, provides the guidance for the containment venting strategy (B.2) of the Order, using SAWA in conjunction with Severe Accident Water Management (SAWM). SAWA/SAWM is designed to maintain the wetwell vent in service until alternate reliable containment heat removal and pressure control are established, as the means for compliance with part B of the Order.

HCGS has implemented Containment Venting Strategy B.2, as the compliance method for Phase 2 of the Order and conforms to the associated guidance in Reference 7 for this compliance method.

Section IV.B: HCVS Existing System

There previously was neither a hardened drywell vent nor a strategy at HCGS that complied with Phase 2 of the Order.

Section IV.C: HCVS Phase 2 SAWA System and SAWM Strategy

The HCVS Phase 2 SAWA system and SAWM strategy utilize the FLEX mitigation equipment and strategies to the extent practical. This approach is reasonable because the external hazards and the event initiator (ELAP) are the same for both FLEX mitigation strategies and HCVS. For SAWA, it is assumed that the initial FLEX response actions are unsuccessful in providing core cooling such that core damage contributes to significant radiological impacts that may impede the deployment, connection and use of FLEX equipment. These radiological impacts, including dose from containment and HCVS vent line shine, were evaluated and modifications made as necessary to mitigate the radiological impacts such that the actions needed to implement SAWA and SAWM are feasible in the timeframes necessary to protect the containment from overpressure related failure. To the extent practical, the SAWA equipment, connection points, deployment locations and access routes are the same as the FLEX primary strategies so that a unit that initially implements FLEX actions that later degrades to severe accident conditions can readily transition between FLEX and SAWA strategies. This approach further enhances the feasibility of SAWA under a variety of event sequences including timing.

HCGS has implemented the containment venting strategy utilizing SAWA and SAWM. HCGS SAWA provides different means of Reactor Pressure Vessel (RPV) injection depending on whether the ELAP and severe accident conditions are the result of external flooding or some other external hazard. For the flooding event, electric motor-driven SAWA pumps have been permanently installed via DCP 80118721 (Reference 39), and are pre-staged at 54 ft. elevation of the Turbine Building (TB) to inject water from the condenser or the flooded TB floor.

For a non-flood scenario, the SAWA system consists of a portable diesel FLEX pump injecting from the Delaware River into the RPV. In both cases, SAWM consists of flow control along with instrumentation and procedures to ensure that the torus vent is not submerged. Procedures have been issued to implement this strategy including guidance in Revision 3 to the Severe Accident Management Guidelines (SAMG). This strategy has been shown via Modular Accident Analysis Program (MAAP) analysis to protect containment without requiring a drywell vent for at least seven days, which is the guidance from NEI 13-02, Revision 1 for the period of sustained operation.

Section IV.C.1: Detailed SAWA Flow Path Description

Attachment 4 provides a simplified sketch of the SAWA flow paths for the non-flooded and flooded conditions.

The SAWA flow path for the non-flooded scenario uses the portable diesel FLEX pump deployed at the Service Water Intake Structure (SWIS) with hose routing and connection points that differ from FLEX. The flow path is from the Delaware River to a new manifold at the Auxiliary Building (AB) truck bay at 102 ft. elevation. The flow path continues from the pump manifold through new piping that ties into the existing ‘B’ RHR / Service Water cross tie on 77 ft. elevation of the Reactor Building (RB) in Room 4209, upstream of MOV 1BCHV-F017B, for injection into the RPV.

The hoses and portable diesel FLEX pump used for the non-flooded condition are stored and protected from external hazards consistent with NRC Order EA-12-049 requirements.

The new piping for the non-flooded condition includes a four-inch manual flow control valve (1BCV-643) and flow indicator (1BCFI-0100) at the truck bay to enable flow monitoring and control. Communication is established between the MCR and the pump manifold location. Due to the capacity of the diesel FLEX pump, the manifold is configured to divert a portion of the flow back to the yard area. Flow can be controlled within the range of 100 gpm to 500 gpm, consistent with the BWROG reference plant analyses described in NEI 13-02, Revision 1.

For the flooded condition, the newly installed SAWA pumps provide a different water source and flow path to provide a diverse means of RPV injection. HCGS installed a pump skid with three motor-driven submersible pumps (H1AD -1A -P-199, H1AD -1B -P-199, and H1AD -1C-P-199) via DCP 80118721 (Reference 39),. The pump skid is installed in Room 1102 on 54 ft. elevation of the Turbine Building (TB). The primary condensate pump suction header was modified with a 6-inch tie-in connection to provide water from the main condensers to the SAWA pumps, using a hard suction hose. The pump skid has two pumps aligned to the condenser that can provide the required flow rate of 500 gpm to the RPV. The pump skid also has one pump aligned to take suction from the floor of the TB when flooded. The discharge piping from the pump skid extends to the 77 ft. elevation of the TB and ties into the Condensate Transfer and Storage line 1-AP-055, which ties into the "A" RHR system upstream of MOV 1BCHV-F017A for injection into the RPV.

Gross flow control for the flooded condition is provided by the number of pumps turned on and off. A new motor control center is provided in the flood protected radwaste area of the AB, which supplies power to the SAWA pumps. The SAWA design for the flooded condition includes a new manual flow control valve (1APV-200), a flow element (1APFE-0100), and local flow indicator (1APFI-0100) at 75 ft. elevation of the radwaste area in the AB, which is flood-protected. Pump flow can be throttled back to approximately 100 gpm by operating only one of the three pumps and manually adjusting valve 1AP-V200 to provide fine control of the injection flow. The valve and flow element are located in a pipe chase in the radwaste area (Room 3187), which is a high radiation area. A reach rod enables manual valve operation from the adjacent corridor (Room 3197), which is a mild environment. The local flow indicator is also located in Room 3197. This design enables the operator to control and monitor SAWA flow without entering the high radiation area. Communication is established between the MCR and the plant operator controlling pump flow in Room 3197. Flow can be controlled within the range of 100 gpm to 500 gpm, consistent with the BWROG reference plant analyses described in NEI 13-02, Revision 1.

The hose and SAWA pumps used for the flooded condition are pre-staged on 54 ft. elevation of the TB and are designed for operation while submerged.

BWROG generic assessment, BWROG-TP-15-008 (Reference 42), provides the principles of SAWA to ensure protection of containment. The SAWA injection paths for non-flooded and flooded conditions are qualified for all of the NEI 12-06 external hazards for which they are credited, in addition to severe accident conditions.

For the non-flooded and flooded conditions, calculation H-1-FLX-MDC-4022 (Reference 30) demonstrates that the portable diesel FLEX pump and the motor-driven SAWA pumps are capable of providing the minimum flow required to satisfy NEI 13-02, Revision 1 requirements.

<u>Section IV.C.2</u>: Severe Accident Assessment of Flow Path

SAWA actions are time validated as shown in Table 2, with consideration of differences from FLEX. In the SAWA event, core damage is not expected for at least one hour so that there will be no excessive radiation levels or heat related concerns during this time period.

The actions inside the RB for the flooded condition where there could be a high radiation field due to a severe accident are as follows:

- Open valve 1APV-044, Condensate Storage Transfer to “A” RHR Pump Discharge Isolation, on 102 ft. elevation of the RB. In order to reduce operator dose, this is one of the anticipatory actions for expected flooded conditions (Table 2, Action 1) in accordance with HC.OP-AB.MISC-0001, *Acts of Nature* (Reference 62).

- Operate breakers on Motor Control Center (MCC) 10B212 and 10B222 in accordance with EOP-401, *FLEX Electrical – Phase 2* (Reference 56), which includes guidance regarding limited access to the RB once HCVS venting is initiated during severe accident conditions. The action to establish FLEX power, including the actions in the RB, can be performed before the dose is unacceptable as shown by time validation and summarized in Table 2, actions 4 and 5. As an additional defense-in-depth measure, EOP-412, *Alternate 10B212/10B222 Control for SAWA* (Reference 60), provides an alternate approach to controlling loads on these MCCs if the RB is inaccessible.

The other SAWA actions all take place outside the RB, or in areas of the RB that are accessible for the actions to be performed.

The radiological dose evaluation considers containment shine and HTV shine dose. Locations that are outside the RB are shielded from the severe accident containment shine radiation by the thick concrete walls of the RB. HTV shine dose is managed by coordinating operator actions with radiological conditions during severe accident venting.

MCC 10B313 provides power to new SAWA MCC 10B378, which provides power and control functions for the SAWA pumps. MCCs 10B313 and 10B378 are located in rooms 3601 and 3602, respectively, on 153 ft. elevation of the radwaste area of the AB. Portions of Room 3601 receive shine dose from the HTV line during severe accident venting. As shown in Table 2, Action 5, FLEX power is provided to the SAWA MCC prior to severe accident venting.

Once SAWA is initiated, the operators will monitor the response of containment from the MCR to determine that venting and SAWA are operating satisfactorily, maintaining containment pressure low to avoid containment failure. Stable or slowly rising trend in torus level with SAWA at the minimum flow rate indicates water on the drywell floor up to the vent pipe or downcomer openings. After some period of time, as decay heat levels decrease, the operators will be able to reduce SAWA flow to keep the core debris cool while avoiding overfilling the torus to the point where the torus vent is submerged.

Section IV.C.3: Severe Accident Assessment of Safety-Relief Valves

HCGS has methods available to extend the operational capability of manual pressure control using SRVs as provided in the plant specific Order EA-12-049 submittal. Assessment of manual SRV pressure control capability for use of SAWA during the Order EA-13-109 defined accident is unnecessary because RPV depressurization is directed by the EPGs in all cases prior to entry into the SAGs.

Section IV.C.4: Available Freeboard Use

The freeboard between the nominal torus water level at approximately 170.5 inches from the bottom of the torus to the top of the water level instrument range at 274 inches provides approximately 655,000 gallons of water volume before the level instrument would be off scale high (Reference 65). The BWROG generic assessment in BWROG-TP-15-011 (Reference 43) provides the principles of Severe Accident Water Management to preserve the torus vent for a minimum of seven days. After containment parameters are stabilized with SAWA flow, SAWA flow will be reduced to a point where containment pressure will remain low while torus level is stable or very slowly rising. The HCGS freeboard volume of 655,000 gallons is greater than the 525,000 gallons that is used in the BWROG generic assessment. A diagram of the available freeboard is shown on Attachment 1.

Section IV.C.5: Upper range of wetwell level indication

The upper range of wetwell (torus) level indication provided for SAWA/SAWM is 274 inches from the bottom of the torus (Reference 65). This defines the upper limit of torus volume that will preserve the torus vent function without considering the additional freeboard between the top of the instrument range and the bottom of the torus vent, as shown in Attachment 1.

<u>Section IV.C.6</u>: Wetwell vent service time

EPRI Technical Report 3002003301 (Reference 19) and BWROG-TP-15-011 (Reference 43), demonstrate that throttling SAWA flow after containment parameters have stabilized, in conjunction with venting containment through the torus vent, will result in a stable or slowly rising torus level. The references demonstrate that, for the scenario analyzed, torus level will remain below the torus vent pipe for greater than the seven days of sustained operation allowing significant time for restoration of alternate containment pressure control and heat removal.

<u>Section IV.C.7</u>: Strategy time line

The overall accident management plan for HCGS is developed from the BWR Owner's Group Emergency Procedure Guidelines and Severe Accident Guidelines (EPG/SAG). As such, the SAWA/SAWM implementing procedures are integrated into the HCGS SAMGs. In particular, EPG/SAG, Revision 3, when implemented with Emergency Procedures Committee Generic Issue 1314, allows throttling of SAWA in order to protect containment while maintaining the wetwell vent in service. The SAMG flow charts direct the use of the hardened vent as well as SAWA/SAWM when the appropriate plant conditions have been reached.

Using Appendix E to NEI 12-06, Revision 1 (Reference 66) and procedure OP-AA-102-106, *Operator Response Time Program* (Reference 63), HCGS has validated that the portable diesel FLEX pump or the motor-driven SAWA pumps can be deployed and commence injection in less than 8 hours. The studies referenced in NEI 13-02, Revision 1 demonstrate that establishing flow within 8 hours will protect containment. The initial SAWA flow rate will be approximately 500 gpm. After a period of time, estimated to be about 4 hours during which the maximum flow rate is maintained, the SAWA flow will be reduced. The reduction in flow rate and the timing of the reduction will be based on stabilization of the containment parameters of drywell pressure and wetwell level.

Generic analysis per NEI 13-02, Revision 1 and EPRI Technical Report 3002003301 (References 7 and 19) demonstrate that SAWA flow could be reduced to 100 gpm after four hours of initial SAWA flow rate and containment would be protected. At some point, torus level will begin to rise, indicating that the SAWA flow is greater than the steaming rate due to containment heat load such that flow can be reduced. While this is expected to be 4-6 hours, no time is specified in the procedures because the SAMGs are symptom-based guidelines.

<u>Section IV.C.8</u>: SAWA Flow Control

HCGS will accomplish SAWA flow control by the use of pump control and throttle valves on the SAWA flow paths. For the non-flooded condition, valve H1BC -1-BC-V643 and flow indicator H1BC -1BCFI-0100 are located at the new manifold for the portable diesel FLEX pump in the truck bay at 102 ft. elevation of the AB (Room 5315). For the flooded condition, valve H1AP -1-AP-V200 is installed on line 1-AP-055 in the RW area pipe chase on 75 ft. elevation of the AB (Room 3187). Local flow indication is provided by H1AP-1APFI-0100 in the corridor adjacent to the pipe chase (Room 3197). A reach rod is provided in Room 3197 to enable the operator to control and monitor SAWA flow without entering the high radiation area in Room 3187.

For the non-flooded and flooded cases, the areas used for flow control have a stay time greater than one hour based on temperature and have negligible radiation dose rates The exact time to throttle flow is not critical since there is a large margin between normal torus level and the level at which the torus vent will be submerged. The communications capabilities that will be used for communication between the MCR and the SAWA flow control location are the same as that evaluated and found acceptable for FLEX strategies (i.e., UHF radios and the plant page). Phase 2 ISE Open Item 7, *Communications,* is closed per the NRC audit report (Reference 29).

<u>Section IV.C.9</u>: SAWA/SAWM Element Assessment

<u>Section IV.C.9.1</u>: SAWA Pumps

HCGS uses one portable FLEX diesel pump deployed at the SWIS for the non-flooded condition, and three electric motor-driven SAWA pumps in the TB for the flooded condition. The portable diesel FLEX pump is a variable speed pump that has a nominal flow rate of 1500 gpm and can maintain the pressures required for RPV injection during an ELAP. Based on the timing and flow requirements for SFP and RPV cooling (e.g., time for SFP fuel uncovery is approximately two days for an at-power ELAP per Reference 32), the FLEX strategy prioritizes RPV injection and Calculation H-1-FLX-MDC-4022 (Reference 30) does not model simultaneous RPV and SFP makeup. Reference 30 demonstrates that the FLEX diesel pump is capable of providing the required flows for FLEX RPV injection, FLEX SFP cooling, and SAWA RPV injection as separate cases. In a FLEX scenario, this pump is deployed within 18.4 hours of an ELAP (Table 3 of Reference 32), assuming a flood scenario for which deployment is performed after storm surge flood depths are below site grade (approximately 11 hours). In a non-flood SAWA scenario, the FLEX diesel pump would be deployed in time to meet the eight-hour RPV injection time constraint, and would also be available for SFP cooling, which would not be required until SAWA flow demands are significantly reduced.

Three electric motor-driven SAWA pumps are permanently installed specifically for a SAWA flooding event, and are not used for SFP cooling for FLEX. Each pump is capable of providing 250 gpm for RPV injection. Reference 30 demonstrates that two motor-driven SAWA pumps are capable of meeting the required initial flow rate of 500 gpm for SAWA. In a SAWA flooding scenario, the portable FLEX diesel pump would be deployed as needed to provide longer term SFP cooling, and could also be used for RPV injection in lieu of the motor-driven SAWA pumps.

Three portable FLEX diesel pumps are stored on site, one of which is allocated to the Salem FLEX strategy for both Salem units. The pumps are stored in diversely located outdoor FLEX storage areas, and are moved into a flood-protected area in the HCGS Unit 2 RB as an anticipatory action in response to storm surge triggers. The pumps are stored and located such that one pump is available for HCGS during an ELAP caused by any of the NEI 12-06 external hazards, in accordance with Order EA-12-049 requirements.

The motor-driven SAWA pumps are permanently installed in the 54 ft. elevation of the TB, and are designed for operation while submerged due to external flooding, which is the only scenario for which they are credited.

Section IV.C.9.2: SAWA analysis of flow rates and timing

The HCGS SAWA initial flow rate is 500 gpm, which is the generic flow rate that may be used by all plants per NEI 13-02, Revision 1, Section 4.1.1.2.1. The initial SAWA flow will be injecting to the RPV within 8 hours of the loss of injection. The reference power level is 3514 MWth, equivalent to the reference plant rated thermal power level used in NUREG-1935, State of the Art Reactor Consequence Analysis (SOARCA). NUREG-1935 is Reference 9 of NEI 13-02, Revision 1.

Section IV.C.9.3: SAWA Pump Hydraulic Analysis

Calculation H-1-FLX-MDC-4022 (Reference 30) analyzed the FLEX pumps and the lineup for RPV injection that would be used for SAWA. This calculation showed that the pumps have adequate capacity to meet the SAWA flow rate required to protect containment.

Section IV.C.9.4: SAWA Method of backflow prevention

Backflow prevention for each SAWA flow path is provided by a check valve that also serves as a Reactor Coolant System (RCS) Pressure Isolation Valve (PIV).

For the non-flooded condition, backflow prevention is provided by PIV 1BCV- 017. In addition, there are two check valves in series on the new piping upstream of the tie-in to the ‘B’ RHR / Service Water cross tie.

For the flooded condition, backflow prevention is provided by PIV 1BCV-114. In addition, the three new motor-driven pumps each have a discharge check valve, and there is a check valve on the new piping upstream of the tie-in to the Condensate Transfer and Storage line.

The RCS PIVs that are credited with backflow prevention are tested in accordance with HCGS programs (i.e., Technical Specification Surveillance Requirement 4.4.3.2.2), and therefore additional testing per Section 6.2 of Reference 7 is not required.

<u>Section IV.C.9.5</u>: SAWA Water Source

For the non-flooded condition, the initial and long term source of water is the Delaware River, which provides an unlimited inventory of water supply. The Delaware River is one of the credited water sources for NRC Order EA-12-049 response. For the flooded condition, the initial water source is primary condensate from the condenser hotwell, which may be augmented by flood water in the TB basement. Based on a normal hotwell inventory of 430,560 gallons (Reference 67), the initial water source can supply 500 gpm for eight hours followed by 100 gpm for approximately 31 hours. Long term water sources for the flooded condition may be flood water in the TB or Delaware River water to the portable FLEX diesel pump after flood levels recede to permit deployment. Therefore, there will be sufficient water for injection to protect containment during the period of sustained operation.

<u>Section IV.C.9.6</u>: SAWA/SAWM Motive Force

<u>Section IV.C.9.6.1</u>: SAWA Pump Power Source

For the non-flooded condition, the portable diesel FLEX pump that is used for SAWA has a fuel storage tank sufficient for greater than 12 hours of operation without refueling. EOP-410, *Severe Accident Water Addition from River (Non-Flood Condition* (Reference 58), directs the operator to adjust the pump speed from idle (900 rpm) to a speed sufficient to provide the required flow rate, in order to optimize fuel usage. EOP-410 also initiates actions to refuel the pump if operation will exceed six hours. EOP-408, *FLEX Fuel Supply* (Reference 57), provides guidance for refueling FLEX portable equipment using onsite fuel supplies. The three onsite portable diesel FLEX pumps are diversely located and stored such that one pump will be available at HCGS during an ELAP caused by any of the NEI 12-06 external hazards.

For the flooded condition, power to the motor driven SAWA pumps is provided by a Phase 2 480 VAC FLEX diesel generator, which is qualified for all external hazards per Order EA-12-049. Each FLEX DG has a storage tank sufficient for greater than12 hours of operation without refueling. The FLEX DG also provides power to the "A" and "C" fuel oil transfer pumps to support refueling of FLEX equipment. EOP-401, *FLEX Electrical – Phase 2* (Reference 56), directs the operator to monitor diesel fuel usage and initiates refueling using with EOP-408, *FLEX Fuel Supply* (Reference 57).

The safety-related onsite fuel supply to meet Emergency DG Technical Specification requirements is protected from all NEI 12-06 external hazards and supports greater than 7 days of FLEX Phase 2 equipment operation (Reference 68). This fuel supply is likewise sufficient for greater than 7 days of SAWA operation for the flooded or non-flooded conditions.

Section IV.C.9.6.2: DG loading calculation for SAWA/SAWM equipment

Table 1 shows that the SAWA/SAWM flow instruments are annubar flow elements and flow meters that do not require electric power.

The FLEX load on the 480 VAC FLEX DG per Order EA-12-049 was evaluated in Calculation E-15.16 (Reference 31). One FLEX DG is capable of supplying the FLEX loads in accordance with NRC Order EA-12-049. Reference 31 was revised to demonstrate the ability of one FLEX DG to supply power to two of the three new motor-driven SAWA pumps, which are identical 45HP, 460V, 3-phase submersible pumps. Reference 31 demonstrates that the total kW and kVA loading is less than the FLEX DG rating of 600 kW and 750 kVA. Therefore, the loading meets the acceptance criteria of the calculation. The FLEX DGs are qualified to carry the rest of the FLEX loads as part of Order EA-12-049 compliance.

Section IV.C.10: SAWA/SAWM Instrumentation

1. HCGS installed SAWA flow instrumentation for the non-flooded and flooded conditions via DCP 80118721 (Reference 39) as follows:

    a. For the non-flooded condition, an annubar flow element (1BCFE-0100), is installed on new 4-inch line 1-BC-209, located near the stairway in truck bay (Room 5315) on 102 ft. elevation of the AB. A mechanical flow indicator, 1BCFI-0100, is located next to line 1-BC-209 near the stairway in the AB truck bay (Room 5315).

    b. For the flooded condition, an annubar flow element (1APFE-0100), is installed on existing 6" line, 1-AP-055, located inside Room 3187 on 75 ft. elevation of the radwaste area of the AB. A mechanical flow indicator, 1APFI-0100, is located in Room 3197, adjacent to Room 3187.

2. The annubar flow elements provide differential pressure for a flow of 0-600 gpm. The flow meters are scaled to convert the annubar differential pressure directly to a flow indication of 0-600 gpm.

3. The flow element and meter installations are connected with 3/8-inch stainless steel instrument sensing lines. The annubar flow elements were procured to B31.1 piping standards. The flow instrumentation is installed in safety-related, Seismic Category 1, flood-protected areas in accordance with HCGS specifications. The SAWA flow instrumentation is of rugged commercial grade design and has no electronics. The flow indicators are located in mild environments as shown in Table 1.

4. No electric power is used for the SAWA flow indication.

5. Regulatory Guide (RG) 1.97 (Reference 48) instrumentation for containment pressure and torus level are provided with power via the FLEX DG.

Section IV.C.10.1: SAWA/SAWM instruments

Table 1 contains a listing of all the instruments needed for SAWA and SAWM implementation. For each instrument, Table 1 also contains the range, expected environmental parameters, qualifications, and power supply for sustained operation.

Section IV.C.10.2: Describe SAWA instruments and guidance

The drywell pressure and torus level instruments, used to monitor the condition of containment, are pressure and differential pressure detectors that are safety-related and qualified for post-accident use. These instruments are referenced in Severe Accident Guidelines for control of SAWA flow to maintain the torus vent in service while maintaining containment protection. These instruments are powered initially by batteries until the FLEX DG is deployed and connected, at which time they are powered by FLEX DG systems for the sustained operating period. Note that other indications of these parameters may be available depending on the exact scenario.

SAWA flow indication is provided by 1BCFI-0100 for the non-flooded condition and 1APFI-0100 for the flooded condition. Each of these indicators receive a differential pressure signal from its respective annubar flow element, 1BCFE-0100 and 1APFE-0100.

No containment temperature instrumentation is required for compliance with HCVS Phase 2. However, most FLEX electrical strategies repower other containment instruments that include drywell temperature, which may provide information for the operations staff to evaluate plant conditions under a severe accident and to provide confirmation for adjusting SAWA flow rates. SAMG strategies will evaluate and use drywell temperature indication if available consistent with the symptom based approach. NEI 13-02, Revision 1 Section C.8.3 discusses installed drywell temperature indication.

Section IV.C.10.3: Qualification of SAWA/SAWM instruments

The drywell pressure and torus level instruments are pressure and differential pressure detectors that are safety-related and qualified for post-accident use. These instruments are qualified as post-accident instruments per RG 1.97, Revision 2 (Reference 48), which is the HCGS committed version per UFSAR Section 7.5, and are therefore qualified for EA-13-109 events.

The SAWA flow indicators are located in mild environments for temperature and radiation dose, and are expected to remain available for the period of sustained operations. Table 1 provides details of the instruments including environmental parameters. The SAWA flow element is an inert metal device rated for the piping system in which it is installed that is not adversely affected by the temperature or radiological effects of the area.

Section IV.C.10.4: Instrument Power Supply through Sustained Operation

HCGS FLEX strategies will restore the containment instruments, containment pressure and torus level necessary to successfully implement SAWA. The strategy will be to use the FLEX generator to re-power battery chargers before the batteries supplying the instruments are depleted. Since the FLEX generators are refueled per FLEX strategies for a sustained period of operation, the instruments will be powered for the sustained operating period.

Section IV.C.11: SAWA/SAWM Severe Accident Considerations

The most important severe accident considerations are the radiation dose and area temperature conditions as a result of the accident, and operation of the HCVS. VTD 432889 (Reference 33) summarizes the evaluations of radiological and temperature conditions in areas containing SAWA equipment or requiring operator access to implement SAWA/SAWM actions. Tables 1 and 2 of Reference 33 provide the results of the radiation and temperature evaluations, respectively.

Section IV.C.11.1: Severe Accident Effect on SAWA Pump and Flowpath

For the non-flooded condition, the portable FLEX diesel pumps are stored in outdoor FLEX storage areas or temporarily stored in flood-protected, mild environment areas of the HCGS RB. For SAWA, one of the pumps is deployed at the SWIS with discharge hoses routed to the truck bay on 102 ft. elevation of the

AB (Room 5315). Room 5315 has negligible radiation dose rates and temperatures that remain below 120°F. The flow path consists of hoses that are rated for their temperature and pressure conditions and are routed from the SWIS to the truck bay in areas that are shielded from containment shine dose (Attachments 6d and 6h). The hoses connect to the new pump manifold, with the remainder of the flow path consisting of steel pipe and components that are unaffected by the SAWA temperature and radiation conditions.

For the flooded condition, the three electric motor-driven SAWA pumps are permanently installed on 54 ft. elevation of the TB in Room 1102, which has negligible radiation dose rates. The normal maximum ambient temperature is 104°F, and ambient room temperature is not a concern during SAWA operation because the pumps are designed to operate under submerged conditions. The maximum water temperature used in the hydraulic analysis is 150°F based on condensate conditions early in the SAWA event (Reference 30, Attachment J). The hose in the flow path is rated for the SAWA temperature and pressure conditions and is not subjected to significant radiation dose. The downstream flow path consists of steel pipe and components that are unaffected by the SAWA temperature and radiation conditions.

Therefore, the SAWA flow path will not be affected by radiation or temperature effects due to a severe accident.

<u>Section IV.C.11.2</u>: Severe Accident Effect on SAWA/SAWM instruments

The SAWA/SAWM instruments are described in section IV.C.9.3, which describes severe accident effects.

<u>Section IV.C.11.3</u>: Severe Accident Effect on personnel actions

Section IV.C.2 describes the RB actions within the first 7 hours. The actions including access routes outside the RB that will be performed after the first use of the vent during severe accident conditions (assumed to be 7 hours per HCVS-FAQ-12) are located such that they are either shielded from direct exposure to the vent line or are a significant distance from the vent line so that expected dose is maintained below the authorized emergency exposure dose limits.

As part of the response to Order EA-12-049, HCGS performed GOTHIC calculations of the temperature response of the RB and AB during the ELAP event. Since, in the severe accident, the core materials are contained inside the primary containment, the temperature response of the RB and AB is driven by the loss of ventilation and ambient conditions and therefore will remain essentially the same for SAWA. FLEX GOTHIC calculations were used to address severe accident conditions with changes to address the sustained operating period and SAWA actions as appropriate. The results of these evaluations are summarized in Reference 33.

Table 2 provides a list of SAWA/SAWM operator actions as well as an evaluation of each for suitability during a severe accident. Attachment 6 shows the approximate locations of the actions.

After valve AP-V044 is aligned inside the RB, the operators can control SAWA/SAWM as well as observe the necessary instruments from outside the RB. The thick concrete RB walls as well as the distance to the core materials mean that there is limited radiological concern with any actions outside the RB. Therefore, all SAWA controls and indications are accessible during severe accident conditions.

The SAWA pumps and monitoring equipment can all be operated from outside the RB. The HCGS FLEX response ensures that the portable FLEX diesel pump and FLEX DGs and other equipment can all be run for a sustained period by refueling. All the refueling locations are located in shielded or protected areas so that there is no radiation hazard from core material during a severe accident. EOP-408, *FLEX Fuel Supply* (Reference 57) includes a precaution to coordinate outdoor actions with torus venting during severe accident conditions. The monitoring instrumentation includes local SAWA flow indication in mild environment areas, and torus level and containment pressure in the MCR.

<u>Section V</u>: HCVS Programmatic Requirements

<u>Section V.A</u>: HCVS Procedure Requirements

Licensees shall develop, implement, and maintain procedures necessary for the safe operation of the HCVS. Procedures shall be established for system operations when normal and backup power is available, and during an extended loss of AC power.

<u>Evaluation:</u>

Procedures have been established for system operations when normal and backup power is available, and during ELAP conditions. The implementing design change documents and related revision requests contain instructions for modifying the HCVS specific procedures.

The HCVS and SAWA procedures have been developed and implemented following the HCGS process for initiating and/or revising procedures, and contain the following details:

- appropriate conditions and criteria for use of the system
- when and how to place the system in operation,
- the location of system components,
- instrumentation available,
- normal and backup power supplies,
- directions for sustained operation, including the storage location of portable equipment,
- training on operating the portable equipment, and
- testing portable equipment via the PM process.
- HCGS does not rely on containment accident pressure (CAP) to achieve net positive suction head (NPSH) for the Emergency Core Cooling System (ECCS) pumps. Therefore, there is no impact to procedures with respect to the effect of torus venting on NPSH (CAP) available to the ECCS pumps.

HCGS has implemented the BWROG Emergency Procedures Committee Issue 1314 that implements the Severe Accident Water Management (SAWM) strategy in the Severe Accident Management Guidelines (SAMGs). The following general cautions, priorities and methods have been evaluated for plant specific applicability and incorporated as appropriate into the plant specific SAMGs using administrative procedures for EPG/SAG change control process and implementation. SAMGs are symptom based guidelines and therefore address a wide variety of possible plant conditions and capabilities. While these changes are intended to accommodate those specific conditions assumed in Order EA-13-109, the changes were made in a way that maintains the use of SAMGs in a symptom based mode while at the same time addressing those conditions that may exist under extended loss of AC power (ELAP) conditions with significant core damage including ex-vessel core debris. The following are examples of guidance found in SAMGs:

Cautions

- Addressing the possible plant response associated with adding water to hot core debris and the resulting pressurization of the primary containment by rapid steam generation.

- Addressing the plant impact that raising suppression pool water level above the elevation of the suppression chamber vent opening elevation will flood the suppression chamber vent path.

Priorities – With significant core damage and reactor pressure boundary breach, SAMGs prioritize the preservation of primary containment integrity while limiting radioactivity releases as follows:

- Core debris in the primary containment is stabilized by water addition (SAWA).

- Primary containment pressure is controlled below the Primary Containment Pressure Limit (wetwell venting).

- Water addition is managed to preserve the Mark I/II suppression chamber vent paths, thereby retaining the benefits of suppression pool scrubbing and minimizing the likelihood of radioactivity and hydrogen release into the secondary containment (SAWM).

Methods – Identify systems and capabilities to add water to the RPV or drywell, with the following generic guidance:

- Use controlled injection if possible.
- Inject into the RPV if possible.
- Maintain injection from external sources of water as low as possible to preserve the suppression chamber vent capability

Section V.B: HCVS Out of Service Requirements

Provisions for out-of-service requirements and compensatory measures for FLEX and HCVS are in OP-HC-108-115-1001, *Operability Assessment and Equipment Control Program* (Reference 64).

Programmatic controls have been implemented to document and control the following:

NOTE: Out of service times and required actions noted below are for HCVS and SAWA functions. Equipment that also supports a FLEX function that is found to be non-functional must also be addressed using the out of service times and actions in accordance with the FLEX program.

The provisions for out-of-service requirements for HCVS and SAWA functionality are applicable in Modes 1, 2, and 3 per NEI 13-02, 6.3.

- If for up to 90 consecutive days, the primary or alternate means of HCVS operation are non-functional, no compensatory actions are necessary.
- If for up to 30 days, the primary and alternate means of HCVS operation or SAWA are non-functional, no compensatory actions are necessary.
- If the out of service times projected to exceed 30 or 90 days as described above, the following actions will be performed through the corrective action program:
    - Determine the cause(s) of the non-functionality,
    - Determine the actions to be taken and the schedule for restoring the system to functional status and prevent recurrence,
    - Initiate action to implement appropriate compensatory actions, and

- Restore full HCVS functionality at the earliest opportunity not to exceed one full operating cycle.

The HCVS system is functional when piping, valves, instrumentation and controls including motive force necessary to support system operation are available. Since the system is designed to allow a primary control and monitoring or alternate valve control by Order criteria 1.2.4 or 1.2.5, allowing for a longer out of service time with either of the functional capabilities maintained is justified. A shorter length of time when both primary control and monitoring and alternate valve control are unavailable is needed to restore system functionality in a timely manner while at the same time allowing for component repair or replacement in a time frame consistent with most high priority maintenance scheduling and repair programs, not to exceed 30 days unless compensatory actions are established per NEI 13-02, Section 6.3.1.3.3.

SAWA is functional when piping, valves, motive force, instrumentation and controls necessary to support system operation are functional.

The system functionality basis is for coping with beyond design basis events and therefore plant shutdown to address non-functional conditions is not warranted. However, such conditions should be addressed by the corrective action program and compensatory actions to address the non-functional condition should be established. These compensatory actions may include alternative containment venting strategies or other strategies needed to reduce the likelihood of loss of fission product cladding integrity during design basis and beyond design basis events even though the severe accident capability of the vent system is degraded or non-functional. Compensatory actions may include actions to reduce the likelihood of needing the vent but may not provide redundant vent capability.

Applicability for allowed out of service time for HCVS and SAWA for system functional requirements is limited to startup, power operation and hot shutdown conditions when primary containment is required to be operable and containment integrity may be challenged by decay heat generation.

Section V.C: HCVS Training Requirements

Licensee shall train appropriate personnel in the use of the HCVS. The training curricula shall include system operations when normal and backup power is available, and during an extended loss of AC power.

Evaluation:

Personnel expected to perform direct execution of the HCVS have received necessary training in the use of plant procedures for system operations when normal and backup power is available and during ELAP conditions. The training will be refreshed on a periodic basis and if required by changes to the HCVS. The personnel trained and the frequency of training were determined using a systematic analysis of the tasks to be performed using the Systems Approach to Training (SAT) process.

In addition, per NEI 12-06 (Reference 40), any non-trained personnel on-site will be available to supplement trained personnel.

Section V.D: Demonstration with other Post Fukushima Measures

HCGS will demonstrate use of the HCVS and SAWA systems in drills, tabletops or exercises as follows:

1. Hardened containment vent operation on normal power sources (no ELAP)

2. During FLEX demonstrations (as required by EA-12-049: Hardened containment vent operation on backup power and from primary or alternate locations during conditions of ELAP/loss of UHS with no core damage.) System use is for containment heat removal AND containment pressure control.

3. HCVS operation on backup power and from primary or alternate location during conditions of ELAP/loss of UHS with core damage. System use is for containment heat removal AND containment pressure control with potential for combustible gases.

Evaluation

NOTE: Items 1 and 2 above are not applicable to SAWA.

The use of the HCVS and SAWA capabilities will be demonstrated during drills, tabletops or exercises consistent with NEI 13-06 and on a frequency consistent with 10 CFR 50.155(e)(4). Drills, tabletops or exercises will be performed to demonstrate the capabilities of different elements of Items 1, 2 and/or 3 above that is applicable to HCGS in subsequent eight year intervals.

Section VI: References

Number	Rev	Title	Location[6]
1. GL 89-16	0	Installation of a Hardened Wetwell Vent (Generic Letter 89-16), dated September 1, 1989.	ML031140220
2. SECY-12-0157	0	Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments	ML12345A030
3. SRM-SECY-12-0157	0	Staff Requirements – SECY-12-0157 – Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments	ML13078A017
4. EA-12-050	0	Order to Modify Licenses with Regard to Reliable Hardened Containment Vents	ML12054A694
5. EA-13-109	0	Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions	ML13143A321
6. NEI 13-02	0	Industry Guidance for Compliance with Order EA-13-109, BWR Mark I & II Reliable Hardened Containment Vents Capable of Operation Under Severe Accident	ML13316A853
7. NEI 13-02[7]	1	Industry Guidance for Compliance with Order EA-13-109, BWR Mark I & II Reliable Hardened Containment Vents Capable of Operation Under Severe Accident	ML15113B318
8. HCVS-WP-01	0	Hardened Containment Vent System Dedicated and Permanently Installed Motive Force, Revision 0, April 14, 2014	ML14120A295 ML14126A374
9. HCVS-WP-02	0	Sequences for HCVS Design and Method for Determining Radiological Dose from HCVS Piping, Revision 0, October 23, 2014	ML14358A038 ML14358A040
10. HCVS-WP-03	1	Hydrogen/Carbon Monoxide Control Measures, Revision 1, October 2014	ML14302A066 ML15040A038

[6] Where two ADAMS accession numbers are listed, the first is the reference document and the second is the NRC endorsement of that document.
[7] NEI 13-02, Revision 1 Appendix J contains HCVS-FAQ-01 through HCVS-FAQ-09.

Number	Rev	Title	Location[6]
11. HCVS-WP-04	0	Missile Evaluation for HCVS Components 30 Feet Above Grade	ML15244A923 ML15240A072
12. JLD-ISG-2013-02	0	Compliance with Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions	ML13304B836
13. JLD-ISG-2015-01	0	Compliance with Phase 2 of Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident	ML15104A118
14. HCVS-FAQ-10	1	Severe Accident Multiple Unit Response	ML15273A141 ML15271A148
15. HCVS-FAQ-11	0	Plant Response During a Severe Accident	ML15273A141 ML15271A148
16. HCVS-FAQ-12	0	Radiological Evaluations on Plant Actions Prior to HCVS Initial Use	ML15273A141 ML15271A148
17. HCVS-FAQ-13	0	Severe Accident Venting Actions Validation	ML15273A141 ML15271A148
18. Phase 1 OIP	0	HCVS Phase 1 Overall Integrated Plan (OIP)	ML14177A508
19. EPRI Technical Report 3002003301	0	Technical Basis for Severe-Accident Mitigating Strategies.	ML15154B388
20. Phase 1 ISE	0	HCVS Phase 1 Interim Staff Evaluation (ISE)	ML14332A154
21. Phase 2 ISE	0	HCVS Phase 2 Interim Staff Evaluation (ISE)	ML16103A320
22. 1^{st} Update	0	First Six Month Update	ML14353A076
23. 2^{nd} Update	0	Second Six Month Update	ML15173A026
24. 3^{rd} Update	0	Third Six Month Update and Combined OIP	ML15362A580
25. 4^{th} Update	0	Fourth Six Month Update	ML16181A210
26. 5^{th} Update	0	Fifth Six Month Update	ML16358A254
27. 6^{th} Update	0	Sixth Six Month Update	ML17178A300
28. 7^{th} Update	0	Seventh Six Month Update	ML17354A772
29. Audit Report	0	HCVS Phase 1 and Phase 2 Audit Report	ML18120A165

Number	Rev	Title	Location[6]
30. H-1-FLX-MDC-4022	1	FLEX Hydraulic Model	N/A
31. E-15.16	1	Hope Creek FLEX Electrical System Loading Analysis	N/A
32. EM-HC-100-1000, Attachment 1	1	Final Integrated Plan - Beyond-Design-Basis FLEX Mitigating Strategies, Hope Creek Generating Station	ML17025A005
33. VTD 432889	2	Hope Creek Generating Station Severe Accident Water Addition Personnel and Equipment Environmental Qualification Report	N/A
34. DCP 4EC-3121	3	Hardened Torus Vent	N/A
35. DCP 80113941	3	Hardened Containment Vent Mechanical	N/A
36. DCP 80113942	3	Hardened Containment Vent Electrical	N/A
37. DCP 80115583	2	Hope Creek Hardened Torus Vent Modification	N/A
38. E-4.6	1	Hope Creek 125 VDC Beyond Design Base Event Battery Sizing Calculation	N/A
39. DCP 80118721	1	Hope Creek Severe Accident Water Addition	N/A
40. NEI 12-06	0	Diverse and Flexible Coping Strategies (FLEX) Implementation Guide	ML12221A205
41. EA-12-049	0	Issuance of Order to Modify Licenses With Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, dated March 12, 2012.	ML12054A735
42. BWROG-TP-15-008	0	Severe Accident Water Addition Timing, September 2015	N/A
43. BWROG-TP-15-011	0	Severe Accident Water Management Supporting Evaluations, October 2015	N/A
44. PSEG Letter LR-N16-0041	N/A	HCGS Request for Relaxation from the Hardened Containment Vent Release Point Height Requirement, June 21, 2016	ML16174A086

Number	Rev	Title	Location[6]
45. PSEG Letter LR-N16-0148	N/A	Supplemental Information Regarding HCGS Request for Relaxation from the Hardened Containment Vent Release Point Height Requirement, September 7, 2016	ML16251A309
46. NRC Letter to PSEG	N/A	HCGS Relaxation of the Release Point Height Requirement of NRC Order EA-13-109, September 30, 2016	ML16256A655
47. Technical Evaluation 80115583-0860	N/A	Technical Evaluation to Document Hope Creek Conformance to HCVS-WP-04	N/A
48. RG 1.97	2	Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Conditions During and Following an Accident	ML060750525
49. TR-1026539	0	EPRI Investigation of Strategies for Mitigating Radiological Releases in Severe Accidents BWR, Mark I and Mark II Studies, September 2012	N/A
50. HC.OP-AB.ZZ-0135 (AB-135)	43	Station Blackout / Loss of Offsite Power / Diesel Generator Malfunction	N/A
51. HC.OP-EO.ZZ-0318 (EOP-318)	12	Containment Venting	N/A
52. Calculation GS-0026	1	Hardened Containment Vent Capacity	N/A
53. VTD 432633	1	Suppression Pool Energy Capacity	N/A
54. HC-MISC-005	8	MAAP Analysis to Support FLEX Initial Strategy	N/A
55. VTD 432632	1	Backup Nitrogen Supply for Hardened Vent	N/A
56. HC.OP-EO.ZZ—0401 (EOP-401)	3	FLEX Electrical – Phase 2	N/A

Number	Rev	Title	Location[6]
57 HC.OP-EO.ZZ-0408 (EOP-408)	1	FLEX Fuel Supply	N/A
58. HC.OP-EO.ZZ-0410 (EOP-410)	0	Severe Accident Water Addition from River (Non-Flood Condition)	N/A
59. HC.OP-EO.ZZ-0411 (EOP-411)	0	SAWA Injection from the Turbine Building	N/A
60. HC.OP-EO.ZZ-0412 (EOP-412)	0	Alternate 10B212 / 10B222 Control for SAWA	N/A
61. SH.OP-AM.FLX-0051	1	Salem/Hope Creek Shared FLEX Equipment Phase 2 Deployment	N/A
62 HC.OP-AB.MISC-0001	33	Acts of Nature	N/A
63. OP-AA-102-106	0	Operator Response Time Program	N/A
64. OP-HC-108-115-1001	37	Operability Assessment and Equipment Control Program	N/A
65. Technical Evaluation 80115232-0380	0	SAWA ISE Items 5 & 6	N/A
66 NEI 12-06	1	Diverse and Flexible Coping Strategies (FLEX) Implementation Guide	ML15244B006
67. HC.OP-AM.ZZ-0001	5	Severe Accident Guidelines	N/A
68 Technical Evaluation 80113610-0070	0	Evaluation of FLEX Portable Equipment Fuel Usage against NEI 12-06 Requirements for Hope Creek	N/A

Table 1: List of HCVS Component, Control and Instrument Qualifications

Component Name	Equipment ID	Range	Location	Local Accident Temp	Local Accident Humidity	Local Radiation Level	Qualification[8]	Qualification Temp	Qualification Humidity	Qualification Radiation	Power Supply
Wetwell Vent Instruments and Components											
Class 1E 125 VDC Batteries	1BD411 1DD411	N/A	AB Rooms 5541 5539	< 120°F (all 1E battery, battery charger and inverter rooms)	90%	Negligible	IEEE 323-1974 IEEE 344-1975	120°F	90%	N/A – mild environment	1BD411 – FLEX power to charger 1DD411 - N/A for 24 hrs
Class 1E Inverter Voltage Indicators	VI-6388B and VI-6388D (DC in) VI-6389B and VI-6389D (AC out)	0 to 150 V	MCR Room 5510	105.9°F	60%	Negligible	RG 1.97	120°F	90%	N/A – mild environment	"D" then "B" 125 VDC battery
Key Lock Switches and Relays for HTV Valves	1GSHS-4964A 1GSHS-4964B 1GSHS-11541A 1GSHS-11541B	N/A	POS AB Room 3576	94.6°F	90%	Negligible	IEEE 323-1984 IEEE 344-1975 IEEE 344-1987	131°F	95% for 96 hours (aging tests)	N/A – mild environment	"D" then "B" 125 VDC battery for control circuits
HTV High Range Radiation Detector	1SPRE-11542A	1E-2 to 1E+4 R/hr	RB Room 4317	310°F Process fluid temp	100%	1.24E+4 R/hr 2.08E+6 TID	IEEE 323-1974 IEEE-344-1975	356°F for 7 days	100%	1E+8 Rads TID	"D" then "B" 125 VDC battery
RM-1000 High Range Radiation Monitor	1SPRY-11542A	1E-2 to 1E+4 R/hr	Control/ Diesel Vestibule Room 5335 Panel 1MC267A	104°F	90%	Negligible	IEEE 323-1974 IEEE-344 1975	120°F for 7 days	95%	1E+3 Rads	"D" then "B" 125 VDC battery
HTV High Range Radiation Indicator	1SPRI-11542A-2	1E-2 to 1E+4 R/hr	ROS AB Room 5301	104°F	90%	Negligible	IEEE 323-1974 IEEE 344-1975	120°F	90%	N/A – mild environment	Not Required

Component Name	Equipment ID	Range	Location	Local Accident Temp	Local Accident Humidity	Local Radiation Level	Qualification[8]	Qualification Temp	Qualification Humidity	Qualification Radiation	Power Supply
HTV High Range Radiation Recorder	1SPRR-11542A	1E-2 to 1E+4 R/hr	POS Room 3576	94.6°F	90%	Negligible	IEEE 323-1974 IEEE 344-1975	120°F	90%	N/A – mild environment	"D" then "B" 125 VDC battery
HTV Flow Transmitter	1SPFT-11542A	0 to 25,000 cfm	RB Room 4317	108.7°F	100%	1.24E+04 Rad/hr 2.08E+06 TID	IEEE-323-1974 IEEE 344-1975	420°F	100%	5E+07	"D" then "B" 125 VDC battery
HTV Flow Recorder	1SPFR-11542A	0 to 25,000 cfm	POS Room 3576	94.6	90%	Negligible	IEEE 323-1974 IEEE 344-1975	120°F	90%	N/A – mild environment	"D" then "B" 125 VDC battery
HTV Flow Indicator	1SPFI-11542A	0 to 25,000 cfm	ROS AB Room 5301	104°F	90%	Negligible	IEEE 323-1974 IEEE 344-1975	120°F	90%	N/A – mild environment	Not Required
N2 Supply Pressure Regulators and Indicators	1KBPCV-11557A 1KBPCV-11557B 1KBPI-11557A1 1KBPI-11557B1	0 to 4000 psig	ROS AB Room 5301	104°F	90%	Negligible	IEEE-344-1975	120°F	90%	N/A – mild environment	Not Required
N2 Service Side (downstream of regulators) Pressure Indicators	1KBPI-11557A2 1KBPI-11557B2	0 to 300 psig	ROS AB Room 5301	104°F	90%	Negligible	IEEE-344-1975	120°F	90%	N/A – mild environment	Not Required

[8] See UFSAR Sections 3.11 and 3.10 for qualification code of record IEEE-323-1974 and IEEE-344-1975, respectively. Where later code years are referenced, this was reconciled in the design process.

Component Name	Equipment ID	Range	Location	Local Accident Temp	Local Accident Humidity	Local Radiation Level	Qualification[8]	Qualification Temp	Qualification Humidity	Qualification Radiation	Power Supply
SAWA/SAWM Instruments											
Drywell Pressure Recorder	1GSPR-4960A2	-5 to 250 psig	MCR Room 5510	105.9°F	50%	Negligible	RG 1.97	RG 1.97	RG 1.97	RG 1.97	125 VDC battery
Torus Water Level Indicator and Recorder	1BJLI-4805-1 1BJLR-4805-1	0 to 180 inches	MCR Room 5510	105.9°F	50%	Negligible	RG 1.97	RG 1.97	RG 1.97	RG 1.97	125 VDC battery
SAWA Non-flooded Flow Element	1BCFE-0100	0 to 600 gpm	Truck Bay Room 5315 in AB	104°F	90%	Negligible	SAWA flow instrumentation is rugged, commercial grade equipment seismically mounted in safety-related areas of the plant that are protected from all external hazards. The instrumentation does not include electronics or require electrical power	N/A – metallic flow element			Not Required
SAWA Non-flooded Flow Indicator	1BCFI-0100	0 to 600 gpm	Truck Bay Room 5315 in AB	104°F	90%	Negligible		180°F	90%	N/A – mild environment	Not Required
SAWA Flooded Flow Element	1APFE-0100	0 to 600 gpm	AB RW Pipe Chase Room 3187	115°F	90%	1E+3 Rad/hr max 4.4E+6 TID		N/A – metallic flow element			Not Required
SAWA Flooded Flow Indicator	1APFI-0100	0 to 600 gpm	AB RW Corridor Room 3197	113°F	90%	Negligible		180°F	90%	N/A – mild environment	Not Required

Table 2: Operator Actions Evaluation

Operator Action		Evaluation Time (Note 1)	Validation Time	Location	Thermal Conditions (Note 2)	Radiological Conditions (Note 2)	Evaluation
1.	SAWA Turbine Building pump setup and valve alignment.	T-2 hrs. to T=0	0.67 hrs.	RB TB	Normal Conditions	Normal Conditions	Acceptable. SAWA TB pumps are permanently installed and pre-staged. In the flood scenario, valve alignment is an anticipatory action in response to Delaware River levels anticipated to exceed 99.5 ft. elevation. Two hours is judged to be adequate warning time based on storm surge characteristics.

Operator Action		Evaluation Time (Note 1)	Validation Time	Location	Thermal Conditions (Note 2)	Radiological Conditions (Note 2)	Evaluation
2.	Block open doors to critical area rooms to facilitate cooling IAW AB-135.	0-1 hour	0.35 hrs.	AB	Done in the first hour, so no concerns.	Done in the first hour, so no concerns.	Acceptable.
3.	ELAP load shed IAW AB-135 including D Channel 120 VAC 1DJ481 shed for 24-hour Hardened Torus Vent (HTV) operation from station battery.	≤ 1.5 hrs.	1.25 hrs.	AB	<120°F Stay times exceed completion times per GOTHIC calculations performed for FLEX actions.	AB areas have negligible dose rates.	Acceptable.

Operator Action		Evaluation Time (Note 1)	Validation Time	Location	Thermal Conditions (Note 2)	Radiological Conditions (Note 2)	Evaluation
4.	FLEX 480V DG operation and refueling IAW EOP-401 and EOP-408.	≤ 5 hrs.	FLEX power available for SAWA at 2.91 hrs. FLEX diesel generator will be operated long term as needed.	RB AB Unit 2 cancelled plant areas Outdoor FLEX Storage Areas (OFSAs)	The FLEX 480V DGs are stored outdoors. They are accessible and capable of operation in site extreme temperature conditions.	FLEX power for SAWA is established before severe accident torus venting is required. Outdoor equipment for long term operation of the FLEX diesel generators are located such that they receive no direct shine from the vent pipe and integrated doses to equipment are considered negligible.	Acceptable. Stay times in AB and RB exceed occupancy requirements. Outdoor actions are coordinated with torus venting and radiological conditions. Rooms used for DG operation and refueling remain accessible.

Operator Action		Evaluation Time (Note 1)	Validation Time	Location	Thermal Conditions (Note 2)	Radiological Conditions (Note 2)	Evaluation
5.	SAWA pump setup and FLEX 480V power for SAWA IAW EOP-411 and EOP-401. Includes RB. valve lineups and MCC breaker operation (flood condition).	≤ 7 hrs.	3.75 hrs.	RB AB	Initial temperature response is similar to FLEX and acceptable.	Actions are completed prior to opening the HTV. HTV shine dose in AB Room 3601 is avoided. RB Rooms 4303 and 4309 – 5 rem stay times exceed task times for MCC 10B212 and 10B222.	Acceptable. Stay times exceed occupancy requirements and actions are completed prior to severe accident venting.
6.	SAWA injection from TB to RPV IAW EOP-411 (flood condition).	≤ 8 hrs.	3.92 hrs (includes Action 5 time).	AB	Room 3197 for flow indication and control has a max temp of 113^{o}F. Room 3602 for MCC 10B378 max temp is 119.1^{o}F.	Room 3197 has a negligible dose rate. Room 3602 max dose rate is 1.37 r/hr	Acceptable. Stay times exceed occupancy requirements.

Operator Action		Evaluation Time (Note 1)	Validation Time	Location	Thermal Conditions (Note 2)	Radiological Conditions (Note 2)	Evaluation
7.	FLEX diesel pump staging (SH.OP-AM.FLX-0051) and setup for SAWA to RPV IAW EOP-410. Includes Security interface at SWIS and truck bay door, hose routing and connections (non-flood).	< 7 hrs or as needed to support Action 9, whichever is shorter.	5.4 hrs.	AB Truck Bay (Room 5315), SWIS, Outdoor deployment path (Attachment 6h)	AB Room 5315 max temperature < 120°F with a stay time of one hour. Temperatures are expected to be significantly lower during the initial period of the ELAP when the hose routing and connections are completed. Also, the truck bay door is blocked open during this action. Outdoor ambient temperatures are not of concern.	Actions are completed prior to opening the HTV so dose rates are negligible.	Acceptable.

Operator Action		Evaluation Time (Note 1)	Validation Time	Location	Thermal Conditions (Note 2)	Radiological Conditions (Note 2)	Evaluation
8.	Align diesel FLEX pump flow path to RPV via B RHR IAW EOP-410 – valve lineup, (non-flood).	As needed to support Action 9.	1.7 hrs.	AB - MCR	Valve alignment is performed via remote-manual operation from the MCR, which is designed for continuous occupancy.	Valve alignment is performed via remote-manual operation from the MCR, which is designed for continuous occupancy.	Acceptable.
9.	Start diesel FLEX pump and control flow IAW EOP-410 (non-flood).	≤ 8 hrs.	7.3 hrs (includes Actions 7 and 8).	AB Truck Bay (Room 5315)	AB Room 5315 max temperature < 120^{o}F with a stay time of one hour.	Negligible dose.	Acceptable. Stay times exceed occupancy requirements.

	Operator Action	Evaluation Time (Note 1)	Validation Time	Location	Thermal Conditions (Note 2)	Radiological Conditions (Note 2)	Evaluation
10.	Open HTV from POS with compressed gas operation from ROS IAW EOP-318.	≤ 7 hrs.	4 hrs. + 0.8 hrs. = **4.8 hrs** (See Evaluation)	POS – 137 ft. elevation of the AB at the Remote Shutdown Panel (Room 3576) ROS –102 ft. elevation of AB (Room 5301)	POS max temperature < 96°F ROS max temperature < 104°F	Negligible dose and unrestricted stay times in the POS and ROS.	Acceptable. Stay times exceed occupancy requirements. FLEX timeline value is 4 hrs for anticipatory venting and was validated in VTD 432563 assuming rupture disk breach from the RB. 4 hours is conservatively added to SAWA time validation (0.8 hrs.) of operation using the POS and ROS including Ar purge IAW EOP-318.

Operator Action		Evaluation Time (Note 1)	Validation Time	Location	Thermal Conditions (Note 2)	Radiological Conditions (Note 2)	Evaluation
11.	Backup HTV valve operation (if primary method fails).	Same as Action 10.					Acceptable. Validation time is the same as Action 9 because EOP-318 Section 5.7 was included in the validation for Action 9, and it includes steps to open the HTV valves from the ROS using hand valves if control of the HTV solenoid valves from the POS is unavailable.

Note 1: Evaluation timing is from NEI 13-02, Revision 1 (Reference 7) to support radiological evaluations.

Note 2: In addition to the thermal and radiological conditions evaluated for each action, the MCR is designed for continuous occupancy during a SAWA event as described in VTD 432889 (Reference 33).

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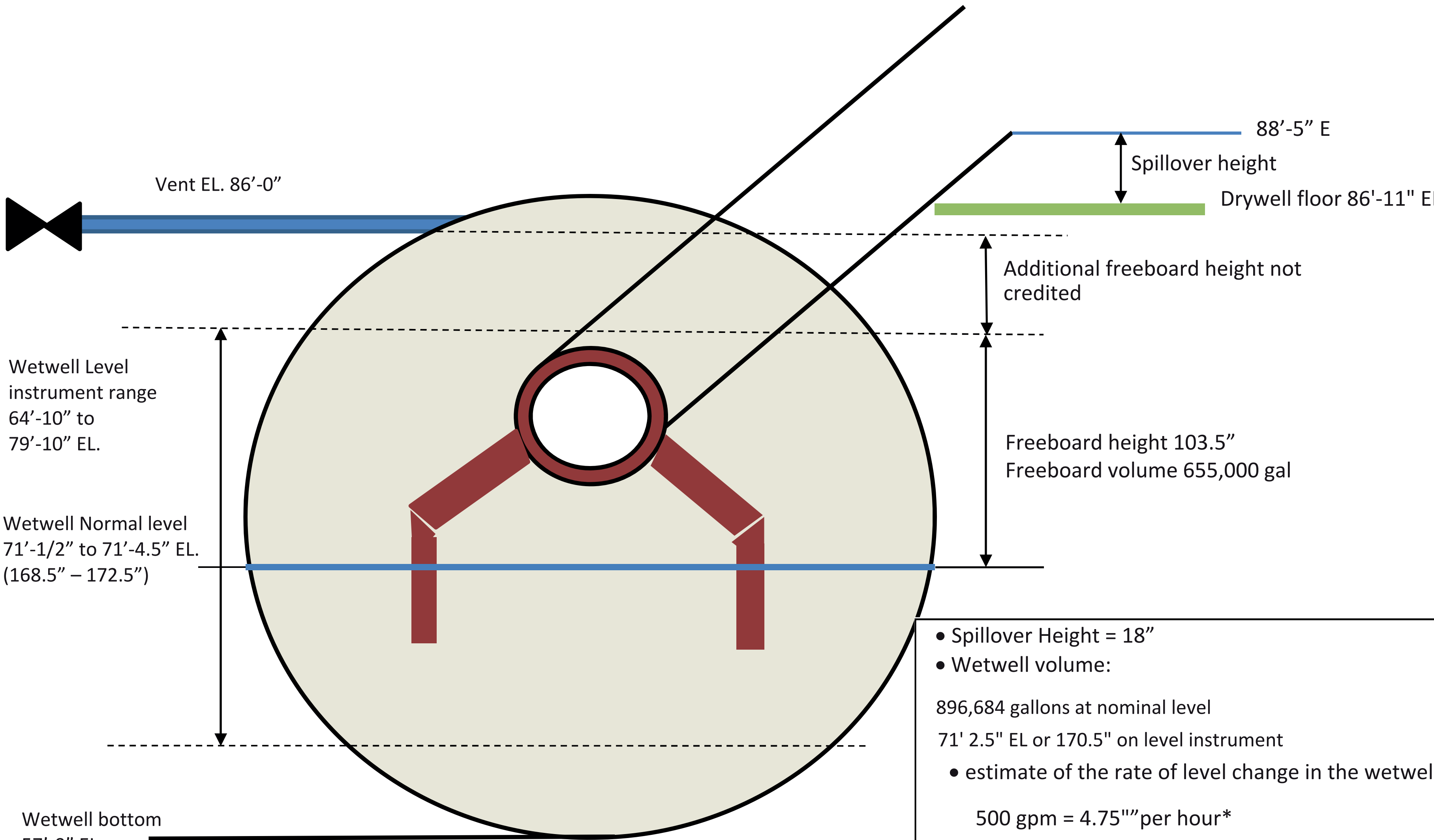
Attachment 1: Phase 2 Freeboard Diagram
(FIP Reference 65)



- Spillover Height = 18”
- Wetwell volume:

896,684 gallons at nominal level

71' 2.5" EL or 170.5" on level instrument

- estimate of the rate of level change in the wetwell

500 gpm = 4.75"”per hour*

100 gpm = <1”per hour*

*Does not account for loss of steam through torus vent. Assumes all SAWA flow becomes liquid in the torus and does not account for thermal expansion. Uses average gal/in level rise in the freeboard volume.

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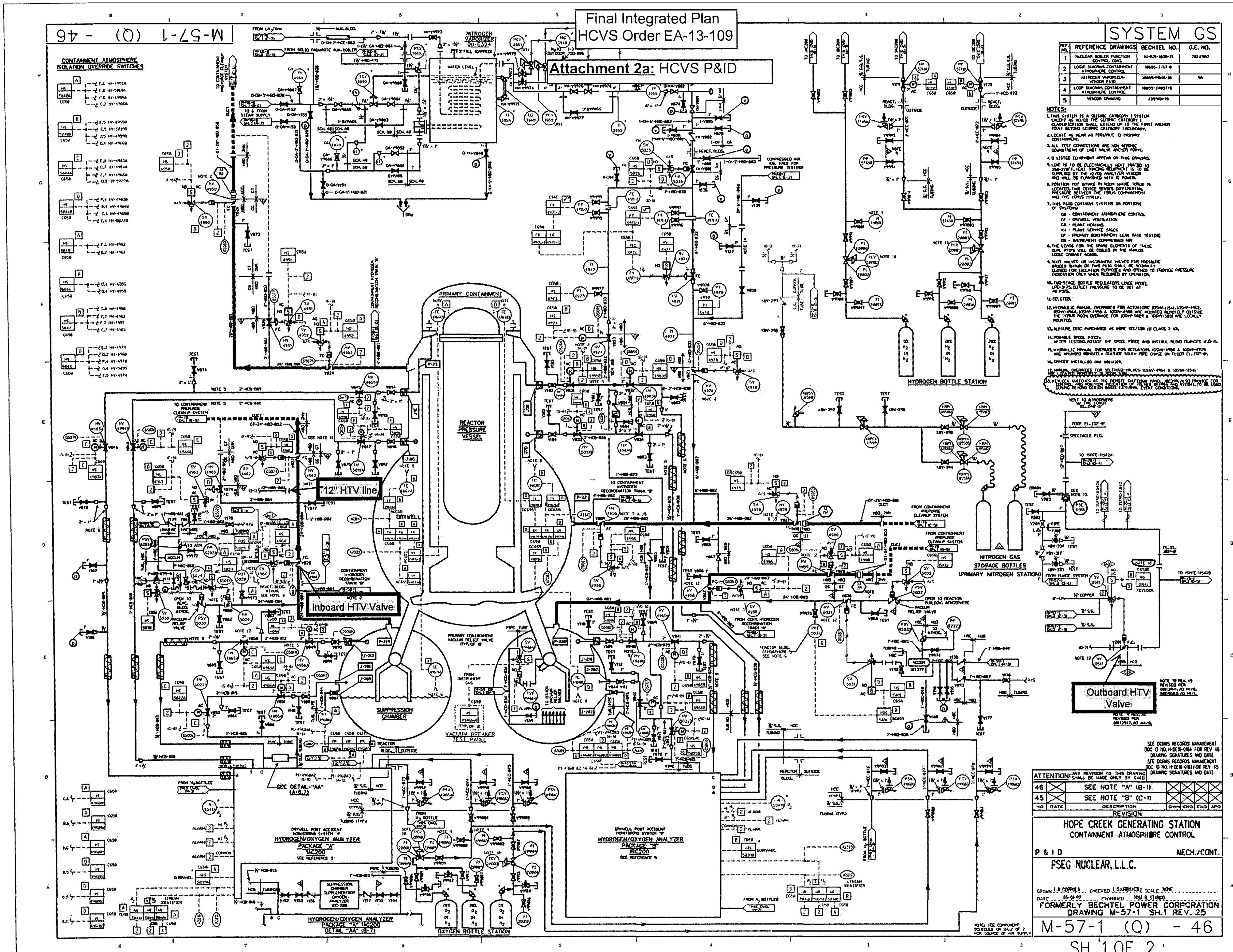
Attachment 2a: HCVS P&ID



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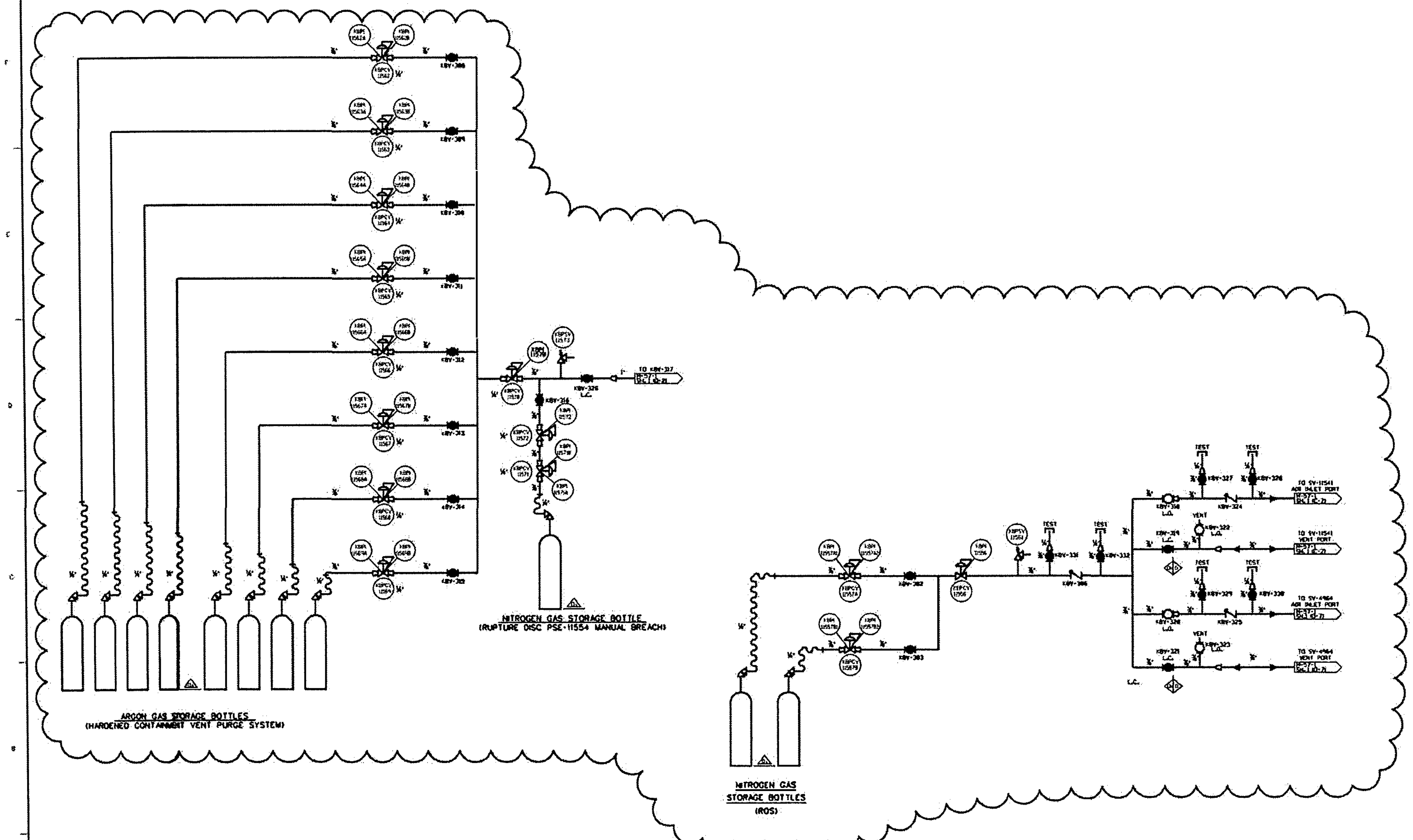
M-57-1 (Q) - 03

SYSTEM GS

Attachment 2b: ROS Compressed Gas Systems

NOTES:
1. COMPONENT SCHEDULE FOR INSTRUMENT AIR USERS.
2. THIS P&ID CONTAINS SYSTEMS OR PORTIONS OF SYSTEMS
   GS - CONTAINMENT ATMOSPHERE CONTROL
   KB - INSTRUMENT COMPRESSED AIR

USER COMPONENT	SOLENOID VALVE	COMPONENT	LOCATION			BRANCH HEADER ISOL VALVE (M-15-0 SH. NO.)	ROOT VALVE (M-15-0 SH. NO.)	ROOT VALVE ROOM NO.	REMARKS
			BLDG.	ELEV.	ROOM NO.				
1GSFV-4971	4971	NITROGEN PURGE ISOLATION VALVE	REACTOR	102'	4330	KBV-264 SH.5 (F-5)	KBV-7146 SH.5 (E-5)	4320	
1GSHV-4950	4950	DRYWELL PURGE EXHAUST	REACTOR	137'	4411	KBV-7007 SH.2 (F-2)	KBV-7006 SH.2 (F-3)	4411	
1GSHV-4951	4951	DRYWELL PURGE EXHAUST	REACTOR	137'	4411	KBV-7007 SH.2 (F-2)	KBV-7008 SH.2 (F-3)	4411	
1GSHV-4952	4952	DRYWELL PURGE EXHAUST	REACTOR	137'	4411	KBV-7007 SH.2 (F-2)	KBV-7008 SH.2 (F-3)	4411	
1GSHV-4956	4956	DRYWELL PURGE INLET VALVE	REACTOR	102'	4321	KBV-264 SH.5 (F-5)	KBV-7147 SH.5 (E-5)	4320	
1GSHV-4958	4958	SUPPRESSION CHAMBER PURGE INLET	REACTOR	054'	4102	KBV-164 SH.5 (E-7)	KBV-7094 SH.5 (D-7)	4102	
1GSHV-4962	4962	SP CHAMBER PURGE EXHAUST	REACTOR	054'	4102	KBV-268 SH.5 (F-3)	KBV-7088 SH.5 (D-3)	4102	
1GSHV-4963	4963	SP CHAMBER PURGE EXHAUST	REACTOR	054'	4102	KBV-268 SH.5 (F-3)	KBV-7084 SH.5 (D-3)	4102	
1GSHV-4964	4964	SP CHAMBER PURGE EXHAUST	REACTOR	054'	4102	KBV-268 SH.5 (F-3)	KBV-7088 SH.5 (D-3)	4102	
1GSHV-4978	4978	NITROGEN PURGE ISOLATION VALVE	REACTOR	102'	4320	KBV-264 SH.5 (F-5)	KBV-7146 SH.5 (E-5)	4320	
1GSHV-4979	4979	DRYWELL PREPURGE CLEANUP IN VLV	REACTOR	102'	4321	KBV-264 SH.5 (F-5)	KBV-7147 SH.5 (E-5)	4320	
1GSHV-4980	4980	DRYWELL PREPURGE CLEANUP IN VLV	REACTOR	054'	4102	KBV-164 SH.5 (E-7)	KBV-7094 SH.5 (D-7)	4102	
1GSHV-5029	5029	RX BLDG ATMOSPHERIC CNTRL VLV	REACTOR	054'	4102	KBV-164 SH.5 (E-7)	KBV-7094 SH.5 (D-7)	4102	
1GSHV-5031	5031	RX BLDG ATMOSPHERIC CNTRL VLV	REACTOR	054'	4102	KBV-268 SH.5 (F-3)	KBV-7093 SH.5 (D-2)	4102	
1GSPSV-5030		RX BLDG VACUUM RELIEF VALVE	REACTOR	054'	4102	KBV-268 SH.5 (F-3)	KBV-7093 SH.5 (D-2)	4102	
1GSPSV-5032		RX BLDG VACUUM RELIEF VLV	REACTOR	054'	4102	KBV-164 SH.5 (E-7)	KBV-7106 SH.5 (C-7)	4102	
1GSHV-5035	5035	RX BLDG NITROGEN SUPPLY VALVE	REACTOR	077'	4201	KBV-262 SH.5 (F-4)	KBV-7087 SH.5 (D-4)	4201	
1GSHV-11541	11541	S.P. CHAMBER DIRECT VENT TO ATMOSPHERE	REACTOR	054'	4102	KBV-269 SH.5 (F-3)	KBV-7068 SH.5 (B-3)	4102	



ATTENTION: ANY REVISION TO THIS DRAWING SHALL BE MADE ONLY BY CAED

SEE DCRMS RECORDS MANAGEMENT DOC ID NO. H-DEIK-0M1 FOR REV 3 DRAWING SIGNATURES AND DATE

NO	DESCRIPTION	DWN	PEER REV	APD	DATE
3	SEE NOTE "B" (B-1)				
2	SEE NOTE "A" (C-1)	GLM		GPY	11/10/00

REVISION

HOPE CREEK GENERATING STATION
CONTAINMENT ATMOSPHERE CONTROL

P & ID MECH./CONT.

PSEG NUCLEAR LLC

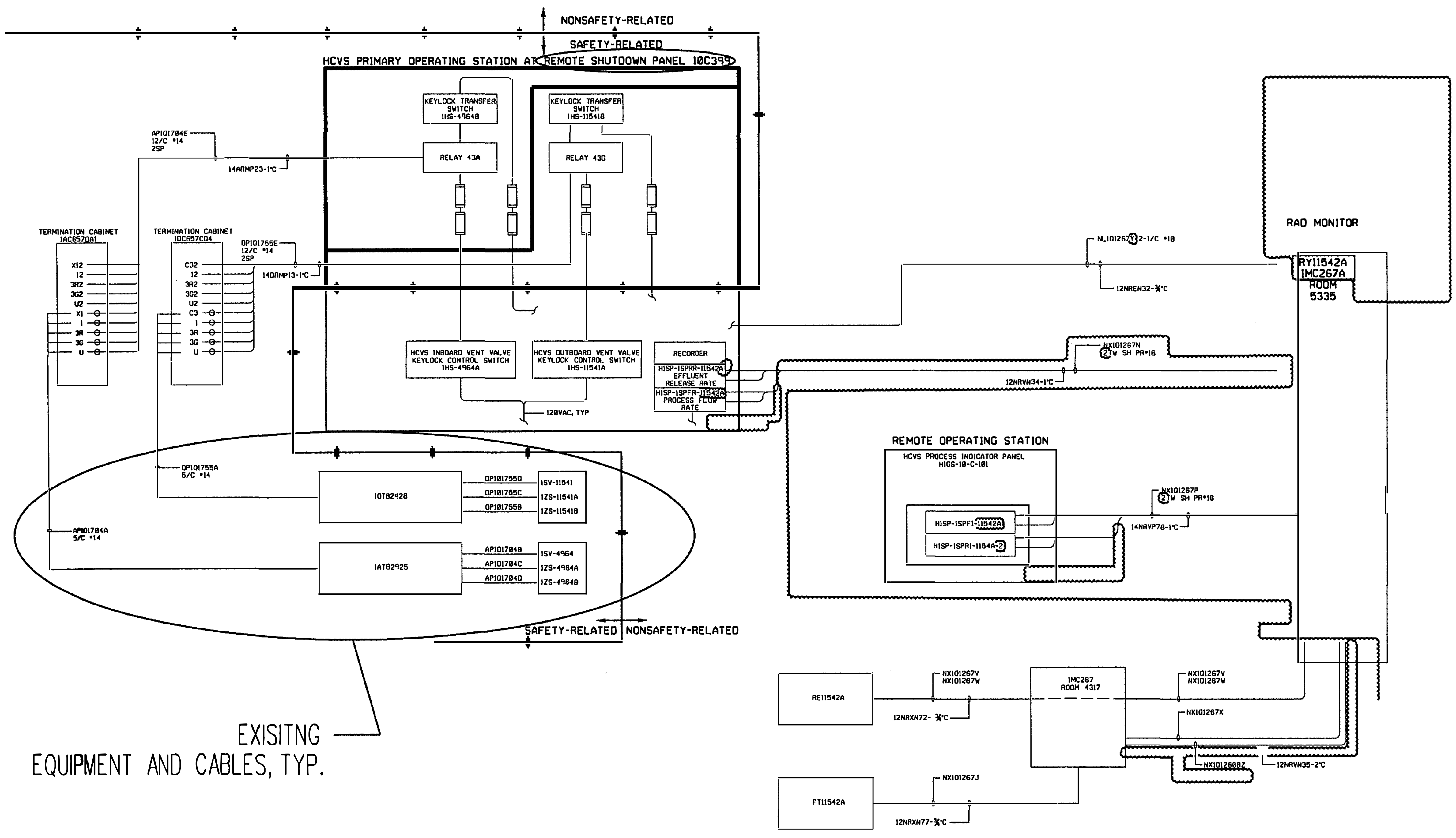
DRAWN R.J. BEATTY PEER REVIEW R.F. BATES
APPROVED EBONE & RANALLI DATE 9-27-90
SCALE NONE

M-57-1 (Q) - 03

SH.2

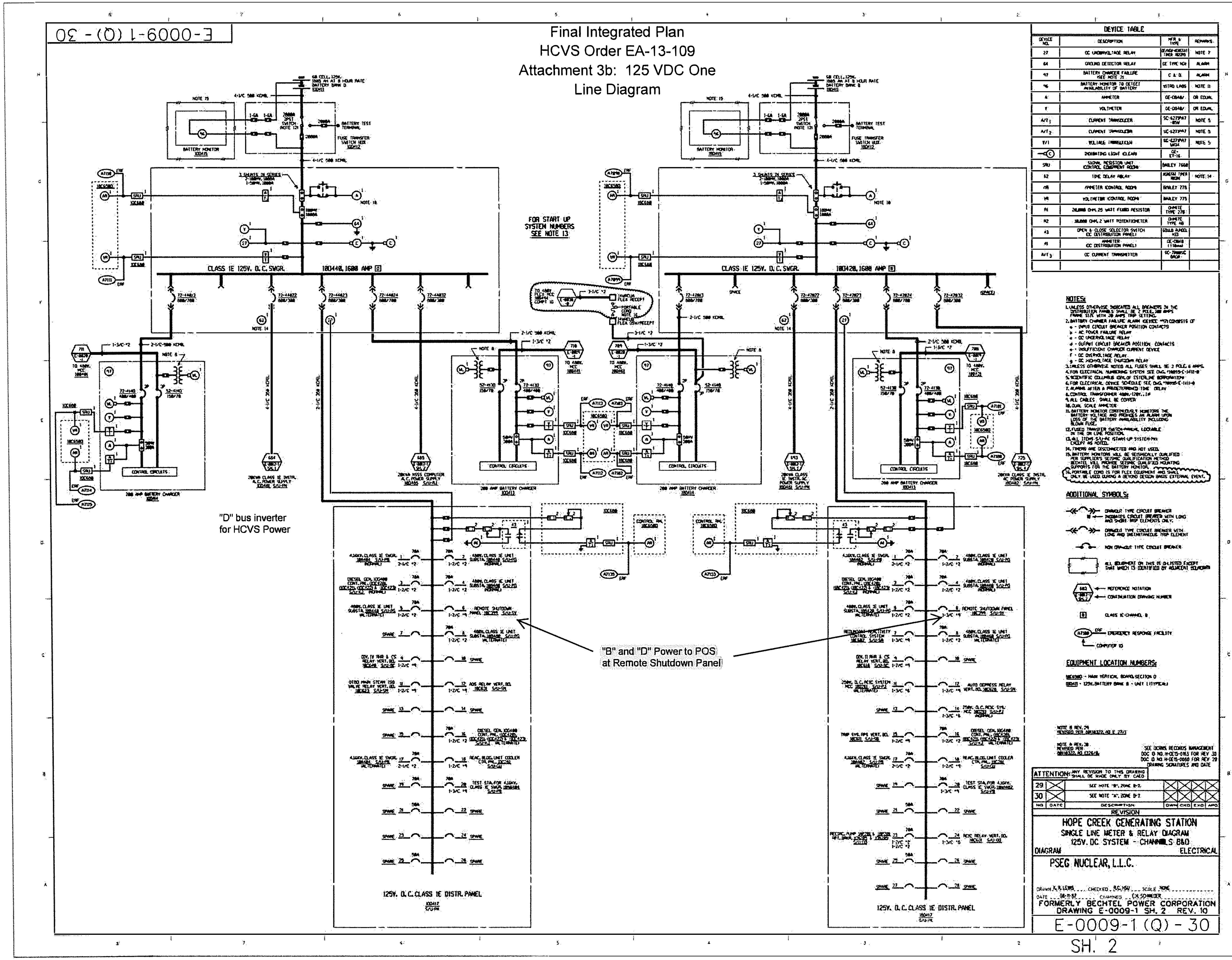
Final Integrated Plan
HCVS Order EA-13-109

Attachment 3a: HCVS Electrical Master Block Diagram



80113942R0
SUP02R3
HOPE CREEK
MASTER BLOCK DIAGRAM
REV. 3 INCORP. FCR 60129190-0001-0150
AND FCR 60129190-0001-0170
REV. 2 INCORP. FCR 60129190-0001-0080
REV. 1 REVISE MASTER BLOCK DIAGRAM
REV. 0 NEW DRAWING
SHEET 1 OF 1

Final Integrated Plan
HCVS Order EA-13-109
Attachment 3b: 125 VDC One Line Diagram



Final Integrated Plan
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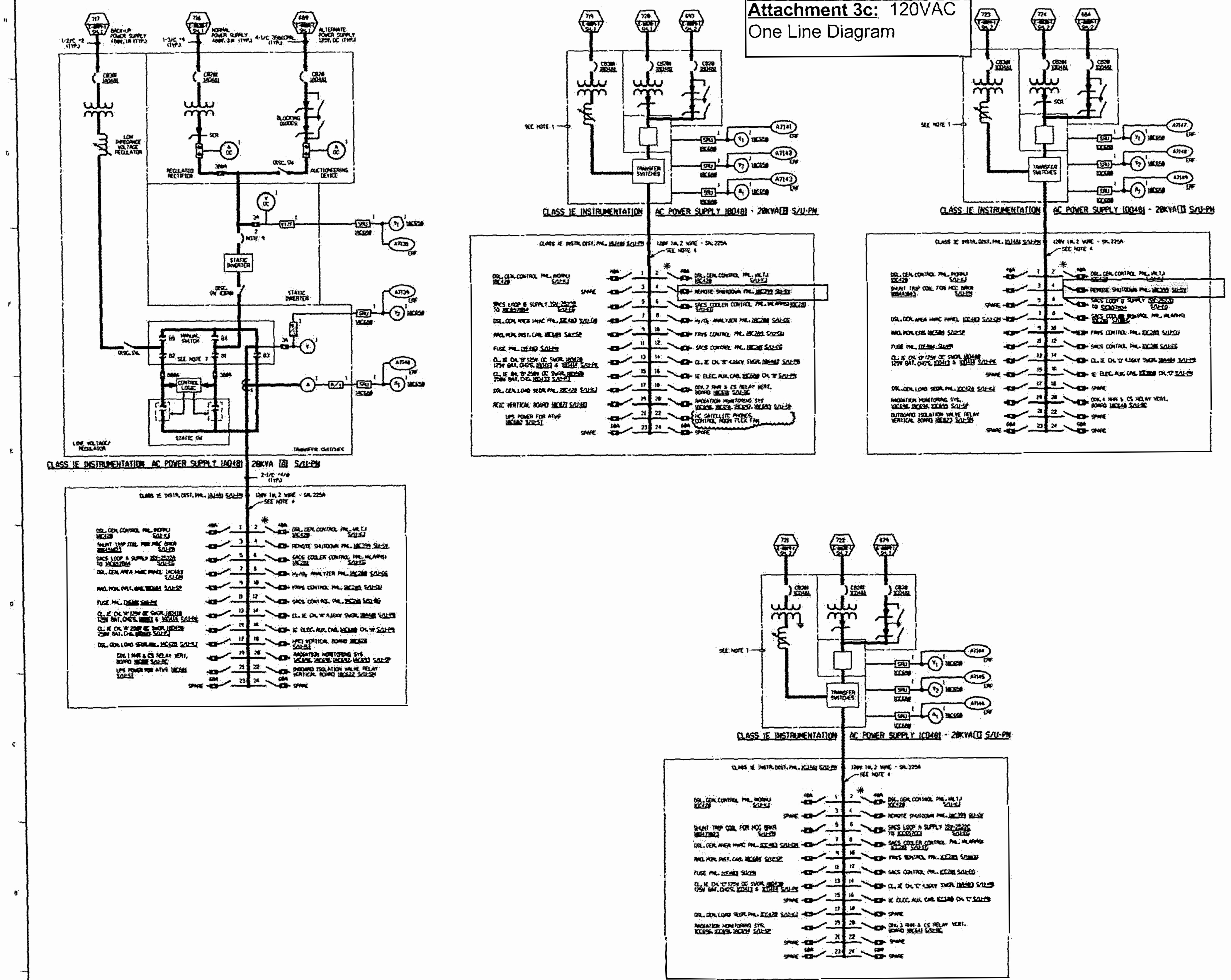
Attachment 3c: 120VAC
One Line Diagram



DEVICE TABLE			
DEVICE NO.	DESCRIPTION	MFR/TYPE	REMARKS
A/T	CURRENT TRANSDUCER	SCIENTIFIC COLUMBUS	
V/T	VOLTAGE TRANSDUCER	SCIENTIFIC COLUMBUS	
VT/F	DC VOLTAGE TRANSDUCER	SCIENTIFIC COLUMBUS	
V_1	DC VOLTMETER	BAILEY TYPE 775	
V_2	AC VOLTMETER	BAILEY TYPE 775	
A_1	AC AMMETER	BAILEY TYPE 775	
V	AC VOLTMETER	GE-AB40	
A	AC AMMETER	GE-AB40	
VDC	DC VOLTMETER	GE-DB40	
ADC	DC AMMETER	GE-DB40	
SRU	SIGNAL RESISTOR UNIT	BAILEY TYPE 760	

NOTES:

1. FOR DETAILS SEE CHANNEL "A" POWER SUPPLY 1AD481.
2. WHENEVER THE RECTIFIER OUTPUT VOLTAGE OF THE NORMAL POWER SUPPLY GOES BELOW THE ALTERNATE POWER SUPPLY VOLTAGE LEVEL, THE LATTER POWER SUPPLY FEEDS THE INVERTER AND VICE VERSA. SHOULD BOTH NORMAL POWER AND ALTERNATE POWER OR ANY ASSOCIATED COMPONENTS OR INVERTER FAIL, LOAD IS AUTOMATICALLY SWITCHED OVER TO A BACK-UP POWER SUPPLY WITHIN ½ HZ AND WITHOUT LOSS OF POWER CONTINUITY TO THE LOAD. WHEN NORMAL POWER IS RESTORED, LOAD IS RETRANSFERRED TO IT AUTOMATICALLY WITH A TIME DELAY AFTER THE LOGIC CHECKS FOR SYNCHRONISM OF PHASES AND VOLTAGE BALANCE BETWEEN THE TWO SOURCES.
3. UNLESS OTHERWISE SPECIFIED ALL BRANCH CIRCUIT FUSES ARE 20 AMPS. FOR CABLE INFORMATION SEE REF. DWG. 1.
4. PANELBOARD NEUTRAL BUS SHALL BE GROUNDED.
5. FOR ELECTRICAL NUMBERING SYSTEM SEE DWG. E-1412-0.
6. DELETED
7. THE MANUAL SWITCH SHALL PROVIDE UNRESTRICTED MAINTENANCE AND TESTING OF THE INVERTER, STATIC SWITCH AND THE BACK-UP POWER SUPPLY EQUIPMENT.
8. ALL EQUIPMENT ON THIS DRAWING IS Q-LISTED.
9. BREAKER WITH SHUNT TRIP ELEMENT ONLY IS TRIPPED AUTOMATICALLY BY A SIGNAL FROM THE CURRENT LIMIT SENSOR IN THE INVERTER AFTER A PRESET TIME DELAY.
10. INTERNAL WIRES BETWEEN CIRCUIT BREAKERS AND FUSE HOLDERS ARE #8 FOR CIRCUITS 1 THROUGH 22 AND #6 FOR CIRCUITS 23 AND 24.

ADDITIONAL SYMBOLS:

S/U-PN ← START-UP SYSTEM NO. PN

← REFERENCE NOTATION

← CONTINUATION DWG. NO. & SHEET NO.

← CIRCUIT BREAKER 1 POLE, 100 AMP., TYPE NON CB NON-AUTOMATIC (TYPICAL)

← INDICATES CLASS 1E CHANNEL "A"

SN ← SOLID NEUTRAL

EQUIPMENT LOCATION NUMBERS:

REFERENCE DRAWINGS:

SEE DCRMS RECORDS MANAGEMENT DOC ID NO. H-GEO-0163 FOR REV 16 DOC ID NO. H-GEO-0030 FOR REV 15 DRAWING SIGNATURES AND DATE

ATTENTION: ANY REVISION TO THIS DRAWING SHALL BE MADE ONLY BY CADD

NO	DATE	DESCRIPTION	DWN	CKD	EXD	APD
15		REVISED PER 80109447 AO E.1/8				
16		REVISED PER 80116322 AO E142/8				

REVISION

HOPE CREEK GENERATING STATION
SINGLE LINE METER & RELAY DIAGRAMS
120V AC INSTRUMENTATION & MISC. SYSTEMS
DIAGRAM ELECTRICAL

PSEG NUCLEAR, L.L.C.

DRAWN LEE G. KIRBY CHECKED SCALE NONE
DATE 09-17-82 EXAMINED

FORMERLY BECHTEL POWER CORPORATION DRAWING E-0012-1 SH. 1 REV. 10

E-0012-1 (Q) - 16

SH. 1 OF 5

Final Integrated Plan
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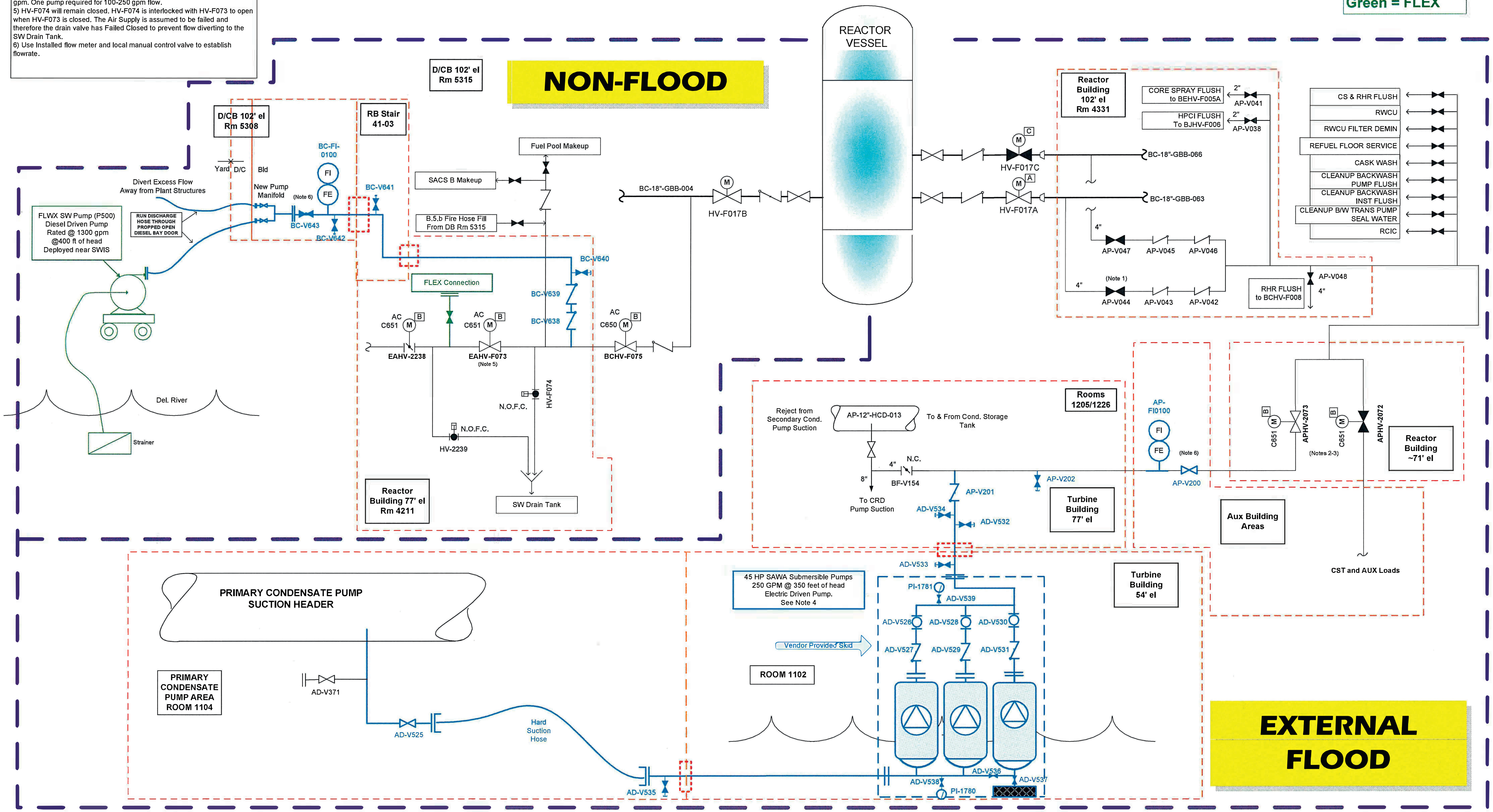
Attachment 4 SAWA Mechanical Master Diagram

Black = Existing
Blue = New
Red = Core Bore
Orange = Area
Green = FLEX

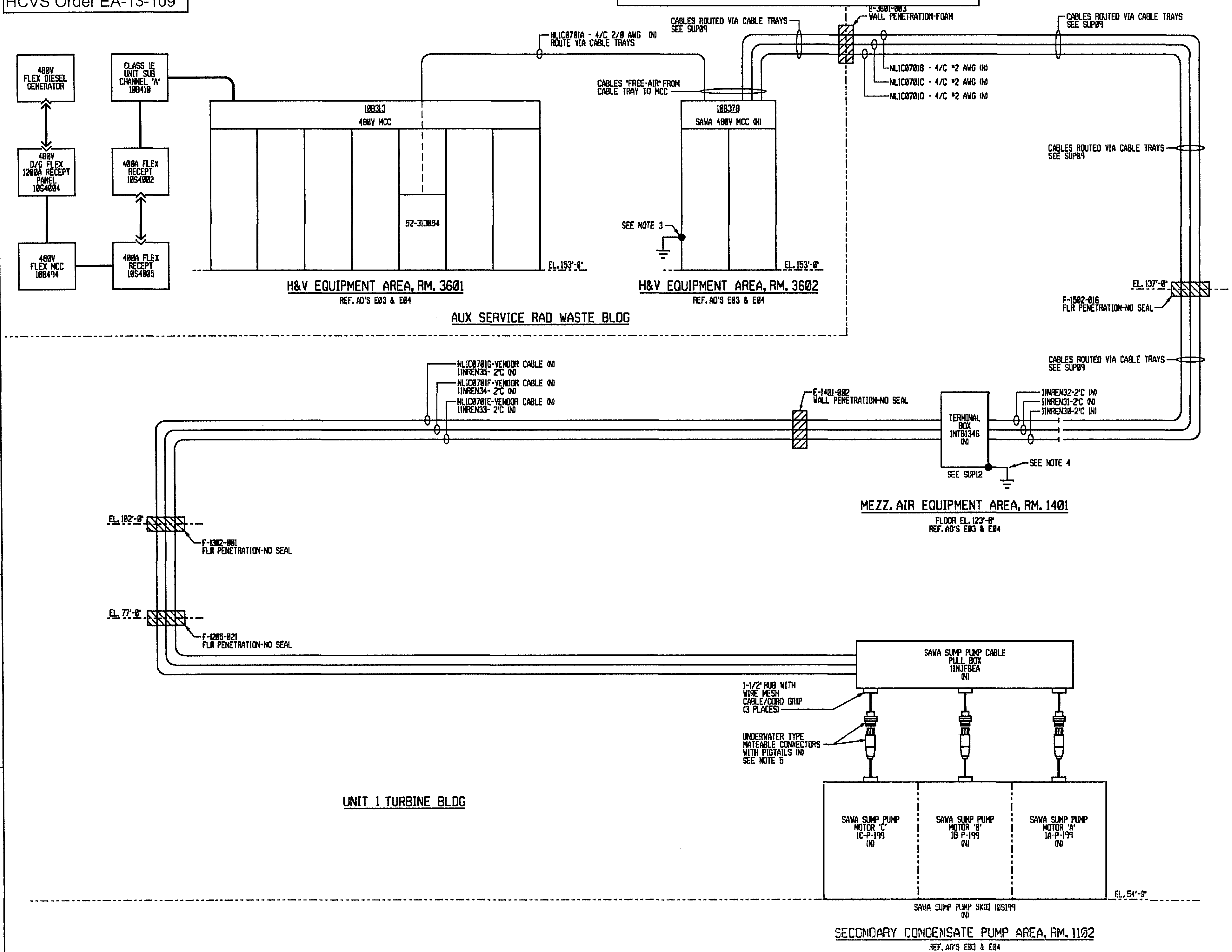
NOTES:

1) Valve AP-V044 needs to be opened less than 1 hour from the loss of all RPV injection.
2) MOVs APHV-2073 and HV-2072 are fed from the B RB FLEX MCC. Do not load shed.
3) Per UFSAR 8.3 (Table 8.3-11) These MOVs have thermal overload bypass circuitry (b/c they are required to achieve Post Fire Remote Shutdown).
4) Pumps operated in parallel. Only 2 pumps required for max flow of 500 gpm. One pump required for 100-250 gpm flow.
5) HV-F074 will remain closed. HV-F074 is interlocked with HV-F073 to open when HV-F073 is closed. The Air Supply is assumed to be failed and therefore the drain valve has Failed Closed to prevent flow diverting to the SW Drain Tank.
6) Use Installed flow meter and local manual control valve to establish flowrate.



Final Integrated Plan
HCVS Order EA-13-109

Attachment 5: SAWA Electrical Master Diagram



NOTES:

1. ALL EQUIPMENT SHOWN IS EXISTING UNLESS OTHERWISE NOTED.
2. SEE SUP09 FOR LOCATION OF ALL NEW SAWA ELECTRICAL EQUIPMENT.
3. 4/0 AWG GROUND CABLE TO STATION GROUND. GROUND 480V MCC PER E-1401-0, SHEET 11.3.
4. 4/0 AWG GROUND CABLE TO STATION GROUND. GROUND TERMINAL BOX PER E-1401-0, SHEETS 20.4 & 20.5.
5. CABLE CONNECTOR VENDOR SHALL BE PROVIDING UNDERWATER TYPE CONNECTORS WITH PIG TAILS THAT HAVE A PRE-DETERMINED LENGTH OF VENDOR CABLE ATTACHED. PUMP SKID VENDOR SHALL ATTACH PIGTAIL WITH MALE CONNECTOR TO SUMP PUMP MOTORS ON SKID. FIELD SHALL ROUTE VENDOR CABLE FROM PULLBOX ON EL. 54'-0" TO TERM BOX 1NTB1536.

LEGEND:

(N) - NEW EQUIPMENT

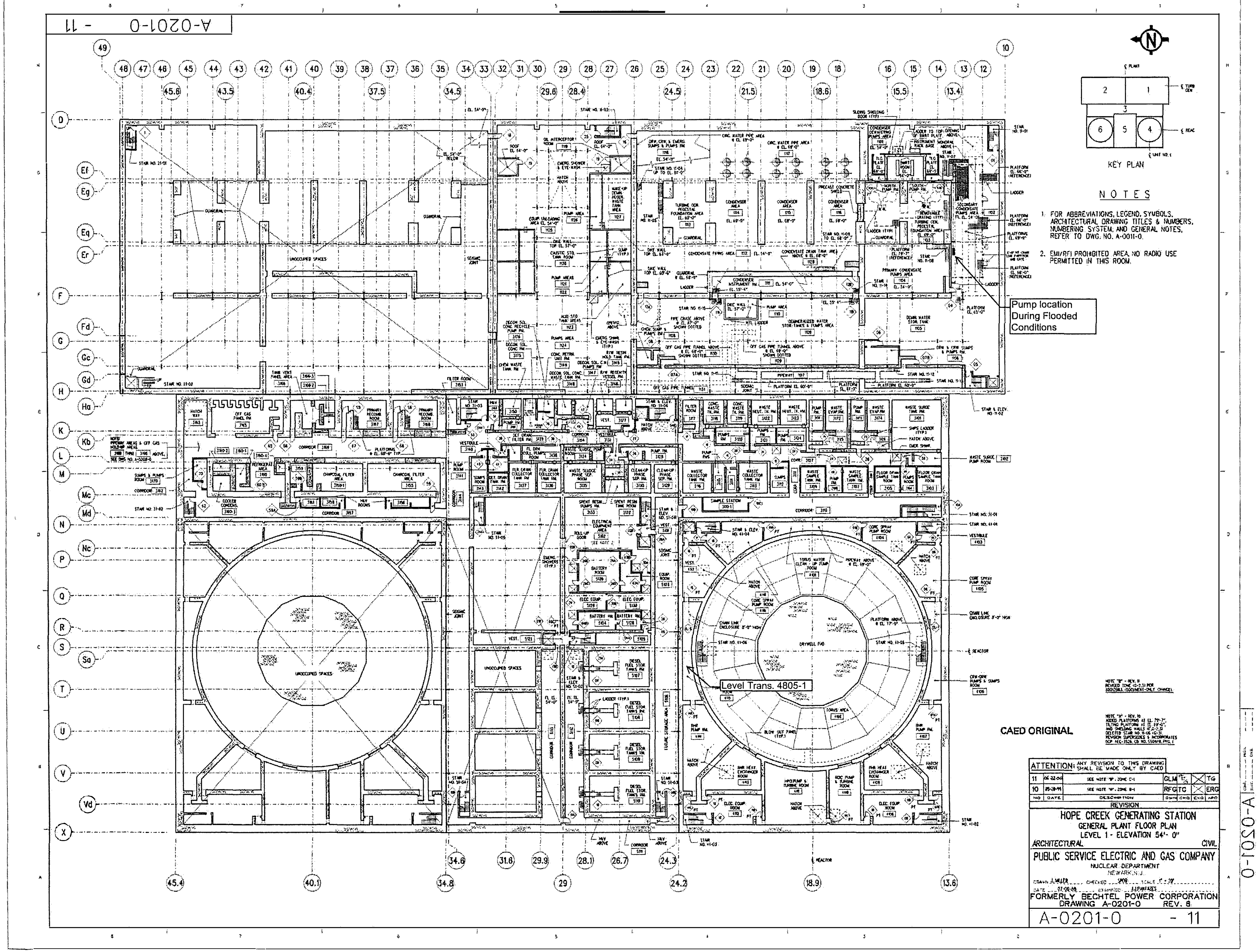
REFERENCE DWGS:

SUP09..........CABLE / CONDUIT ROUTING MASTER DIAGRAM
SUP12..........TERMINAL BOX 1NTB1346 DETAIL
AO E03.........WIRING DIAGRAM
AO E04.........CABLE BLOCK DIAGRAM

PRELIMINARY
FOR REVIEW ONLY
NOT FOR CONSTRUCTION

80118721R0
SUP01R0
HOPE CREEK SEVERE ACCIDENT WATER ADDITION (SAWA) MASTER DIAGRAM
BLOCK DIAGRAM

Attachment 6a: 54 ft. El Layout



Final Integrated Plan

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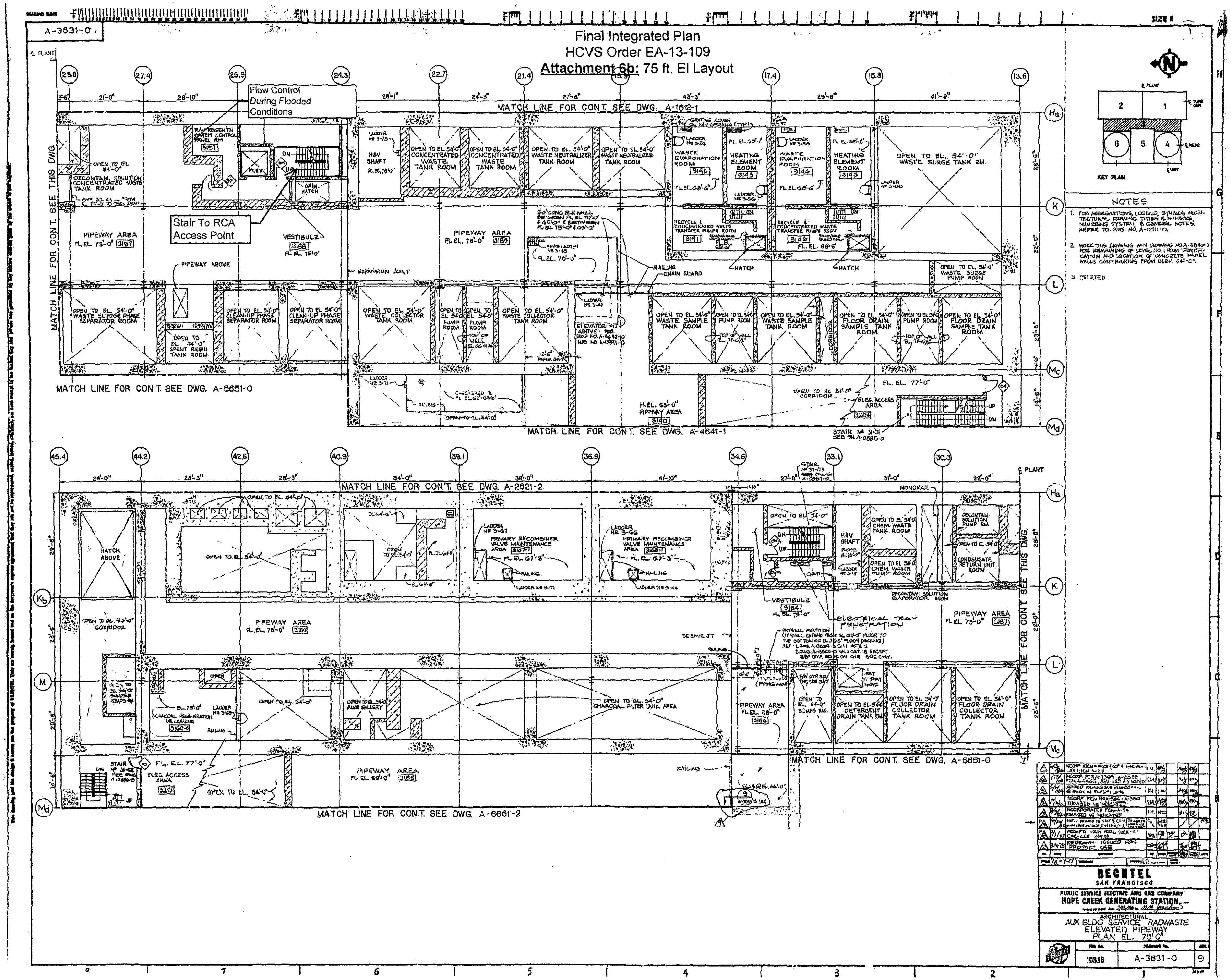
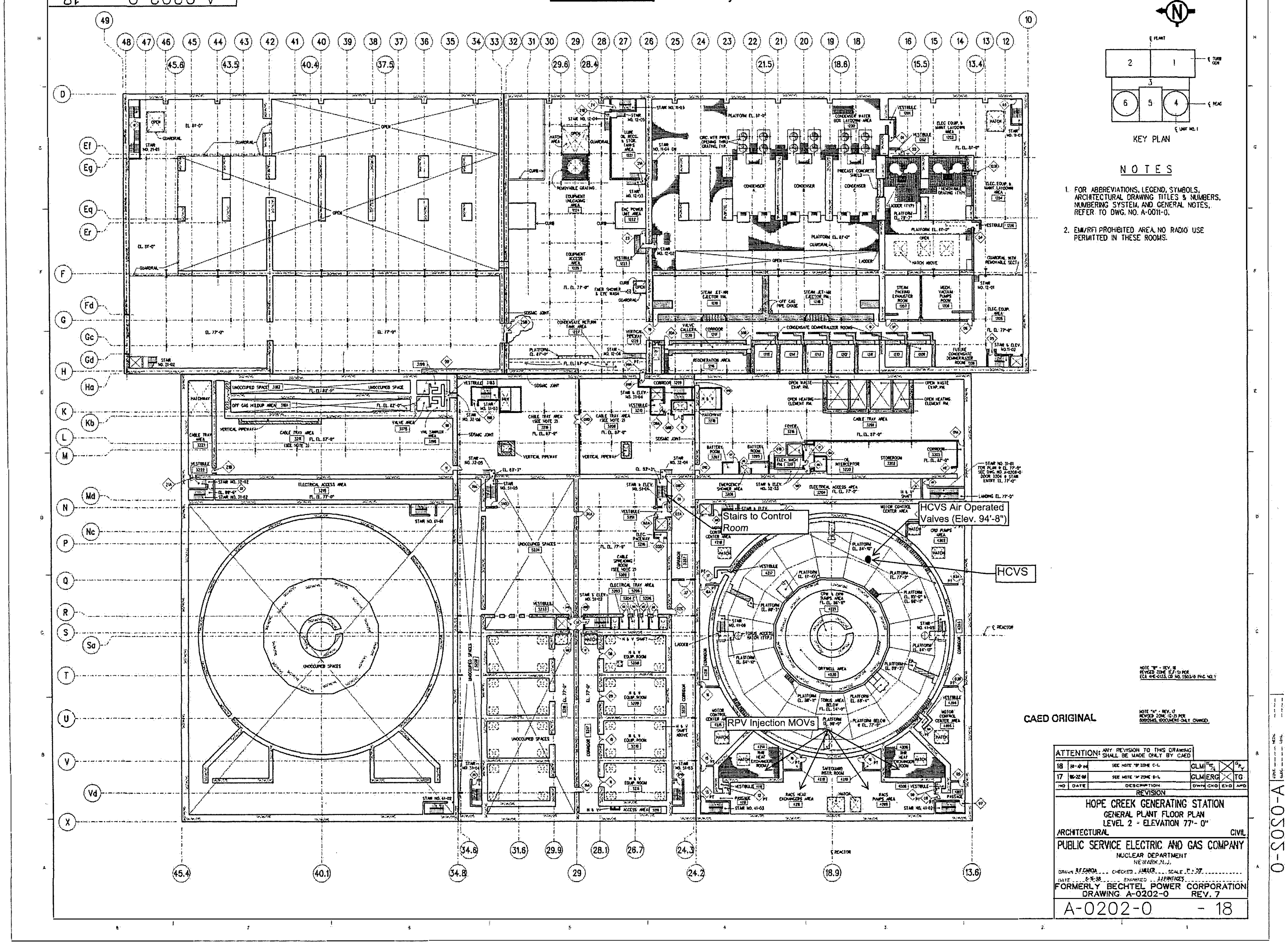
Attachment 6b: 75 ft. El Layout



Final Integrated Plan

HCVS Order EA-13-109

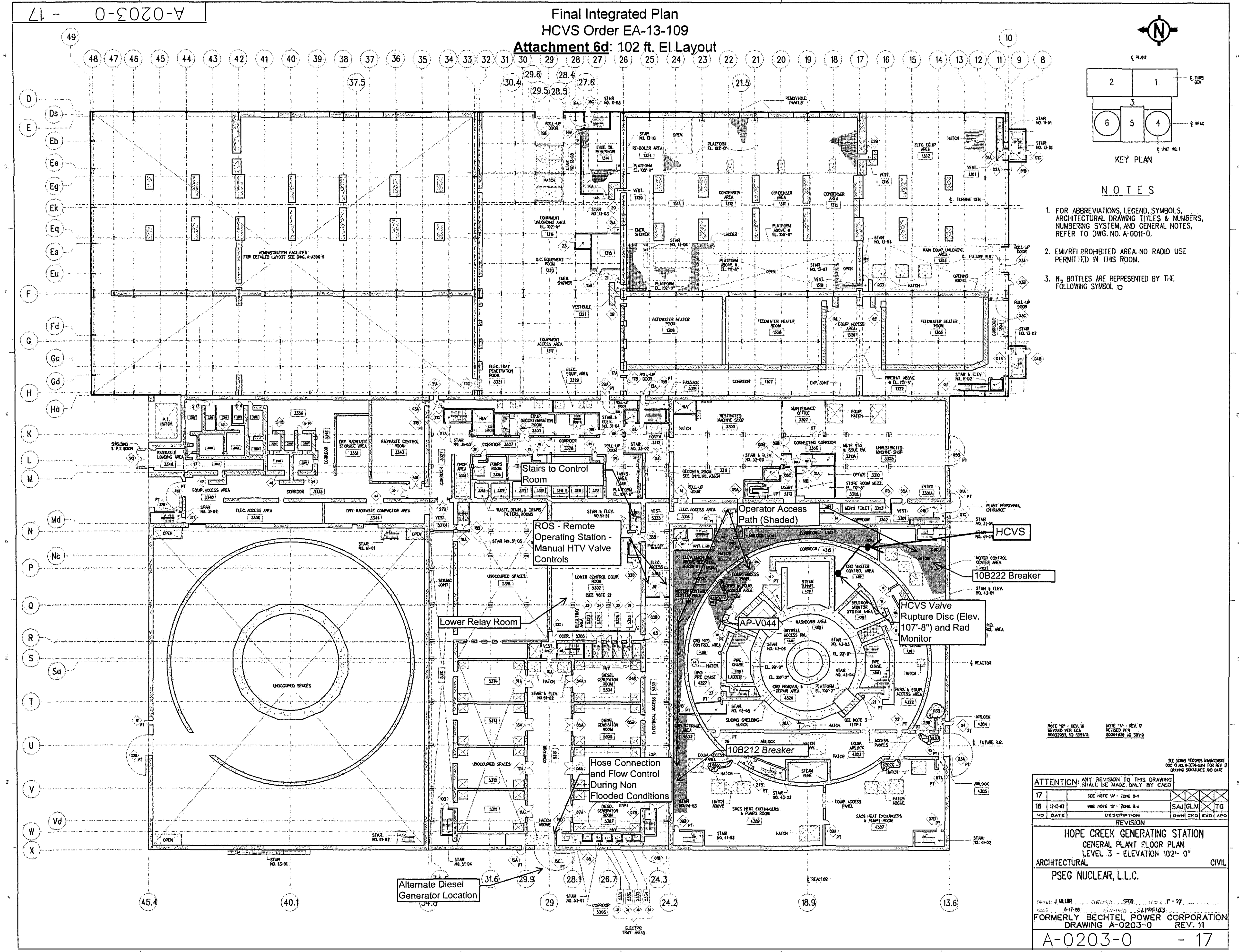
Attachment 6c: 77 ft. El Layout



Final Integrated Plan

HCVS Order EA-13-109

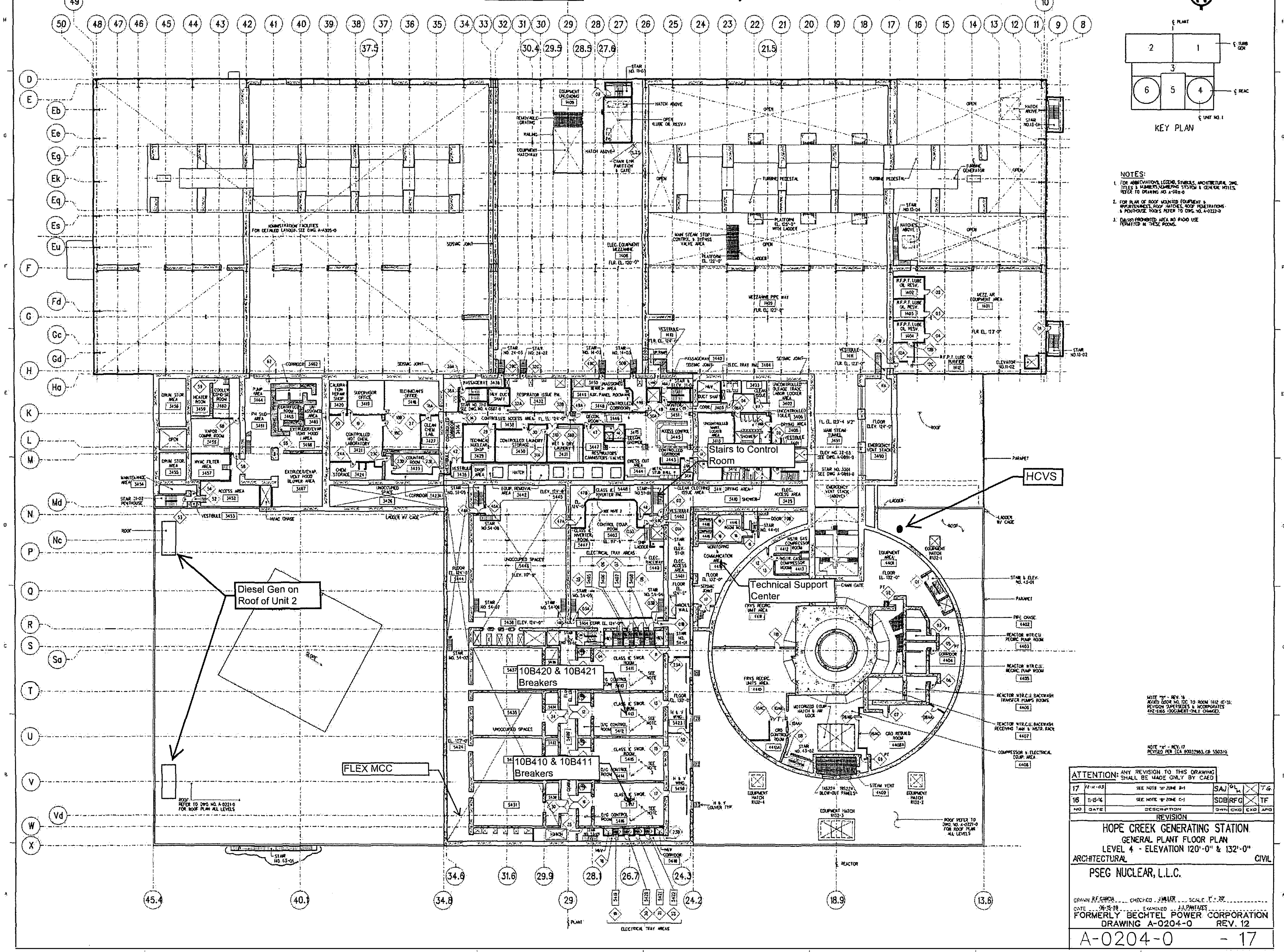
Attachment 6d: 102 ft. El Layout



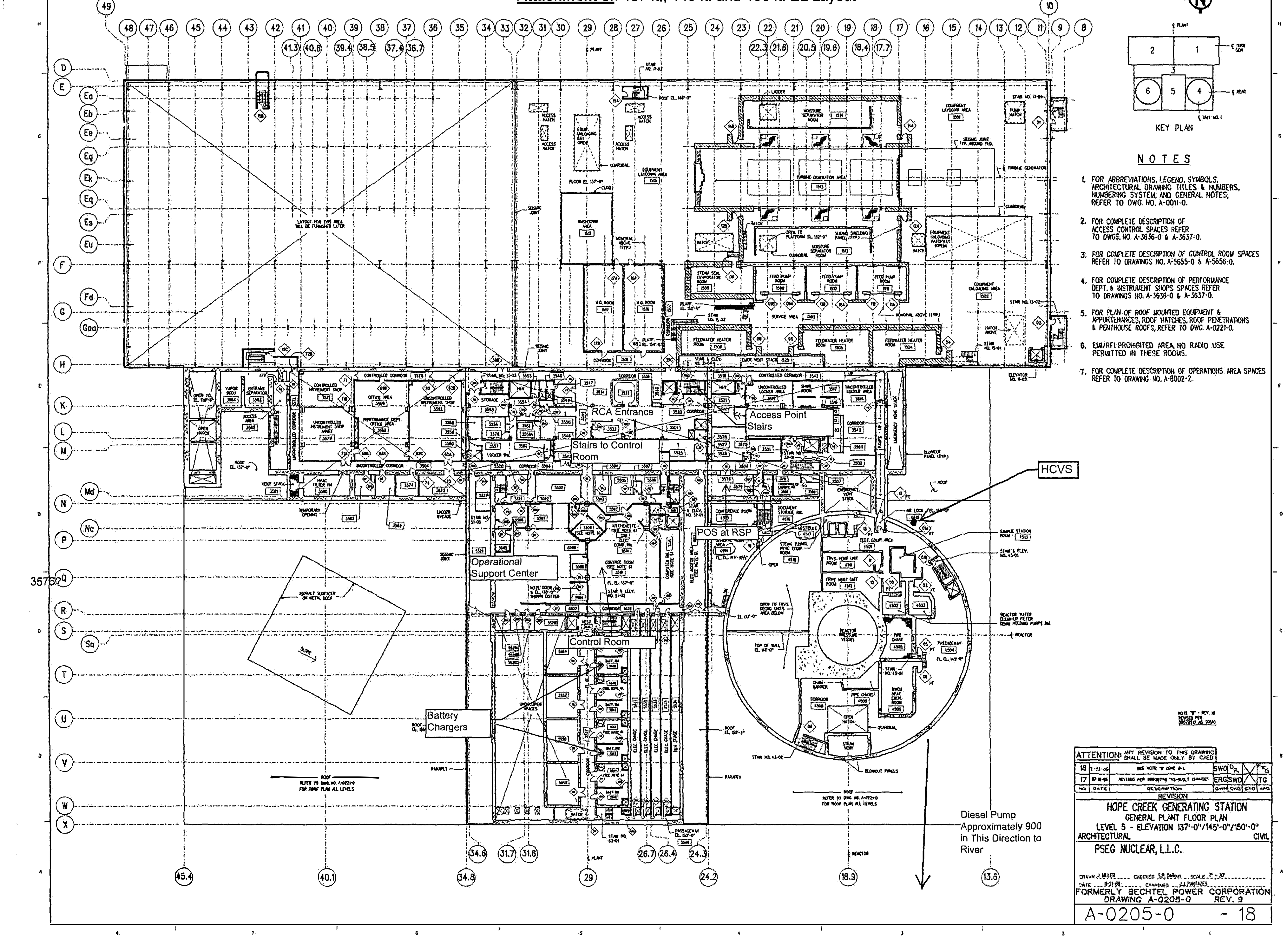
Final Integrated Plan

HCVS Order EA-13-109

Attachment 6e:120 ft. and 132 ft. El Layout



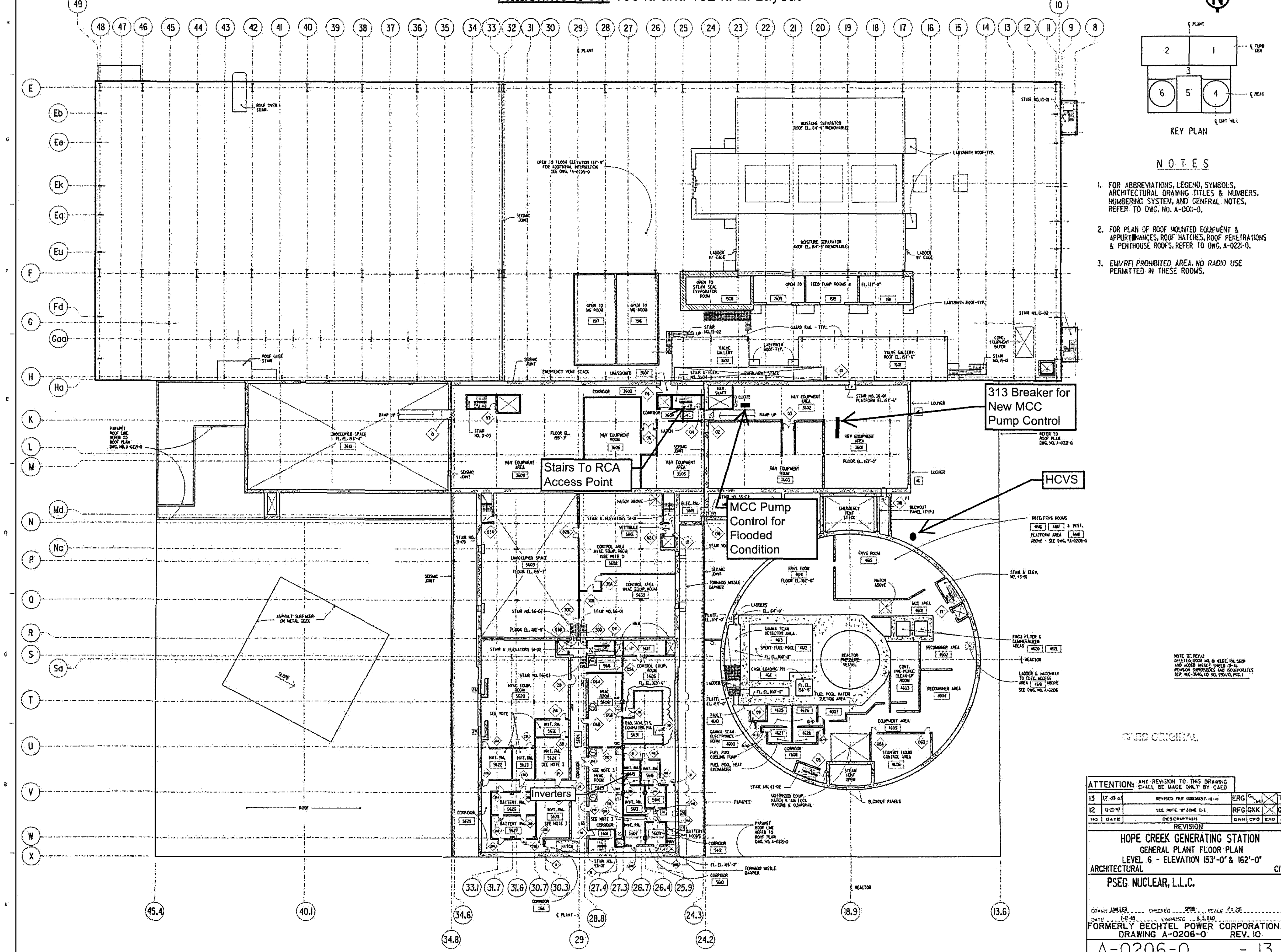
Attachment 6f: 137 ft., 145 ft. and 150 ft. EL Layout



Final Integrated Plan

HCVS Order EA-13-109

Attachment 6g: 155 ft. and 162 ft. El Layout



Final Integrated Plan
HCVS Order EA-13-109
Attachment 6h: SAWA Hose Route for Non-Flood Scenario