Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

CNL-19-004

June 7, 2019

10 CFR 2.202
10 CFR 50.4

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

Browns Ferry Nuclear Plant, Units 1, 2 and 3
Renewed Facility Operating License Nos. DPR-33, DPR-52, and DPR-68
NRC Docket Nos. 50-259, 50-260, 50-296

Subject: **Tennessee Valley Authority, Browns Ferry Nuclear Plant, Unit 2, Completion of Required Action for NRC Order EA-13-109, Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (CAC No. MF4541)**

References:

1. Letter from TVA to NRC, "Tennessee Valley Authority, Browns Ferry Nuclear Plant, Unit 1, Completion of Required Action for NRC Order EA-13-109, Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (CAC No. MF4540)," dated January 22, 2019 (ML19022A305)
2. Letter from TVA to NRC, "Tennessee Valley Authority, Browns Ferry Nuclear Plant, Unit 3, Completion of Required Action for NRC Order EA-13-109, Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (CAC No. MF4542)," dated May 31, 2018 (ML18169A178)

On June 6, 2013, the Nuclear Regulatory Commission 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," to all Boiling Water Reactor licensees with Mark I and Mark II primary containments. The order was immediately effective and directed the Tennessee Valley Authority to install a reliable hardened venting capability for instances of pre-core damage and under severe accident conditions, including those involving a breach of the reactor vessel by molten core debris.

This letter, along with Enclosure 1, provides the notification required by Item IV.D.4 of Order EA-13-109 that full compliance (Phase 1 and Phase 2) with the requirements described in Attachment 2 of the Order has been achieved for Browns Ferry Nuclear Plant (BFN), Unit 2. BFN Units 1, 2, and 3 are now in full compliance to the Order since Unit 1 previously reached full compliance on November 22, 2018, and Unit 3 reached full compliance on March 31, 2018, as documented in References 1 and 2.

Enclosure 2 contains the BFN Units 1, 2, and 3 Hardened Containment Vent System Final Integrated Plan, which provides strategies for the enhancement of hardened venting capabilities to manage containment over-pressurization for Mitigation Strategies for Beyond-Design-Basis External Events (FLEX) and establishment of hardened venting capabilities for non-mitigated (Severe Accident) Extended Loss of all AC Power.

There are no new regulatory commitments resulting from this submittal. If you have any question regarding this submittal, please contact Jamie L. Paul at (256) 729-2636.

I declare under penalty of perjury that the foregoing is true and correct. Executed on the 7th day of June 2019.

Respectfully,

E. K. Henderson
Director, Nuclear Regulatory Affairs

Enclosures:

1. Tennessee Valley Authority, Browns Ferry Nuclear Plant, Unit 2, Completion of Required Action for NRC Order EA-13-109, Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions

2. Tennessee Valley Authority, Browns Ferry Nuclear Plant, Reliable Hardened Containment Vents Capable of Operation Under Severe Accidents, Final Integrated Plan

cc (w/Enclosures):

NRR Director - NRC Headquarters
NRC Regional Administrator - Region II
NRR Project Manager - Browns Ferry Nuclear Plant
NRC Senior Resident Inspector - Browns Ferry Nuclear Plant

ENCLOSURE 1

Tennessee Valley Authority, Browns Ferry Nuclear Plant, Unit 2, Completion of Required Action for NRC Order EA-13-109, Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions

CNL-19-004

BACKGROUND

On June 6, 2013, the Nuclear Regulatory Commission issued Order EA-13-109, Order Modifying Licenses with Regard to Requirements for Reliable Hardened Containment Vents (HCVS) Capable of Operation Under Severe Accident Conditions (Reference 1), to the Tennessee Valley Authority. This Order was immediately effective and directs Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3, to install a reliable hardened venting capability for pre-core damage and under severe accident conditions, including those involving a breach of the reactor vessel by molten core debris in response to Order EA-13-109. BFN developed an Overall Integrated Plan (OIP) (Phase 1 in Reference 2 and Phases 1 and 2 in Reference 5) to provide HCVS. The information provided herein, as well as the implementation of the OIP, documents full compliance for BFN, Unit 2, in response to the Order (Reference 1).

OPEN ITEM RESOLUTION

The Phase 1 and 2 NRC Interim Staff Evaluation (ISE) Open Items (References 11 and 12, respectively) have been addressed and documented in the subsequent Order EA-13-109 six-month status reports (References 3-10, and 14). A list of the open items and a summary of the closure action is listed below:

Browns Ferry Nuclear Plant, Unit 2 HCVS Phase 1 ISE Open Items		Response
1	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.	An evaluation of temperature and radiological conditions was performed to ensure that Operating personnel can safely access and operate controls at the Remote Operating Station located in the Diesel Buildings and in the Reactor Building. This evaluation is documented in Unit 2 Engineering Change Package (ECP) 71390 Technical Evaluation. MDQ0000642015000351, HCVS Operator (Mission) Dose Calculation, and MDQ0009992014000291, Temperature Response of the Reactor Building Following an Extended Loss of AC Power, were used to validate the evaluation. This ISE Open Item was closed as documented in Reference 13.
2	Make available for NRC audit documentation that procedure 1/2/3-EOI Appendix-13 has been revised to include venting for loss of DC power.	For Unit 2, 2-EOI Appendix-13 Revision 9 was revised to include venting for loss of DC power. This ISE Open Item was closed as documented in Reference 13.

Browns Ferry Nuclear Plant, Unit 2 HCVS Phase 1 ISE Open Items		Response
3	Make available for NRC staff audit documentation demonstrating that all load sheds will be accomplished within one hour of event initiation and will occur in an area not impacted by a possible radiological event.	Calculation EDQ0009992013000202, 250V DC Unit Batteries, 1, 2, & 3 Evaluation for the Beyond Design Basis External Event (BDBEE) Extended Loss of AC Power (ELAP), has been issued to determine load shedding impact on the unit batteries. The performance of the load shed is directed by 0-FSI-1, FLEX Support Instruction, and performed in accordance with 0-FSI-3F, Load Shed of 250V Main Bank Battery 1, 2, 3. The load shed is performed in the Control Bay and Electrical Board rooms only and will not require entry into areas that are impacted by a possible radiological event. This ISE Open Item was closed as documented in Reference 13.
4	Make available for NRC staff audit documentation that demonstrates that operating units that have not implemented the order will be able to vent through the existing vent system unaffected by the implementation of HCVS on other units.	A conceptual meeting was held in November 2014, and a staging plan was used to separate the existing Hardened Wetwell Vent (HWWV) from the HCVS. The HCVS has been implemented on all BFN Units. This ISE Open Item was closed as documented in Reference 13.
5	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.	The existing wetwell vent and the HCVS have been designed for 1 percent of rated thermal power at Extended Power Uprate (3952 MWt) conditions. This analysis is available and documented in Calculation NDQ0000642015000341, HCVS Modular Accident Analysis Program. This ISE Open Item was closed as documented in Reference 13.

Browns Ferry Nuclear Plant, Unit 2 HCVS Phase 1 ISE Open Items		Response
6	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.	A communication system has been implemented (ECP 70852) that uses hand held radios for communication between the main control room (MCR) and the remote operating station. This Radio System consists of a Ultra High Frequency (UHF)/Very High Frequency (VHF) trunked system and an independent VHF channel (F4). The In-plant Radio System is accessed by handheld radios. The In-plant Radio System has normal and emergency Diesel Generator (DG) backed power supply. The radio system is powered from two Class 1E redundant power sources, the 480V DG Auxiliary Boards A and B. Primary power source will be from the 480V DG Auxiliary Board A via a second 480-208V/120V transformer/distribution center. In the event of loss of primary power source, power to radio equipment will be automatically transferred to backup source via transfer switches located in each cabinet, with exception of cabinet 4, which receives power via cabinet 1 transfer switch. Backup power source includes Uninterrupted Power Supply (UPS) with battery capacity to supply four (4) UHF channels for three hours. Therefore, in this configuration, capacity is reduced from five simultaneous conversations to three. The loads supplied via UPS can be alternatively supplied from a portable generator via a transfer switch (0-FSI-4B). UPS conservation can be accomplished by switching off one of the two UPSs until such time the active UPS reaches “low level.” Then, the UPS previously switched off can be returned to service extending the overall time the radio system can remain operable without portable generator power to approximately 6 hours. BFN maintains a large number of handheld radios, batteries, and charging units. The FLEX program does not maintain dedicated handheld radios. These units, spare batteries, and chargers will be gathered if not readily available in the control rooms. Handheld Radios can additionally be operated in “Radio-to-Radio” mode enabling communications not affected by shielding or distance. This ISE Open Item was closed as documented in Reference 13.

Browns Ferry Nuclear Plant, Unit 2 HCVS Phase 1 ISE Open Items		Response
7	Make available for NRC staff audit documentation of 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.	An evaluation was performed and concluded that the containment isolation valves will open under the maximum expected differential pressure and is documented in Flowserve Report RAL-70181, Design Review Report of Size 14 Class 150 Wafer Butterfly Valve with Pneumatic Actuator, Revision 1. This ISE Open Item was closed as documented in Reference 13.
8	Make available for NRC staff audit documentation of a seismic qualification evaluation of HCVS components.	Electrical and instrument and control components were procured as seismically qualified or as Seismic Class I to ensure their functionality following a seismic event. Seismic qualification reports of HCVS components are available for audit. This ISE Open Item was closed as documented in Reference 13.
9	Make available for NRC staff audit descriptions of all instrumentation and controls (existing and planned) necessary to implement this order including qualification methods.	Instrumentation and controls necessary to implement this order including equipment description, location, and qualifications are available for audit. This ISE Open Item was closed as documented in Reference 13.
10	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, and etc.) required for HCVS venting including confirmation that the components are capable of performing their functions during ELAP and severe accident conditions.	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, and etc.) required for HCVS venting including confirmation that the components are capable of performing their functions during ELAP and severe accident conditions are available for audit. This ISE Open Item was closed as documented in Reference 13.

Browns Ferry Nuclear Plant, Unit 2 HCVS Phase 1 ISE Open Items		Response
11	Make available for NRC staff audit the final sizing evaluation for HCVS batteries/battery charger including incorporation into FLEX DG loading calculation.	HCVS batteries/battery charger final sizing evaluation was performed and documented in the Engineering Change Technical Evaluation of ECP 71390 for Unit 2. There is no incorporation of the HCVS battery/battery charger required into the FLEX DG loading calculation due to no plans or requirements to recharge the HCVS battery after depletion. The HCVS electrical loads will be aligned back to their normal power supply which is the Unit Battery. The recharging of the Unit Battery is incorporated into the FLEX DG loading calculations. Calculation EDQ0003602014000281 Revision 3, Electrical Evaluation for Portable Power Supply for Unit Battery Chargers, and calculation EDQ0003602015000325 Revision 1, Electrical Evaluation for 4KV Spare FLEX Turbine Generators, were used to validate the evaluation. This ISE Open Item was closed as documented in Reference 13.
12	Make available for NRC staff audit documentation of the HCVS nitrogen pneumatic system design including sizing and location.	The HCVS evaluation has been completed and documented in ECP 71390 for Unit 2 and calculation MDQ0000322015000347, HCVS Nitrogen System Sizing Analysis. As documented in ECP 71390 Engineering Change Technical Evaluation (Page 28 of 75), there are 10 Nitrogen Cylinders required for Unit 2 for 7 days of Hardened Vent operation. There are 5 Nitrogen Cylinders installed to support Hardened Vent operation for Unit 1. 24 Nitrogen Cylinders are required for Units 2 and 3 for 7 days simultaneous operation. There are 5 Nitrogen Cylinders installed to support Hardened Vent operation for Units 2 and 3. There are 6 Nitrogen Cylinder carts with 6 Nitrogen Cylinders on each cart available in the FLEX Storage building with no other committed use of them. This ISE Open Item was closed as documented in Reference 13.
13	Make available for NRC staff audit the seismic and tornado missile final design criteria for the HCVS stack.	Tornado and seismic missile criteria are located in the Primary Containment System (64A) Design Criteria Document (DCD). As part of ECP 71390 for Unit 2, a markup reflecting these changes was generated and the DCD was revised. This ISE Open Item was closed as documented in Reference 13.

Browns Ferry Nuclear Plant, Unit 2 HCVS Phase 1 ISE Open Items		Response
14	Provide a description of the final design of the HCVS to address hydrogen detonation and deflagration.	The final design of HCVS at BFN to address hydrogen detonation and deflagration is the installation of a check valve near the vent discharge release point. A description of this design is contained in the Technical Evaluation for ECP 71390 for Unit 2. This ISE Open Item was closed as documented in Reference 13.
15	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	The HCVS provides a direct vent path from the wetwell to an exhaust point above the Reactor Building Roof in accordance with NEI 13-02, Section 4.1.5. This is a leak tight system with no boundary valves outside the primary containment isolation valves (PCIVs) that would allow hydrogen gas migration and ingress into the Reactor Building or other buildings. Per NEI 13-02 Frequently Asked Question FAQ-04, an effluent release velocity of 8000 feet per minute will assure that the effluent plume will not be entrained into the roof recirculation zone of a given building. A description of this design is contained in the Technical Evaluation for ECP 71390 for Unit 2. This ISE Open Item was closed as documented in Reference 13.
16	Provide design details that minimize unintended cross flow of vented fluids within a unit and between units on the site.	The BFN design includes a separate HCVS stack for each unit as well as meeting the testing criteria and valve requirements for PCIVs and control and boundary valves. A description of this design is contained in the Technical Evaluation for 71390 for Unit 2. This ISE Open Item was closed as documented in Reference 13.

<table>
<tr><th colspan="2">Browns Ferry Nuclear Plant, Unit 2
HCVS Phase 2 ISE Open Items</th><th>Response</th></tr>
<tr><td>1</td><td>Licensee to perform a hydraulic evaluation to ensure flow adequacy can be met for all 3 units using 1 FLEX pump to support SAWA flow requirement.</td><td>Calculation MDN0003602014000233, Hydraulic Analysis for Fukushima FLEX Connection Modifications, was revised to include a bounding case that concluded that a single FLEX pump (with booster pump) can provide 500 gallons per minute (gpm) to Unit 2 RPV (each at RPV pressure of 106 psig) in response to a Severe Accident Water Addition (SAWA) event.

This ISE Open Item was closed as documented in Reference 13.</td></tr>
<tr><td>2</td><td>Licensee to evaluate the SAWA equipment and controls, as well as the ingress and egress paths for the expected severe accident conditions (temperature, humidity, radiation) for the sustained operating period.</td><td><u>Equipment and Controls</u>

Plant instrumentation for Severe Accident Water Management (SAWM) is qualified to NRC Regulatory Guide (RG) 1.97 or equivalent and is considered qualified for the sustained operating period without further evaluation. The following plant instruments are qualified to RG 1.97:

Drywell (DW) Pressure Indicators, 1,2,3-PI-64-67B, and Suppression Pool Level Indicators, 1,2,3-LI-64-159A.

Passive components that do not need to change state after initially establishing SAWA flow do not require evaluation beyond the first 8 hours, at which time they are expected to be installed and ready for use to support SAWA/SAWM.

The following additional equipment performing an active SAWA/SAWM function is considered:
• SAWA/SAWM flow instrument,
• SAWA/SAWM pump,
• FLEX generator, and
• SAWA throttle valve.

These components will be used at a remote location (outside Reactor Building) and have been evaluated for the environmental conditions applicable at those locations.

<u>Ingress and Egress</u>

For locations outside the Reactor Building between 7 hours and 7 days when SAWA is being utilized, BFN performed a qualitative evaluation of equipment and deployment locations and confirmed they are protected by distance and/or buildings with substantial shielding to minimize dose rates. A quantitative evaluation of expected dose rates, AREVA document 51-9262174-003, Projected Dose Rate Contour Map of Shine from the HCVS Vent Line Extending Above Refueling Floor (BFNP), has been performed per HCVS-WP-02 and found the dose rates at deployment locations including ingress/egress paths are acceptable.

This ISE Open Item was closed as documented in Reference 13.</td></tr>
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<table>
<tr><th colspan="2">Browns Ferry Nuclear Plant, Unit 2
HCVS Phase 2 ISE Open Items</th><th>Response</th></tr>
<tr><td>3</td><td>Licensee to demonstrate how SAWA flow is capable to perform its intended function for the sustained operating period under the expected temperature and radiological conditions.</td><td><u>Equipment and Controls</u>
Plant instrumentation for SAWA that is qualified to RG 1.97 or equivalent is considered qualified for the sustained operating period without further evaluation. The following plant instruments are qualified to RG 1.97:
DW Pressure Indicators, 1,2,3-PI-64-67B, and Suppression Pool Level Indicators, 1,2,3-LI-64-159A.
Passive components that do not need to change state after initially establishing SAWA flow do not require evaluation beyond the first 8 hours, at which time they are expected to be installed and ready for use to support SAWA/SAWM.
The following additional equipment performing an active SAWA/SAWM function is considered for temperature and radiation effects:
• SAWA/SAWM flow instrument,
• FLEX/SAWA pump,
• FLEX generator, and
• SAWA throttle valve.
<u>Temperature</u>
The location of SAWA equipment and controls that are the same or similar as FLEX will be bounded by the FLEX evaluations for temperature.
<u>Radiation</u>
For equipment locations outside the Reactor Building between 7 hours and 7 days when SAWA is being utilized, BFN performed a qualitative evaluation of equipment and deployment locations and confirmed they are protected by distance and/or buildings with substantial shielding to minimize dose rates. A quantitative evaluation of expected dose rates, AREVA document 51-9262174-003, Projected Dose Rate Contour Map of Shine from the HCVS Vent Line Extending Above Refueling Floor (BFNP), was performed per HCVS-WP-02, Sequences for HCVS Design and Method for Determining Radiological Dose from HCVS Piping, and found the dose rates at deployment locations are acceptable.
This ISE Open Item was closed as documented in Reference 13.</td></tr>
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<tr><th colspan="2">Browns Ferry Nuclear Plant, Unit 2
HCVS Phase 2 ISE Open Items</th><th>Response</th></tr>
<tr><td>4</td><td>Licensee to demonstrate that containment failure as a result of overpressure can be prevented without a drywell vent during severe accident conditions.</td><td>The wetwell vent has been designed and installed to meet NEI 13-02 Revision 1 guidance which will ensure that it is adequately sized to prevent containment overpressure under severe accident conditions.
The SAWM strategy will ensure that the wetwell vent remains functional for the period of sustained operation. BFN will follow the guidance (flow rate and timing) for SAWA/SAWM described in BWROG-TP-15-008, SAWA Timing, and BWROG-TP-15-011, SAWM Supporting Evaluations. The wetwell vent will be opened prior to exceeding the Primary Containment Pressure Limit value of 62 psig. Therefore, containment over pressurization is prevented without the need for a drywell vent.
This ISE Open Item was closed as documented in Reference 13.</td></tr>
<tr><td>5</td><td>Licensee to 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.</td><td>Using Figure 2.1.C from the combined Phase 1 and 2 OIP, compare the reference plant parameters to the plant specific parameters.
<table>
<tr><th>Reference Plant</th><th>Browns Ferry Nuclear Plant</th></tr>
<tr><td>Torus freeboard volume is 525,000 gallons</td><td>Torus freeboard volume is 757,544 gallons</td></tr>
<tr><td>SAWA flow is 500 gpm at 8 hours followed by 100 gpm from 12 hours to 168 hours</td><td>SAWA flow is 500 gpm at 8 hours followed by 100 gpm from 12 hours to 168 hours</td></tr>
<tr><td colspan="2">The above parameters for BFN compared to the reference plant that determine success of the SAWM strategy demonstrate that the reference plant values are bounding. Therefore, the SAWM strategy implemented at BFN makes it unlikely that a DW vent is needed to prevent containment overpressure related failure.</td></tr>
</table>
This ISE Open Item was closed as documented in Reference 13.</td></tr>
<tr><td>6</td><td>Licensee to demonstrate that there is adequate communication between the MCR and the operator at the FLEX pump during severe accident conditions.</td><td>BFN utilizes the Harris Radio System to communicate between the MCR and the operator at the FLEX pump. This communication method is the same as accepted in Order EA-12-049. These items will be powered and remained powered using the same methods as evaluated under EA-12-049 and continued for the period of sustained operation.
This ISE Open Item was closed as documented in Reference 13.</td></tr>
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MILESTONE SCHEDULE - ITEMS COMPLETE

Milestone	Target Completion Date	Activity Status	Comments
Submit Phase 1 Overall Integrated Plan	June 2014	Complete	
Submit Phase 2 Overall Integrated Plan	December 2015	Complete	
Submit 6 Month Updates:			
Update 1	December 2014	Complete	
Update 2	June 2015	Complete	
Update 3	December 2015	Complete	Simultaneous with Phase 2 OIP
Update 4	June 2016	Complete	
Update 5	December 2016	Complete	
Update 6	June 2017	Complete	
Update 7	December 2017	Complete	
Update 8	June 2018	Complete	
Update 9	December 2018	Complete	

Phase 1 Specific Milestones			
Phase 1 Modifications:			
Hold preliminary/conceptual design meeting	November 2014	Complete	
Unit 2 Design Engineering On-site/Complete	December 2016	Complete	
Unit 2 Implementation Outage	March 2017	Complete	
Unit 2 Walk Through Demonstration/Functional Test	April 2017	Complete	
Phase 1 Procedure Changes			
Operations Procedure Changes Developed	July 2016	Complete	
Site Specific Maintenance Procedure Developed	July 2016	Complete	
Procedure Changes Active	November 2016	Complete	
Phase 1 Training:			
Training Complete	September 2016	Complete	
Phase 1 Completion			
Unit 2 HCVS Implementation	April 2017	Complete	

Phase 2 Specific Milestones			
Phase 2 Modifications:			
Milestone	Target Completion Date	Activity Status	Comments
Hold preliminary/conceptual design meeting	January 2017	Complete	
Unit 2 Design Engineering On-site/Complete	May 2018	Complete	
Unit 2 Walk Through Demonstration/Functional Test	April 2019	Complete	
Unit 2 Implementation Outage	April 2019	Complete	
Phase 2 Procedure Changes			
Operations Procedure Changes Developed	March 2018	Complete	
Site Specific Maintenance Procedure Developed	March 2018	Complete	
Procedure Changes Active	March 2018	Complete	
Phase 2 Training:			
Training Complete	March 2018	Complete	
Phase 2 Completion			
Unit 2 HCVS Implementation	April 2019	Complete	
Submit Unit 2 Phase 1 and 2 Completion Report	June 2019	Complete with this submittal	

ORDER EA-13-109 COMPLIANCE ELEMENTS SUMMARY

The elements identified below for BFN, Unit 2, as well as the HCVS Phase 1 and Phase 2 OIP (Reference 5), the 6-Month Status Reports (References 3-10, and 14) and additional docketed correspondence demonstrate compliance with Order EA-13-109.

HCVS PHASE 1 AND PHASE 2 FUNCTIONAL REQUIREMENTS AND DESIGN FEATURES – COMPLETE

The BFN, Unit 2, Phase 1 HCVS provides a vent path from the wetwell 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 alternating current power.

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

HCVS PHASE 1 AND PHASE 2 QUALITY STANDARDS – COMPLETE

The design and operational considerations of the Phase 1 and Phase 2 HCVS installed at BFN, Unit 2, comply with the requirements specified in the Order and described in NEI 13-02, Revision 1, "Industry Guidance for Compliance with Order EA-13-109." NEI-13-02, Revision 1, was endorsed, in part, by the NRC's Japan Lessons-Learned Project Directorate (JLD) Interim Staff Guidance (ISG), JLD-ISG-2015-01, Revision 0, as an acceptable means for implementing the requirements of Order EA-13-109 (Reference 15). 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. All 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.

HCVS PHASE 1 AND PHASE 2 PROGRAMMATIC FEATURES - COMPLETE

Storage of portable equipment for BFN, Unit 2, 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 BFN, Unit 2, has been completed in accordance with an accepted training process as recommended in NEI 13-02, Revision 1, Section 6.1.3.

Operating and maintenance procedures for BFN, Unit 2, have been developed and integrated with existing procedures to ensure safe operation of the Phase 1 and Phase 2 HCVS. Procedures have been verified and are available for use in accordance with the site procedure control program.

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 6.1.2 and 6.2.

BFN, Unit 2, 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 Phase 2 OIP for Order EA-13-109 (Reference 5).

BFN, Unit 2, 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.

REFERENCES:

The following references support the BFN, Unit 2, compliance with the requirements of Order EA-13-109:

1. NRC Order Number EA-13-109, “Issuance of Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions,” dated June 6, 2013 (ML13143A321).

2. Letter from TVA to NRC, “Tennessee Valley Authority’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 (Order Number EA-13-109),” dated June 30, 2014 (ML14181B169)

3. Letter from TVA to NRC, “Tennessee Valley Authority's Browns Ferry Nuclear Plant First Six-Month Status Report in Response to the 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 (ML14353A428)

4. Letter from TVA to NRC, “Tennessee Valley Authority's Browns Ferry Nuclear Plant Second Six-Month Status Report in Response to the 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, 2015 (ML15181A338)

5. Letter from TVA to NRC, “Tennessee Valley Authority's Browns Ferry Nuclear Plant Third Six-Month Status Report and Phase 1 and Phase 2 Overall Integrated Plan in Response to the 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 29, 2015 (ML15365A554)

6. Letter from TVA to NRC “Tennessee Valley Authority’s Browns Ferry Nuclear Plant Fourth Six-Month Status Report in Response to the 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 30, 2016 (ML16182A517)

7. Letter from TVA to NRC “Tennessee Valley Authority Browns Ferry Nuclear Plant’s Fifth Six-Month Status Report in Response to the 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 (ML16357A577).

8. Letter from TVA to NRC “Tennessee Valley Authority Browns Ferry Nuclear Plant’s Sixth Six-Month Status Report in Response to the 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 30, 2017 (ML17181A333).

9. Letter from TVA to NRC “Tennessee Valley Authority Browns Ferry Nuclear Plant’s Seventh Six-Month Status Report in Response to the 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 20, 2017 (ML17354A250).

10. Letter from TVA to NRC “Tennessee Valley Authority Browns Ferry Nuclear Plant’s Eighth Six-Month Status Report in Response to the 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, 1018 (ML18179A139).

11. Letter from NRC to TVA, “Browns Ferry Nuclear Plant, Units 1, 2, and 3 - Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Phase 1 of Order EA-13-109 (Severe Accident Capable Hardened Vents) (TAC Nos. MF4540, MF4541, and MF4542),” dated February 11, 2015 (ML14356A362)

12. Letter from NRC to TVA, “Browns Ferry Nuclear Plant, Units 1, 2, and 3 - Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Phase 2 of Order EA-13-109 (Severe Accident Capable Hardened Vents) (CAC Nos. MF4540, MF4541, and MF4542),” dated September 6, 2016 (ML16244A762)

13. Letter from NRC to TVA, “Browns Ferry Nuclear Plant, Units 1, 2, and 3 - 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 (CAC Nos. MF4540, MF4541, and MF4542; EPID L-2014-JLD-0044),” dated February 21, 2018 (ML18038B606)

14. Letter from TVA to NRC, “Tennessee Valley Authority Browns Ferry Nuclear Plant’s Ninth Six-Month Status Report in Response to the 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 27, 2018 (ML18361A801)

15. NRC Interim Staff Guidance 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," Revision 0, dated April 29, 2015 (ML15104A118)

ENCLOSURE 2

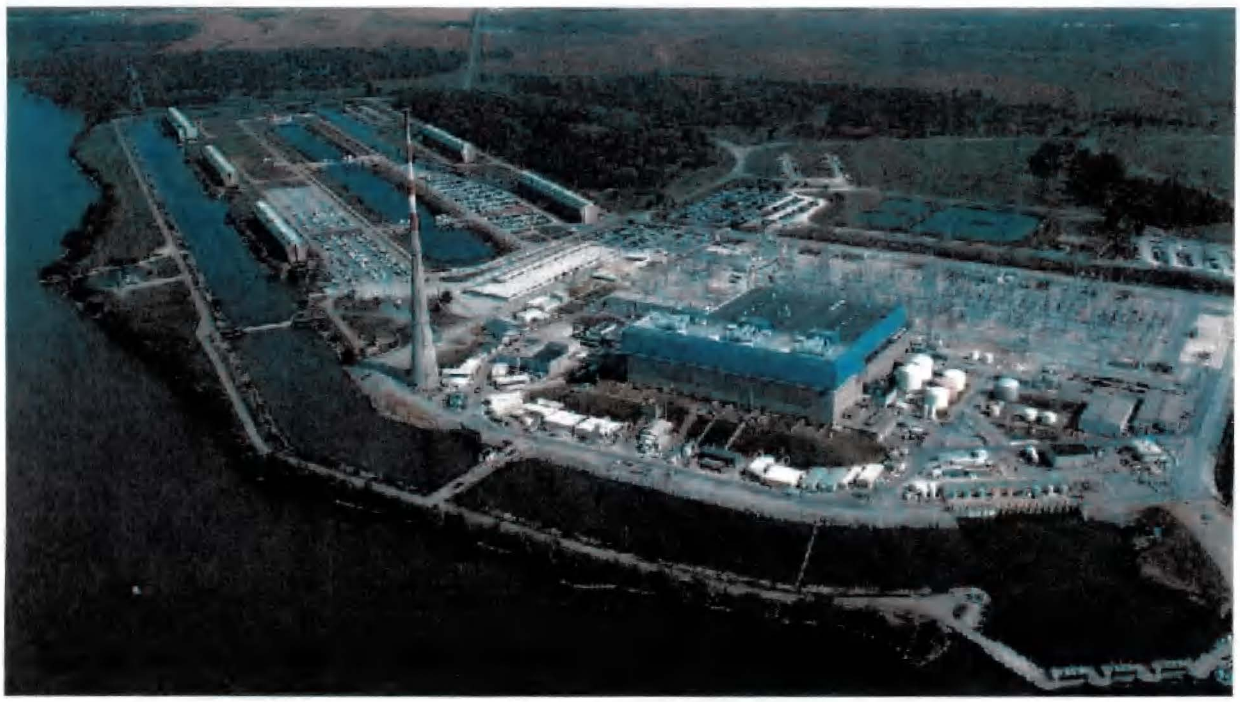
Tennessee Valley Authority, Browns Ferry Nuclear Plant, Reliable Hardened Containment Vents Capable of Operation Under Severe Accidents, Final Integrated Plan

CNL-19-004

Tennessee Valley Authority
Browns Ferry Nuclear Plant

Reliable Hardened Containment Vents Capable of Operation Under Severe Accidents

Final Integrated Plan



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Name Date

Revision 0

April 8, 2019

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Section I: Introduction

In 1989, the NRC issued Generic Letter 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 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 Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accidents, June 6, 2013 (Reference 5). The Order (EA-13-109) 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 ELAP.

BFN is required by NRC Order EA-13-109 to have a reliable, severe accident capable HCVS. Order EA-13-109 allows implementation of the HCVS Order in two phases.

- Phase 1 upgraded the venting capabilities from the containment wetwell to provide reliable, severe accident capable hardened vent to assist in preventing core damage and, if necessary, to provide venting capability during severe accident conditions. BFN achieved Phase 1 compliance on April 1, 2018.
- Phase 2 provided additional protections for severe accident conditions through the development of a reliable containment venting strategy that makes it unlikely that BFN would need to vent from the containment drywell during severe accident conditions. BFN achieved Phase 2 compliance on April 8, 2019.

NEI developed guidance for complying with NRC Order EA-13-109 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 contained guidance for compliance with both Phase 1 and Phase 2 of the order. NEI 13-02, Revision 1 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 NEI 13-02 Revision 1 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 the order, BFN submitted a phase 1 OIP in June of 2014 (Reference 18) and subsequently submitted a combined Phase 1 and 2 OIP in December 2015 (Reference 19). These OIPs followed the guidance in NEI 13-02 Revision 0 and 1 respectively, Compliance with Order EA-13-109, Severe Accident Reliable Hardened Containment Vents. 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, BFN conforms to NEI 13-02 Revision 1 for both Phases of Order EA-13-109.

The NRC performed a review of each OIP submittal and provided BFN with 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 progress reports (References 22 through 30) 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 the E-Portal were used by the NRC staff to determine whether the ISE Open Item appeared to be addressed.

By submittal of this FIP, BFN 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-FAQs and HCVS-WPs documents. In addition, the site has addressed the NRC Phase 1 and Phase 2 ISE Open Items as documented in 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 (Reference 39).

Section III contains the BFN FIP details for Phase 1 of the Order. Section IV contains the FIP 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 MCR or ROS at the appropriate time based on procedural guidance in response to plant conditions from observed or derived symptoms.

- The vent utilizes containment parameters of pressure and level from the MCR instrumentation to monitor effectiveness of the venting actions.
- The vent operation is monitored by HCVS valve position, temperature and effluent radiation levels.
- The HCVS motive force 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 7 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 BFN are seismic, external flooding, high winds, extreme high temperature, and extreme cold. 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 one-line diagram of the HCVS vent flowpath.

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

The Phase 2 actions can be summarized as follows:

- Utilization of SAWA to initially inject water into the RPV.
- Utilization of 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 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 limits for ERO dose or plant safety guidelines for temperature and humidity.

The SAWA flowpath is the same as the FLEX primary injection flowpath with the modification that the hose run inside the RB was replaced with hard piping. The flowpath will be from the FLEX suction in the Tennessee river through a FLEX pump with 3 outlets with individual flow indicators (one for each unit). Flow will be monitored that is provided to the Containment Integrated Leak Rate Test (CILRT) connection in each Unit. The water will pass through the CILRT connection to Condensate Storage and Supply line into either Loop of the Core Spray System. Flow will then be directed into the RPV via the Core Spray injection valves. Drywell pressure and Suppression Pool level will be monitored and flow rate will be adjusted by use of the FLEX pump control valve at the SA-A1 staging area. Communication is established between the MCR and the FLEX pump location. Attachment 4 contains a one-line diagram of the SAWA flowpath.

Motor Operated Valves will be powered from the FLEX DGs connected in the Electrical Board Rooms located in the CB as described in the EA-12-049 compliance documents.
The FLEX DGs are located near the DGB, which is away from the discharge of the HCVS. In the event of an ELAP due to a flood then the FLEX DGs will be located and connected in accordance with EA-12-049 Mitigation Strategies for Beyond-Design Basis External Events response, dated August 28, 2015. See Attachment 6 for applicable locations. Refueling of the FLEX DG is accomplished from the plant diesel generator 7 Day Tanks as described in the EA-12-049 FIP.

Evaluations for projected SA conditions (radiation/temperature) indicate that personnel can complete the initial and support activities without exceeding the ERO-allowable dose for equipment operation or site safety standards.

Electrical equipment and instrumentation is powered from the existing Unit batteries, and from AC distribution systems that are powered from the FLEX DGs. The battery chargers are also powered from the FLEX DG to maintain the battery capacities during the Sustained Operating period.

Section II: List of Acronyms

AC	Alternating Current
BDBEE	Beyond Design Basis External Event
BFN	Browns Ferry Nuclear Plant
BWROG	Boiling Water Reactor Owners' Group
CAD	Containment Atmospheric Dilution System
CAP	Containment Accident Pressure
CB	Control Bay
CST	Condensate Storage Tank
DC	Direct Current
DG	Diesel Generator
DGB	Diesel Generator Building
ECCS	Emergency Core Cooling Systems
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
F	Degrees Fahrenheit
FAQ	Frequently Asked Question
FIP	Final Integrated Plan
FLEX	Diverse & Flexible Coping Strategy
FESB	FLEX Equipment Storage Building
GPM	Gallons per minute
HCVS	Hardened Containment Vent System
HWWV	Hardened Wetwell Vent
ISE	Interim Staff Evaluation
ISG	Interim Staff Guidance
JLD	Japan Lessons Learned Project Directorate
MAAP	Modular Accident Analysis Program
MCR	Main Control Room
N2	Nitrogen
NEI	Nuclear Energy Institute
NPSH	Net Positive Suction Head
NRC	Nuclear Regulatory Commission
OIP	Overall Integrated Plan
PCIV	Primary Containment Isolation Valve
PCPL	Primary Containment Pressure Limit
PSIG	Pounds per Square Inch - Gauge
RB	Reactor Building
RCIC	Reactor Core Isolation Cooling System
RM	Radiation Monitor
ROS	Remote Operating Station
RPV	Reactor Pressure Vessel
RWCU	Reactor Water Cleanup
SA	Severe Accident
SAMG	Severe Accident Management Guidelines
SAWA	Severe Accident Water Addition
SAWM	Severe Accident Water Management
SBGT	Standby Gas Treatment System
SFP	Spent Fuel Pool
SRV	Safety-Relief Valve
UFSAR	Updated Final Safety Analysis Report
VAC	Voltage AC
VDC	Voltage DC

Section III: Phase 1 Final Integrated Plan Details

Section III.A: HCVS Phase 1 Compliance Overview

BFN modified the existing hardened wetwell vent path installed in response to NRC Generic Letter 89-16 to comply with NRC Order EA-13-109.

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

BFN installed a HWWV for all three units under Plant Modifications DCN W17930A for Unit 1, DCN W17491A for Unit 2, DCN W17931A for Unit 3, and DCN W17337A for Common Header in response to NRC Generic Communication GL 89-16. HWWV is part of Primary Containment System 64A and as such is described in Primary Containment Design Criteria Document BFN-50-7064A. HWWV provides a direct vent path from the wetwell (also referred to as the torus) to an exhaust point inside the concrete portion of the existing plant stack above elevation 666.5 feet. The HWWV flowpath utilizes a 14 inch line which taps off of the 20 inch torus vacuum breaker piping at RB elevation 565 feet. Two 14 inch pneumatically operated butterfly valves (FCV-064-0221 and FCV-064-0222) are located within the section of HWWV piping inside the RB. The HWWV penetrates the RB wall along column line U at a location approximately 6 feet east of column line R10 as shown on TVA drawing 0-17E401-11.

After exiting the RB, the pipe ties into a common header before heading to the existing vent stack. Manual valve SHV-064-0737 and associated position indication is located in the 14-inch section of piping just outside the RB in an underground valve pit south of column line U. Manual valve SHV-064-0737 serves to isolate the specific Unit HWWV from the common header and the associated position indication provides readout inside the specific MCR. The HWWV valves (FCV-064-0221 and FCV-064-0222) are equipped with key lock isolation signal override switches to allow bypass of the containment isolation signal to allow venting during a loss of containment heat removal event and to prevent inadvertent operation. The HWWV is not adequate to satisfy NRC Order EA-13-109 guidance including the new requirements for Unit separation, effluent release point, the need to address flammable gasses, and requirements to function during a severe accident. However, portions of the system interior to the RB and up to manual valve SHV-064-0737 are adequate for reuse.

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

The EA-13-109 compliant HCVS system utilizes the portion of the GL-89-16 wetwell vent system up to 1,2,3-SHV-064-0737. The vent system is initiated, operated and monitored from the MCR using the switches described above. A ROS has been installed in a readily accessible location and provides a means to manually operate the wetwell vent. The controls available at the ROS are accessible and functional under a range of plant conditions, including severe accident conditions. The ROS locations are in the DGBs. Table 2 contains the evaluation of the acceptability of the ROS location with respect to severe accident conditions.

The final HCVS utilization does not contain any new electrical circuitry for bypassing isolation signals. The ROS opens the valves directly with compressed nitrogen so that no electrical signal overrides are needed.

The MCR is the primary operating station for the HCVS. During an ELAP, electric power to operate the vent valves can be provided by the HCVS batteries with a capacity to supply required loads for at least the first 24 hours. Normally the Unit Batteries will provide electrical power for operation of the vent valves. Before the Unit batteries are depleted, the FLEX DG will supplement and recharge batteries to support operation of the vent valves. The ROS is designated as the alternate control location and method. Since the ROS does not require any electrical power to operate, the valve solenoids do not need any additional backup electrical power. Attachment 2 shows the HCVS vent flowpath.

At the MCR location, the operators can operate the HCVS isolation valves, monitor HCVS vent valve position, drywell pressure, and torus level. The indicators for the HCVS Radiation Monitor and vent pipe temperature are located in the MCR. The ROS consists of manual valves that directly port nitrogen to the actuators of the HCVS isolation valves. Backup nitrogen pressure is available at the ROS. Table 1 contains a complete list of instruments available to the operators for operating and monitoring the HCVS.

The hardened vent radiation monitor uses a 24 VDC input power which is normally powered from 250V Reactor Motor Operated Valve Board B. If required the hardened vent radiation monitor can be powered from the HCVS battery via Instrument Transfer Switch 1,2,3-XSW-064-0006.

Attachment 3 contains a one-line block diagram of the HCVS electrical distribution system.

The wetwell 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. The hardened vent piping between the wetwell and the RB roof is designed to 62 psig at 350F.

HCVS features to prevent inadvertent actuation include a key lock switch at the primary control station and closed valves at the ROS which is an acceptable method of preventing inadvertent actuation per NEI 13-02.

As required by EA-13-109, Section 1.2.11, the wetwell vent is designed to prevent air/oxygen backflow into the discharge piping to ensure the flammability limits of hydrogen, and other non-condensable gases, are not reached. BFN design includes a check valve near the end of the vent pipe. Guidance for this design is contained in HCVS-WP-03. The relevant design calculations conclude that the check valve will preclude a flammable mixture from occurring in the vent pipe.

The HCVS radiation monitor with an ion chamber detector is qualified for the ELAP and external event conditions. In addition to the radiation monitor (RM), a temperature 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 harsh environmental conditions (although they are not considered part of the site EQ program).

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

The functional requirements of Phase 1of NRC Order EA-13-109 are outlined below along with an evaluation of the BFN response to maintain compliance with the Order and guidance from JLD-ISG-2015-01. Due to the difference between NEI 13-02, Revision 0 and Revision 1, only Revision 1 will be evaluated. Per JLD-ISG-2015-01, this is acceptable as Revision 1 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 35), 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 remote manual actions performed by plant personnel to open the HCVS vent path is in the following table:

Table 3-1: HCVS Operator Actions

Primary Action	Primary Location/ Component	Notes
1. Verify that Primary Containment Isolation Valves (PCIVs) are closed: FCV-64-18, 19, 20, 21 FSV 84-8B & 8C FCV 76-19 & 24	Indicating lights located in the MCR	
2. Disable PCIV keylock switch if required.	PCIV keylock switch located in the MCR.	Reference EOI Appendix 13
3. Verify that power supplies for all valves and instruments can be supplied by dedicated batteries	Instruments and controls located in the MCR	A 24 hour supply of power will be available to the HCVS. After 24 hours of operation the portable generators may be aligned to supply power to the HCVS.
4. Verify that the pneumatic supply to the CIVs required for service is operable and aligned with replaceable nitrogen bottles.	Nitrogen bottles are located in an area that is accessible to operators, near the ROS located in the associated DGB.	Prior to depletion of the pneumatic sources actions will be required to connect back-up sources at a time greater than 24 hours.
5. Open Wetwell PCIVs FCV-64-221 & 222..	Hand switches located in the MCR panel	Hand switches are also located at the ROS by operation of manual valves.

Permanently installed electrical power and pneumatic supplies are available to support operation and monitoring of the HCVS for a minimum of 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 DGs and nitrogen 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. These were identified in the OIP and subsequent NRC ISE.

Table 3-2: Failure Evaluation

Functional Failure Mode	Failure Cause	Alternate Action	Failure with Alternate Action Impact on Containment
Failure of Vent to Open on Demand	Valves fail to open/close due to loss of normal AC power	No action needed, power is already tied into Unit Battery for 8 hours maximum	No
Failure of Vent to Open on Demand	Valves fail to open/close due to loss of normal DC power (long term)	Connect dedicated batteries via transfer switch for minimum 24 hours	No
Failure of Vent to Open on Demand	Valves fail to open/close due to complete loss of batteries (long term)	Recharge Unit Batteries with FLEX provided generators, 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	No action needed, N2 can be supplied by nitrogen tanks, which is sufficient for greater than 8 cycles of FCV-064-0222 valve over first 24 hours	No
Failure of Vent to Open on Demand	Valves fail to open/close due to loss of alternate pneumatic air supply (long term)	Tie-in nitrogen cylinders to N2 system supporting HCVS valves, replace bottles as needed.	No
Failure of Vent to Open on Demand	Valves fail to open/close due to SOV failure	Use nitrogen supply from the ROS that is located in the DGB.	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 Main Control Room. Alternate control of the HCVS is accomplished from the ROS which are located in the DGBs. FLEX actions that will maintain the MCR and ROS habitable were implemented in response to NRC Order EA-12-049 (Reference 36).

These include:

1. Restoring MCR ventilation via the FLEX DG. MCR ventilation was included as a load in the 480 Volt FLEX DG sizing calculations and is acceptable.
2. Opening CB doors to the outside.
3. Operating portable DGs and fans to move outside air through the MCR (if required).
4. Opening doors in the RB to establish natural circulation air flow in the RB.

Table 2 contains a thermal evaluation of all the operator actions that may be required to support HCVS operation. The relevant calculations (References 32 and 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 MCR. Under the postulated scenarios of order EA-13-109 the MCR is adequately protected from excessive radiation dose and no further evaluation of its use is required. (Ref. HCVS-FAQ-06)

Alternate control of the HCVS is accomplished from the ROS. The ROS was evaluated for radiation effects due to a severe accident and determined to be acceptable. The ROSs is located in the Unit 1/2 and Unit 3 DGBs, which similar to the MCR, is also protected from environmental conditions related to operation of HCVS. The Unit 1/2 DGB is located on the west side of the Unit 1 RB. The Unit 3 DGB is located on the east side of the Unit 3 RB. The ROS is located on the northern side of the Unit 1/2 and Unit 3 DGBs at elevation 583 feet. The wall which separates the Unit 1/2 and Unit 3 DGBs from the Unit 1 and Unit 3 RBs provides shielding for the ROSs. The vent location is located along the RBs southern wall. Based on these locations, the distance from the HCVS vent line to the ROSs is approximately the same as that of the MCR. The described characteristics for the ROS location ensure that the ROSs will meet habitability requirements for operation of the HCVS.

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. If venting operations create the potential for airborne contamination in the MCR, the 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, and inadequate containment cooling.

Evaluation:

Primary control of the HCVS is accomplished from the MCR. Under the postulated scenarios of order EA-13-109 the MCR is adequately protected from excessive radiation dose and no further evaluation of its use is required (HCVS-FAQ-06).

Alternate control of the HCVS is accomplished from the ROS located in the Unit 1/2 and Unit 3 DGBs. The ROS located in the Unit 1/2 and Unit 3 DGBs are in an area evaluated to be accessible before and during a severe accident.

For ELAP with injection, the HCVS wetwell vent will be opened to protect the containment from overpressure. The operator actions and timing of those actions to perform this function under ELAP conditions were evaluated as part of BFN response to NRC Order EA-12-049 as stated in Reference 41 (BFN SER).

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 calculation (Reference 34) 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 Calculation NDQ0000642015000341 contains the verification of 1 percent power flow capacity at design pressure (62 psig). A MAAP analysis was performed in BFN Calculation NDQ0000642015000341 which validates that BFN's suppression pool is capable of absorbing the decay heat generated for the first 3 hours following a shutdown using decay heat values associated with the uprated thermal power value of 3952 MWth. In addition MAAP generates mass flow rates based on a range of assumed discharge coefficients in order to show that the as-designed HCVS can relieve the effects of decay heat during the transient. BFN Calculation NDQ0010642015000342 for Unit 1, NDQ0020642015000400 for Unit 2 and NDQ0030642015000399 for Unit 3 performs a Gothic analysis to determine flow rates and the actual discharge coefficients for the HCVS piping configuration based on set wetwell pressures. Once determined the actual discharge coefficient was verified to be within the range specified by MAAP in BFN Calculation NDQ0000642015000341. MAAP ultimately concludes the chosen vent size is adequate to maintain primary containment temperatures and pressures below 350F and 62 psig while venting steam/energy equivalent to one percent of the planned extended uprated thermal power. In making this conclusion, MAAP considers both the successful implementation of FLEX as well as early and latent failures of the Reactor Core Isolation Cooling System (RCIC) which results in a severe accident. Severe accident scenarios considered by MAAP include scenarios where core debris is cooled in the reactor vessel and external to the reactor vessel.

The decay heat absorbing capacity of the suppression pool and the selection of venting pressure were made such that the HCVS will have sufficient capacity to maintain containment pressure at or below the lower of the containment design pressure (56 psig) or the PCPL (62 psig).This calculation of containment response is contained in HCVS MAAP Analysis NDQ0000642015000341 that was submitted in Reference 39 for Phase 1 ISE Open Item 5 and which shows that containment is maintained below the design pressure once the vent is opened.

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

Evaluation :The wetwell vent exits the Primary Containment by using portions of the original HWWV piping inside the Unit 1, 2, 3 RB while portions downstream of 1,2,3-SHV-064-0737 are abandoned in place. 1,2,3-SHV-064-0737 and associated position indication equipment are permanently removed as the only function for 1,2,3-SHV-064-0737 was to isolate the Unit from the common HWWV header. Operation of the HCVS will utilize existing PCIVs

1,2,3-FCV-064-0221 and 1,2,3-FCV-064-0222. The portion of piping downstream of 1,2,3-SHV-064-0737 which ties to the common header was cut as close as possible to the penetration at the south wall of the Unit 1 valve pit and welded shut. As noted, piping upstream of 1,2,3-SHV-064-0737 is reused. New HCVS piping elbows up at the flange upstream of 1,2,3-SHV-064-0737 traveling vertically up the exterior wall of the Unit 1, 2, 3 RB. All new HCVS piping is 14 inches schedule 40 while the existing HWWV piping is 14 inches schedule 30. The piping continues up the exterior wall of the Unit 1, 2, 3 RB until it reaches approximate elevation 665 feet where it turns to penetrate the siding of the Unit 1, 2, 3 RB superstructure. Once inside the superstructure the piping continues vertically until it penetrates the roof of the superstructure, ultimately terminating at approximate elevation 741 feet and 6 inches. The system is designed to preclude Hydrogen/Carbon Monoxide detonation by placement of a vent discharge check valve at the approximate elevation of the Unit 1, 2, 3 RB roof. The potential for lightning strike is mitigated through the installation of a lightning protection device installed on the HCVS piping near the vent release point.

A number of alternate routings were assessed and Part of the HCVS-FAQ-04 guidance is designed to ensure that vented fluids are not drawn immediately back into any emergency ventilation intakes. Such ventilation intakes should be below a level of the pipe by 1 foot for every 5 horizontal feet. The chosen release point is situated away from the MCR ventilation system intake and exhaust openings. Therefore, the vent pipe is appropriately placed relative to this air intake.

The vent pipe extends approximately 3 feet 6 inches above the existing vent tower elevation of 738 feet, the highest existing elevation of the RB roof. This satisfies the guidance for height from HCVS-FAQ-04.

HCVS-WP-04 provides criteria that demonstrate robustness of the HCVS pipe. BFN meets all the requirements of this white paper. This evaluation documents that the HCVS pipe is adequately protected from all external events and no further protection is required.

BFN evaluated the vent pipe robustness with respect to wind-borne missiles against the requirements contained in HCVS-WP-04. This evaluation demonstrated that the pipe was robust with respect to external missiles per HCVS-WP-04 in that:

1. For the portions of exposed piping below 30 feet above grade, The various BFN site areas were reviewed for their potential to create missiles ,defined by NRC Regulatory Guide 1.76 Revision 1, dated March 2007, which may strike unprotected HCVS piping and components located less than 30 feet above grade. The review was performed to validate the first assumption from NEI White Paper HCVS-WP-04. It has been determined that it is not credible that any tornado borne commodities within the scope of the first assumption will strike and jeopardize function of the HCVS. This review and conclusions are documented in BFN White Paper “Validation of NEI White Paper HCVS-WP-04 First Assumption for Missile Protection of Hardened Containment Vent System at BFN.”
2. The exposed piping greater than 30 feet above grade has the following characteristics:
   a. The total vent pipe exposed area is not in excess of 250 square feet (ft^2) which results in a potential missile target area less than the 300 ft^2 limit specified in HCVS-WP-04.
   b. The pipe is made of schedule 40 carbon steel and is not plastic and the pipe components have no small tubing susceptible to missiles
   c. There are no obvious sources of missiles located in the proximity of the exposed HCVS components.
3. BFN 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. Hurricanes are not screened for BFN.

Based on the above description of the vent pipe design, the BFN 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

The HCVS for Units 1, 2 & 3 are fully independent of each other. Therefore, the status at each unit is independent of the status of the other unit.

Since design conditions associated with the beyond design basis event do not have to be included or considered in design basis calculations and the design is not required to exceed the current capability of the limiting containment components (NRC Order EA-13-109, Ref. 4.1.4), the PCIV design conditions are acceptable for the HCVS. The valves that are considered PCIVs and are associated with the HCVS are listed below:

- 1,2,3-FCV-064-0019
- 1,2,3-FCV-064-0020
- 1,2,3-FCV-064-0021
- 1,2,3-FCV-064-0221 (Note, this valve has been evaluated for the increased HCVS design conditions because it is in the vent flowpath, see Section 6.4.7)
- 1,2,3-FCV-064-0222 (Note, this valve has been evaluated for the increased HCVS design conditions because it is in the vent flowpath, see Section 6.4.7)
- 1,2,3-FSV-084-0008B
- 1,2,3-FSV-084-0008C
- 1,2,3-FSV-076-0019

Boundary valves design temperature and pressures were evaluated against the HCVS design pressure (62 psig) and temperature (350F) to determine if the boundary valve can remain closed during HCVS operation. The identified boundary valves are acceptable for HCVS service and will remain closed as required. Other components directly interfacing with the HCVS pressure boundary have been evaluated and determined to be capable of maintaining the pressure boundary at HCVS design conditions.

Based on the above description, the BFN design meets the requirements to minimize unintended cross-flow of vented fluids within a unit and between units on site.

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.

<u>Evaluation</u>

The existing wetwell vent will allow initiating and then operating and monitoring from a control panel located in the MCR.

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.

<u>Evaluation</u>

To meet the requirement for an alternate means of operation, a readily accessible alternate location, called the ROS was added. The ROS contains manually operated valves that supply pneumatics to the HCVS flowpath valve actuators so that these valves may be opened without power to the valve actuator solenoids and regardless of any containment isolation signals that may be actuated. This provides a diverse method of valve operation therefore improving system reliability.

The location for the ROS is in the Unit 1/2 and Unit 3 DGBs, which similar to the MCR, is also protected from environmental conditions related to operation of HCVS.

Refer to the sketch provided in Attachment 6 for the HCVS site layout. The controls available at the ROS location are accessible and functional under a range of plant conditions, including severe accident conditions with due consideration to source term and dose impact on operator exposure, extended loss of AC power (ELAP), inadequate containment cooling, and loss of RB ventilation. Table 1 contains an evaluation of all the required 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 all 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.

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 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.

The FLEX DGs will start and load, thus there will be no need to use other power sources for HCVS wetwell venting components during the first 24 hours. However, this order element does not allow crediting the FLEX DGs for HCVS wetwell venting components until after 24 hours.

Therefore, backup electrical power required for operation of HCVS components in the first 24 hours will come from a dedicated HCVS Battery. These batteries are permanently installed where they are protected from screened in hazards, and have sufficient capacity to provide this power without recharging. Unit 1 Calculation EDQ0010642015000349, “Unit 1 HCVS Electrical Design and Equipment Sizing Analysis,” and Unit 2/3 EDQ0000642016000510, “Unit 2 and 3 HCVS Electrical Design and Equipment Sizing Analysis,” demonstrated that the HCVS battery capacity is sufficient to supply HCVS wetwell venting components for 24 hours. At 24 hours, FLEX DGs can be credited to repower the battery charger to recharge the Unit 250V batteries, gas control during recharging and room temperature control is per the response to order EA-12-049. Calculation EDQ0003602015000325, “Electrical Evaluation for 4kV FLEX Turbine Generators,” included the 250VDC battery chargers in the FLEX DG loading calculation, so there is no additional load on the FLEX DG and they are capable of carrying HCVS wetwell venting components electrical loads. Attachment 3 contains a block diagram of the HCVS electrical distribution system.

Pneumatic power for the HCVS valve actuators is normally provided by the Control Air System and with backup nitrogen provided from the CAD system. Following an ELAP event, and the loss of Control Air and CAD systems, a backup nitrogen system is provided with installed nitrogen bottles to provide operating pneumatics to the Hardened Containment Vent Valves. Therefore, for the first 24 hours post-ELAP initiation, pneumatic force will be supplied from the installed nitrogen backup system bottle racks located in the DGBs. Calculation MDQ0000322015000347 demonstrated that these installed bottles have the capacity to supply the required motive force to those HCVS valves needed to maintain flow through the HCVS effluent piping for 24 hours without replenishment.

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

Evaluation

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 CAP that would provide net positive suction head to the 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.

The containment isolation valves must be open to permit vent flow. The physical features that prevent inadvertent actuation are the key lock switch for Hardened Containment Vent valves at the primary control station and closed valves at the ROS. These design features meet the requirement to prevent inadvertent actuation of HCVS.

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 HCVS valve position, vent pipe temperature and effluent radiation levels in the MCR, as well as information on the status of supporting systems. which are nitrogen pressure indication at the ROS.

This monitoring instrumentation provides the indication from the MCR per Requirement 1.2.4. In the event that the FLEX DGs do not energize the emergency buses, the HCVS and required instrumentation will be supplied by the HCVS battery and designed for sustained operation during an ELAP event using the FLEX equipment.

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 pipe temperature, radiation monitoring, and support system monitoring, are seismically qualified as indicated on Table 1 and they include the ability to handle harsh environmental conditions (although they may not be considered part of the site EQ 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 an ion chamber detector coupled to a process and control module. The process and control module is mounted in Unit 1/2 and Unit 3 Computer Rooms on elevation 1C of the CB. The RM detector is fully qualified for the expected environment at the vent pipe during accident conditions, and the process and control module is qualified for the mild environment in the 1C CB. Both components are qualified for the seismic requirements. Table 1 includes a description and qualification information on the radiation monitor.

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 wetwell 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 wetwell and up to and including the existing PCIVs 1,2,3-FCV-064-0221 and 1,2,3-FCV-064-0222 is designed to the plants design basis pressure and temperature of 56 psig at 304F. Wetwell vent piping and components installed downstream of the containment isolation boundary are designed for beyond design basis conditions.

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. Phase 1 ISE Open Item 10 which was closed during NRC audit and documented in ML18038B606 (Reference 39), contains the response regarding the evaluation of HCVS components for severe accident conditions.

Refer to EA-13-109, requirement 1.2.11 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 check valve is installed near the top of the pipe in accordance with HCVS-WP-03. This valve will open on venting, but will close to prevent air from migrating back into the pipe after a period of venting. The check valve is installed and tested to ensure that it limits back-leakage to preclude a detonable mixture from occurring in the case venting is stopped prior to the establishment of alternate reliable containment heat removal. The use of a check valve meets the requirement to ensure the flammability limits of gases passing through the vent pipe will not be reached.

1.2.12 The HCVS shall be designed to minimize the potential for hydrogen gas migration and ingress into the RB 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 provide acceptable method(s) 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. The HCVS outboard 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.

BFN has implemented the following operation, testing and inspection requirements for the HCVS to ensure reliable operation of the system. These are from NEI 13-02, Table 6.1. The implementing modification packages 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. Cycle the HCVS check valves not used to maintain containment integrity during unit operations.[3]	Once per every[2] operating cycle. 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.	(1) Prior to first declaring the system functional; (2) Once every three operating cycles thereafter; and (3) After restoration of any breach of system boundary within the buildings
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] valves move to their proper (intended) positions.	Once per every other operating cycle

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.

[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.

Evaluation:

The HCVS upstream of and including the second containment isolation valve 1,2,3-FCV-064-0222 and penetrations are not being modified for order compliance so that they 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 structure.

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 itunlikely 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 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. NEI 13-02, Revision 1, endorsed by NRC in JLD-ISG-2015-01, provides the guidance for the containment venting strategy (B.2) of the order. NEI 13-02, Revision 1, provides SAWA in conjunction with SAWM, which 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.

BFN has implemented Containment Venting Strategy (B.2), as the compliance method for Phase 2 of the Order and conforms to the associated guidance in NEI 13-02 Revision 1 for this compliance method.

<u>Section IV.B</u>: HCVS Existing System

There previously was neither a hardened drywell vent nor a strategy at BFN 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.

BFN has implemented the containment venting strategy utilizing SAWA and SAWM. The SAWA system consists of a FLEX (SAWA) pump injecting into the RPV, and SAWM consists of flow control at the FLEX (SAWA) pump along with instrumentation and procedures to ensure that the wetwell vent is not submerged (SAWM). Procedures have been issued to implement this strategy including Revision 3 to the SAMG. This strategy has been shown via MAAP analysis to protect containment without requiring a drywell vent for at least seven days which is the guidance from NEI 13-02 for the period of sustained operation.

Section IV.C.1: Detailed SAWA Flowpath Description

The SAWA flowpath is the same as the FLEX primary injection path. The SAWA system, shown on Attachment 4, consists of a FLEX pump injecting into the RPV, and SAWM consists of flow control at the FLEX pump along with wetwell level indication to ensure that the wetwell vent is not submerged (SAWM). The SAWA injection path, starts at the Tennessee River, goes to the FLEX Triton pump via suction hoses, goes through the FLEX Dominator pump to a Flow Meter Trailer and a flexible discharge hose, then to the Containment Integrated Leak Rate Test (CILRT) connection which penetrates the RB wall. The piping is connected to the Condensate Storage & Supply (CS&S) system piping which supplies Core Spray (CS) Loops I and II, which is then injected to the RPV using the CS injection valves. The hoses and pumps are stored in the FESB, which is protected from all hazards. BWROG generic assessment, BWROG-TP-15-008, provides the principles of SAWA to ensure protection of containment. This SAWA injection path is qualified for all the screened in hazards (Section III) in addition to severe accident conditions.

Section IV.C.2: Severe Accident Assessment of Flowpath

The actions inside the RB where there could be a high radiation field, due to a severe accident, will be to open valve at the CILRT connection on the 1st floor of the RB, open valves on 2nd floor of RB located on mezzanine and close valve located on the refuel floor. The action to open and close valves inside the RB can be performed before the dose is unacceptable, under the worst-case scenario within the first hour, after the loss of RPV injection. This time was validated as part of the Time Sensitive Action validation for EA-12-049, however Condition Report 1448509 was initiated to perform validation of RB actions only to validate these actions could be performed for a severe accident unit within one hour. Procedure 0-FSI-1 directs early accomplishment of actions that must be done early in the severe accident event where there is a loss of all AC power and a loss of all high-pressure injection to the core. In this event, core damage is not expected for at least one hour so that there will be no excessive radiation levels or heat related concerns in the RB when the valves are operated. The other SAWA actions all take place outside the RB at the MCR, FLEX Pump staging area, RB outer wall, FESB, and the deployment pathways. Since these locations are outside the RB, they are shielded from the severe accident radiation by the thick concrete walls of the RB. 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 wetwell level with SAWA at the minimum flow rate indicates water on the drywell floor up to the 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 wetwell vent is submerged.

<u>Section IV.C.3</u>: Severe Accident Assessment of Safety-Relief Valves

BFN 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 defined accident is unnecessary because RPV depressurization is directed by the EPGs in all cases prior to entry into the SAGs.

<u>Section IV.C.4</u>: Available Freeboard Use

The freeboard between -1 inch and 26.3 feet elevation in the wetwell provides approximately 757,544 gallons of water volume before the water level reaches the bottom of the vent pipe. BWROG generic assessment BWROG-TP-15-011, provides the principles of SAWM to preserve the wetwell 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 wetwell level is stable or very slowly rising. As shown in AREVA analysis 32-9248484-003 (Reference 40), the wetwell level will not reach the wetwell vent for at least seven days. A diagram of the available freeboard is shown on Attachment 1.

<u>Section IV.C.5</u>: Upper range of wetwell level indication

The upper range of wetwell level indication provided for SAWA/SAWM is 20 feet. This defines the upper limit of the instrumented volume of the wetwell that will preserve the wetwell vent function as shown in Attachment 1.

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

BFN AVEVA Analysis 32-9248484-003 (Reference 40) and BWROG-TP-15-011 demonstrate(s) that throttling SAWA flow after containment parameters have stabilized, in conjunction with venting containment through the wetwell vent will result in a stable or slowly rising wetwell level. The references demonstrate that, for the scenario analyzed, wetwell level will remain below the wetwell 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 BFN is developed from the BWR Owner's Group EPGs/SAGs. As such, the SAWA/SAWM implementing procedures are integrated into the BFN 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 use of the hardened vent as well as SAWA/SAWM when the appropriate plant conditions have been reached.

Using NEI 12-06 Appendix E has validated that the SAWA pump can be deployed and commence injection in less than 8 hours. The studies referenced in NEI 13-02 demonstrated that establishing flow within 8 hours will protect containment. The initial SAWA flow rate will be at least 500 GPM. After a period of time, estimated to be about 4 hours, in 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.

NEI 13-02 generic analysis per NEI 13-02 (Reference 7) demonstrated 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 wetwell 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.

Section IV.C.8: SAWA Flow Control

BFN will accomplish SAWA flow control by the use of throttle valves located at the FLEX pumps. The operators at the FLEX pump will be in communication with the MCR via radios and the exact time to throttle flow is not critical since there is a large margin between normal wetwell level and the level at which the wetwell 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. The communications capabilities have been tested to ensure functionality at the SAWA flow control and monitoring locations.

Section IV.C.9: SAWA/SAWM Element Assessment

Section IV.C.9.1: SAWA Pump

BFN uses one Triton and one Dominator portable diesel-driven pumps for FLEX and SAWA. These pumps are capable of providing 500 GPM to each Unit at the pressures required for RPV injection during an ELAP. These pumps have been shown to be capable of supplying the required flow rate to the RPV and the SFP for FLEX and for SAWA scenarios. The pumps are stored in the FESB where they are protected from all screened-in hazards and are rugged, over the road, trailer-mounted units, and therefore will be available to function after a seismic event.

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

BFN SAWA flow is 500 GPM which is the amount assumed in NEI 13-02 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 MDN0003602014000233, “Hydraulic Analysis for Fukushima FLEX Connection Modifications,” 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

The BFN SAWA flowpath goes through check valves in the CS system. The CS check valves are also IST whose integrity of check function (open and closed) is demonstrated by other plant testing requirements such that additional testing per NEI 13-02 Revision 1 Section 6.2 is not required for these valves per NEI 13-02 Revision 1 6.2.4 Note 3. Thus, backflow is prevented by check valves in the SAWA flowpath inside the RB.

Section IV.C.9.5: SAWA Water Source

The initial source of water for SAWA is the Tennessee River which can provide water injection without makeup based on the FLEX analysis. This long-term strategy of water supply was qualified for order EA-12-049 response and is available during a severe accident. Therefore, there will be sufficient water for injection to protect containment during the period of sustained operation.

Section IV.C.9.6: SAWA/SAWM Motive Force

Section IV.C.9.6.1: SAWA Pump Power Source

The SAWA pumps are stored in the FESB where they are protected from all screened-in hazards. The SAWA pumps are commercial fire pumps rated for long- term outdoor use in emergency scenarios. The pumps are diesel-driven by an engine mounted on the skid with the pump. The pumps will be refueled by the FLEX refueling equipment that has been qualified for long-term refueling operations per EA-12-049. The action to refuel the SAWA pumps was evaluated under severe accident conditions in Table 2, and demonstrated to be acceptable. Since the pumps are stored in a protected structure, are qualified for the environment in which they will be used, and will be refueled by a qualified refueling strategy, they will perform their function to maintain SAWA flow needed to protect primary containment per EA-13-109.

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

Table 1 shows the electrical power source for the SAWA/SAWM instruments. For the instruments powered by the 250V Unit Battery, calculation EDQ0009992013000202 demonstrates that they can provide power until the FLEX DG restores power to the battery charger.

The FLEX load on the FLEX DG per EA-12-049 was evaluated in calculation EDQ0003602015000325 . This calculation demonstrated sufficient margin to full load. The are no additional loads on the FLEX DGs for SAWA and SAWM. The FLEX DG was qualified to carry the rest of the FLEX loads as part of Order EA-12-049 compliance.

Section IV.C.10: SAWA/SAWM Instrumentation

Section IV.C.10.1: SAWA/SAWM instruments

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

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

The drywell pressure and wetwell 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 wetwell vent in service while maintaining containment protection. These instruments are powered by unit batteries or inverters that maintain operation of the instrument during the BDBEE and will be re-powered by FLEX DG systems for the sustained operating period. These instruments are powered by the ECCS ATU inverter and included in the FLEX DG loading calculations (EDQ0009992013000202) for EA-12-049. Note that other indications of these parameters may be available depending on the exact scenario.

The SAWA flow meter is a paddle-wheel flow meter mounted in the piping on the flow indicator trailer and powered by the pump’s electrical system.

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 wetwell level instruments are pressure and differential pressure detectors that are safety-related and qualified for post-accident use. These instruments are qualified per RG-1.97, Revision 3 (Reference 37), which is the BFN committed version per Design Criteria BFN-50-7307 as post-accident instruments and are therefore qualified for EA-13-109 events.

The SAWA flow meter is rated for continuous use under the expected ambient conditions and so will be available for the entire period of sustained operation. Furthermore, since the pump is deployed outside the RB, and a significant distance from the vent pipe, there is no concern for any effects of radiation exposure to the flow instrument.

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

BFN FLEX strategies will restore the containment instruments, containment pressure and wetwell level, necessary to successfully implement SAWA. The strategy will be to use the FLEX DG to re-power battery chargers before the batteries supplying the instruments are depleted. Since the FLEX DGs 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

*S*ection IV.C.11.1: Severe Accident Effect on SAWA Pump and Flowpath

Since the FLEX pump is stored in the FESB and will be operated from outside the RB, and a significant distance from the vent pipe, there will be no issues with radiation dose rates at the SAWA pump control location and there will be no significant dose to the SAWA pump.

Inside the RB the SAWA flowpath consists of hard pipe which will remain unaffected by the radiation or elevated temperatures inside the RB. Therefore, the SAWA flowpath will not be affected by radiation or temperature effects due to a severe accident.

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

The SAWA/SAWM instruments are described in section IV.C.10.2, that section provides severe accident effects.

Section IV.C.11.3: 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 ERO exposure guidelines.

As part of the response to Order EA-12-049, BFN performed calculations of the temperature response of the Reactor and Control Buildings 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 CB is driven by the loss of ventilation and ambient conditions and therefore will not change. Thus, the FLEX calculations are acceptable for severe accident use.

Table 2 provides a list of SAWA/SAWM operator actions as well as an evaluation of each for suitability during a severe accident.

After the SAWA pipe 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 no radiological concern with any actions outside the RB. Therefore, all SAWA controls and indications are accessible during severe accident conditions.

The SAWA monitoring equipment can all be operated from the MCR or from outside the RB at ground level. The BFN FLEX response ensures that the FLEX pump, FLEX DGs and other equipment can all be run for a sustained period by refueling. All the refueling locations are located in shielded or in areas that are a significant distance from the vent pipe so that there is no radiation hazard from core material during a severe accident. The monitoring instrumentation includes SAWA flow at the FLEX pump, and wetwell level and containment pressure in the MCR.

Section V: HCVS Programmatic Requirements

Section V.A: 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.

Evaluation:

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

The HCVS and SAWA procedures have been developed and implemented following BFN's 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

BFN has implemented the BWROG Emergency Procedures Committee Issue 1314 that implements the SAWM strategy in the 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.

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 RPV 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 of the HCVS and compensatory measures have been included in procedure OPDP-8 “Operability Determination Process and Limiting Conditions for Operation Tracking.”

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 up for 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 system to determine:
    - The cause(s) of the non-functionality,
    - 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.

<u>Section V.C</u>: 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 ELAP.

<u>Evaluation:</u>

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 as any changes occur to the HCVS. The personnel trained and the frequency of training was determined using a systematic analysis of the tasks to be performed using the Systems Approach to Training process.

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

<u>Section V.D</u>: Demonstration with other Post Fukushima Measures

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

1. Hardened containment vent operation on normal power sources (no ELAP)
2. During drill or tabletop 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.

<u>Evaluation:</u>

<u>NOTE</u>: Items 1 and 2 above are not applicable to SAWA.

The use of the HCVS and SAWA capabilities will be demonstrated during drills or tabletops consistent with NEI 13-06 and on a frequency consistent with 10 CFR 50.155(e)(4). The above capabilities will be demonstrated during drills or tabletops by April 1, 2022, which is within four years of the first unit compliance with Phase 2 of Order EA-13-109, or consistent with the next strategy drill or tabletop. Subsequent drills or tabletops will be performed to demonstrate the capabilities of different elements of Items 1, 2 and/or 3 above that is applicable to BFN in subsequent eight year intervals.

<u>Section VI</u>: References

Document	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	Issuance of Order to Modify Licenses with Regard to Reliable Hardened Containment Vents	ML12054A694
5. EA-13-109	0	Issuance of 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 Conditions	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 Conditions	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
11. HCVS-WP-04	0	Missile Evaluation for HCVS Components 30 Feet Above Grade	ML15244A923 ML15240A072

[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.

Document	Rev	Title	Location[6]
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 Conditions	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	Letter from TVA to NRC, "Tennessee Valley Authority'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 (Order Number EA-13-109)," dated June 30, 2014	ML14181B169
19. Combined OIP	0	Letter from TVA to NRC, "Tennessee Valley Authority's Browns Ferry Nuclear Plant Third Six-Month Status Report and Phase 1 and Phase 2 Overall Integrated Plan in Response to the 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 29, 2015	ML15365A554
20. Phase 1 ISE	0	Letter from NRC to TVA, "Browns Ferry Nuclear Plant, Units 1, 2 and 3 - Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Phase 1 of Order EA-13-109 (Severe Accident Capable Hardened Vents) (TAC NOS. MF4540, MF4541 and MF4542)", dated February 11, 2015.	ML14356A362

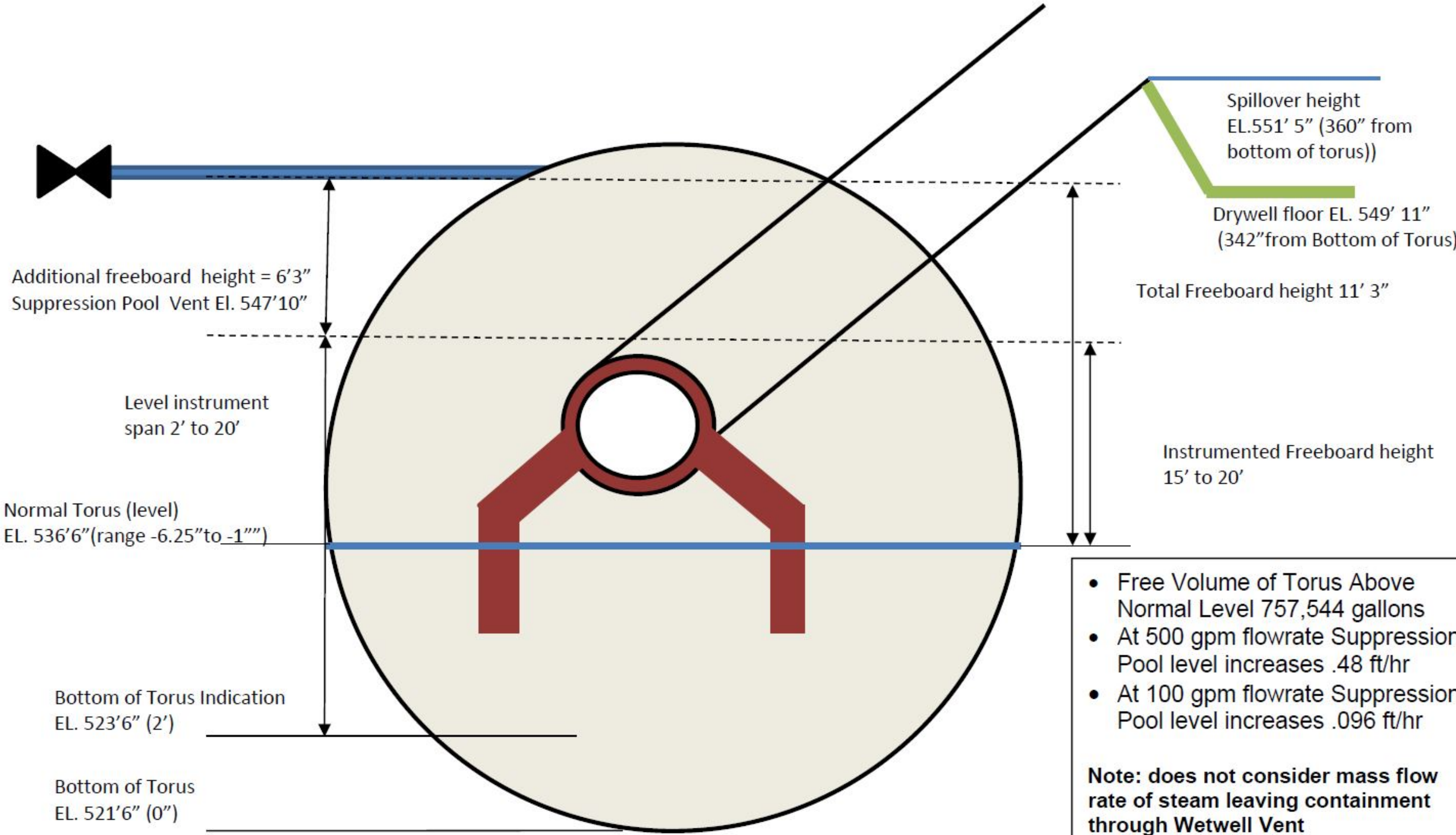
Document	Rev	Title	Location[6]
21. Phase 2 ISE	0	Letter from NRC to TVA, “Browns Ferry Nuclear Plant, Units 1, 2 and 3 - Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Phase 2 of Order EA-13-109 (Severe Accident Capable Hardened Vents) (CAC Nos. MF4540, MF4541 and MF4542),” dated September 6, 2016	ML16244A762
22. 1st Update	0	Letter from TVA to NRC, “Tennessee Valley Authority's Browns Ferry Nuclear Plant First Six-Month Status Report in Response to the 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	ML14353A428
23. 2nd Update	0	Letter from TVA to NRC, “Tennessee Valley Authority's Browns Ferry Nuclear Plant Second Six-Month Status Report in Response to the 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, 2015	ML15181A338
24. 3rd Update	0	Letter from TVA to NRC, “Tennessee Valley Authority's Browns Ferry Nuclear Plant Third Six-Month Status Report and Phase 1 and Phase 2 Overall Integrated Plan in Response to the 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 29, 2015	ML15365A554
25. 4th Update	0	Letter from TVA to NRC “Tennessee Valley Authority’s Browns Ferry Nuclear Plant Fourth Six-Month Status Report in Response to the 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 30, 2016	ML16182A517

Document	Rev	Title	Location[6]
26. 5th Update	0	Letter from TVA to NRC "Tennessee Valley Authority Browns Ferry Nuclear Plant's Fifth Six-Month Status Report in Response to the 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	ML16357A577
27. 6th Update	0	Letter from TVA to NRC "Tennessee Valley Authority Browns Ferry Nuclear Plant's Sixth Six-Month Status Report in Response to the 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 30, 2017	ML17181A333
28. 7th Update	0	Letter from TVA to NRC "Tennessee Valley Authority Browns Ferry Nuclear Plant's Seventh Six-Month Status Report in Response to the 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 20, 2017	ML17354A250
29. 8th Update	0	Letter from TVA to NRC "Tennessee Valley Authority Browns Ferry Nuclear Plant's Eighth Six-Month Status Report in Response to the 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, 2018	ML18179A139
30. 9th Update	0	Letter from TVA to NRC "Tennessee Valley Authority Browns Ferry Nuclear Plant's Ninth Six-Month Status Report in Response to the 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 27, 2018.	ML18361A801

Document	Rev	Title	Location[6]
31. Unit 3 Compliance Letter		Letter from TVA to NRC "Tennessee Valley Authority, Browns Ferry Nuclear Plant, Unit 3, Completion of Required Action for NRC Order EA-13-109, Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (CAC No. MF4542)" dated May 31,2018.	ML18169A178
32. Reactor Building FLEX Calculation.	3	MDQ0009992014000291 Temperature Response of the Reactor Building Following an Extended Loss of AC Power.	N/A
33. Transient Temperature response in ELAP Calculation.	7	MDQ0003602014000222 BFN ELAP Transient Temperature Analysis	N/A
34. Operator Mission Dose		MDQ0000642015000351 Hardened Containment Vent System Operator Mission Dose	N/A
35. NEI 12-06	0	Diverse and Flexible Coping Strategies (FLEX) Implementation Guide	ML12221A205
36. 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
37. RG 1.97	3	Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Conditions During and Following an Accident	ML003740282
38. TR-1026539	0	EPRI Investigation of Strategies for Mitigating Radiological Releases in Severe Accidents BWR, Mark I and Mark II Studies, October 2012	N/A
39. Phase 1and 2 ISE Open Item Audit	NA	Letter from NRC to TVA, "Browns Ferry Nuclear Plant, Units 1, 2 and 3 - 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 (CAC NOS. MF4540, MF4541 AND MF4542; EPID L-2014-JLD-0044)," dated February 21, 2018.	ML18038B606
40. 32-9248484-003	NA	Browns Ferry Nuclear Power Plant (BFN) Severe Accident Water Addition (SAWA) Analysis	N/A

Document	Rev	Title	Location[6]
41. BFN FLEX SER	NA	Letter from NRC to TVA "Browns Ferry Nuclear Plant, Units 1, 2, And 3 - Safety Evaluation Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Pool Instrumentation Related to Orders EA-12-049 AND EA-12-051 (CAC NOS. MF0902, MF0903, MF0904; MF0881, MF0882, AND MF0883; EPID NOS. L-2013-JLD-0003; AND L-2013-JLD-0004)," dated September 24, 2018.	ML18236A331
42. CR 1448509	NA	Validation of Reactor Building actions only of 0-FSI-2F	NA
43. Unit 1 Compliance Letter	0	Letter from TVA to NRC "Tennessee Valley Authority, Browns Ferry Nuclear Plant, Unit 1, Completion of Required Action for NRC Order EA-13-109, Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (CAC No. MF4540)," dated January 22, 2019.	ML19022A305

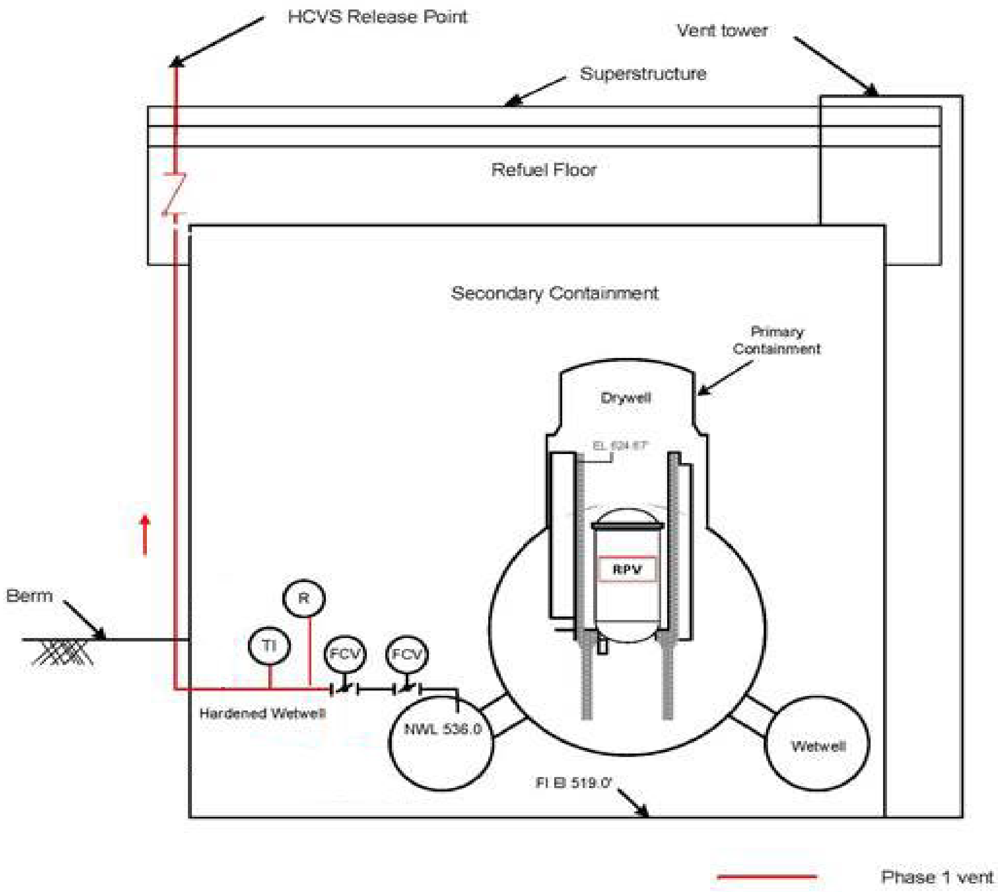
<u>Attachment 1</u>: Phase 2 Freeboard diagram



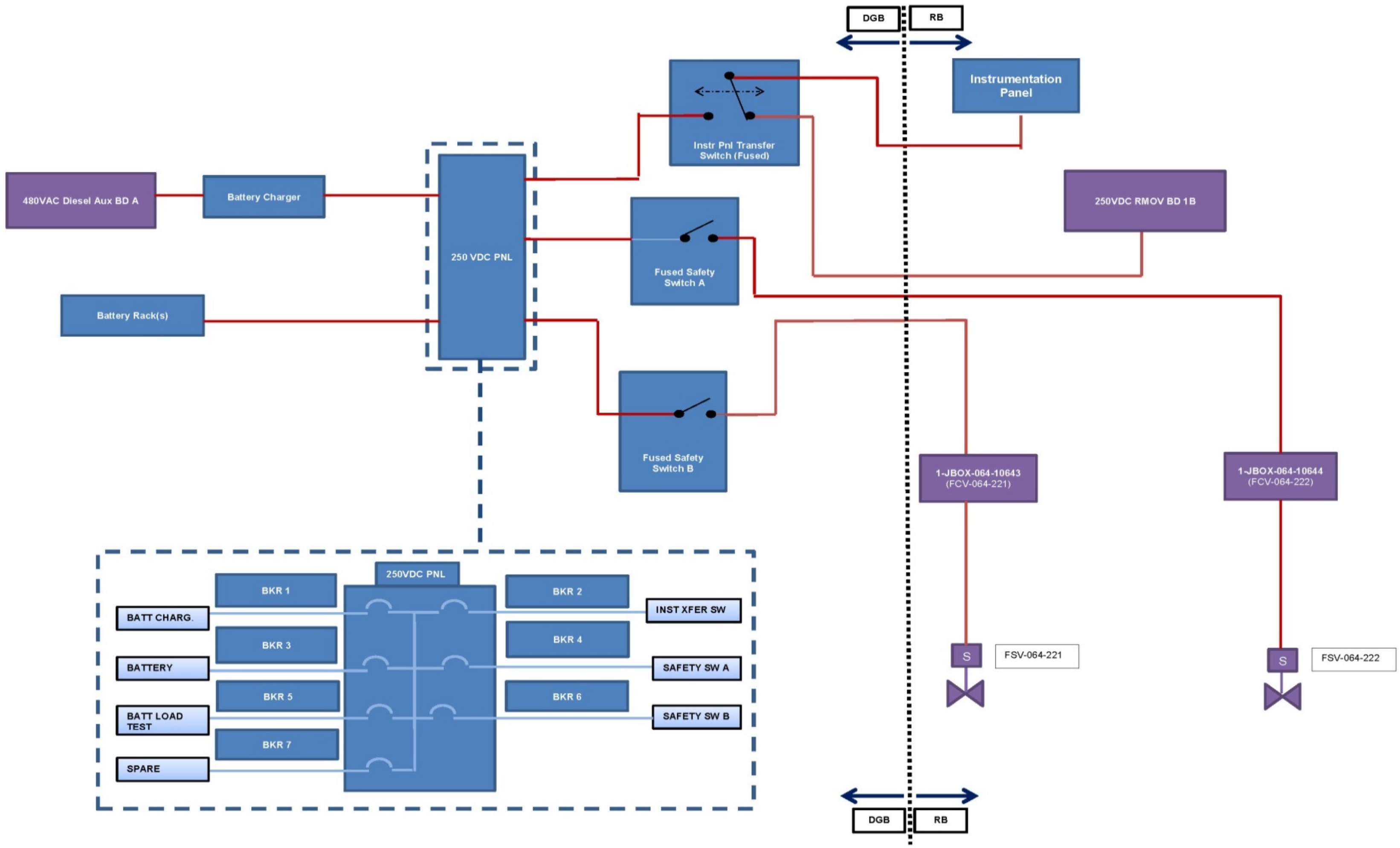
- Free Volume of Torus Above Normal Level 757,544 gallons
- At 500 gpm flowrate Suppression Pool level increases .48 ft/hr
- At 100 gpm flowrate Suppression Pool level increases .096 ft/hr

Note: does not consider mass flow rate of steam leaving containment through Wetwell Vent

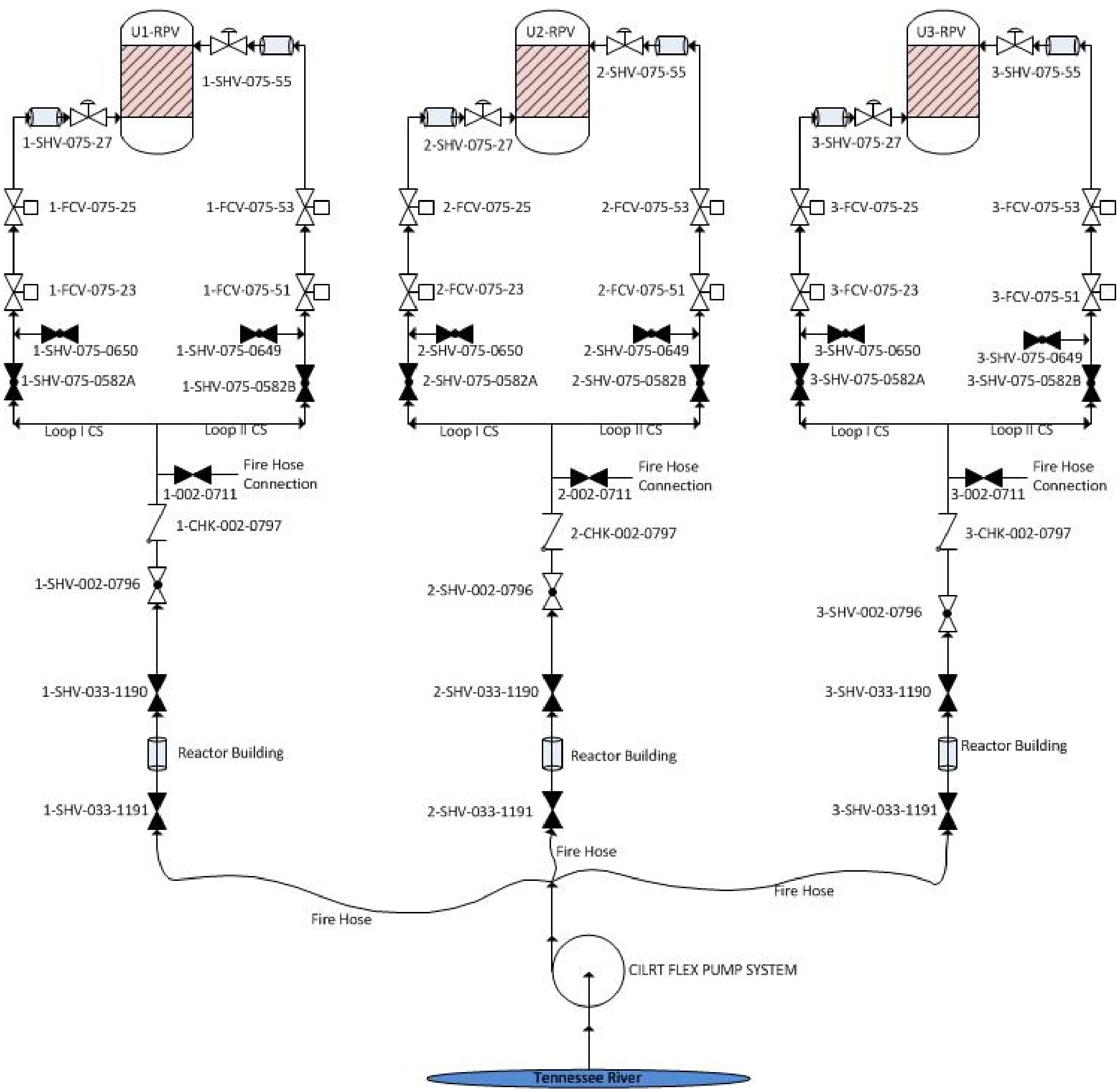
<u>Attachment 2</u>: One Line Diagram of HCVS Vent Path



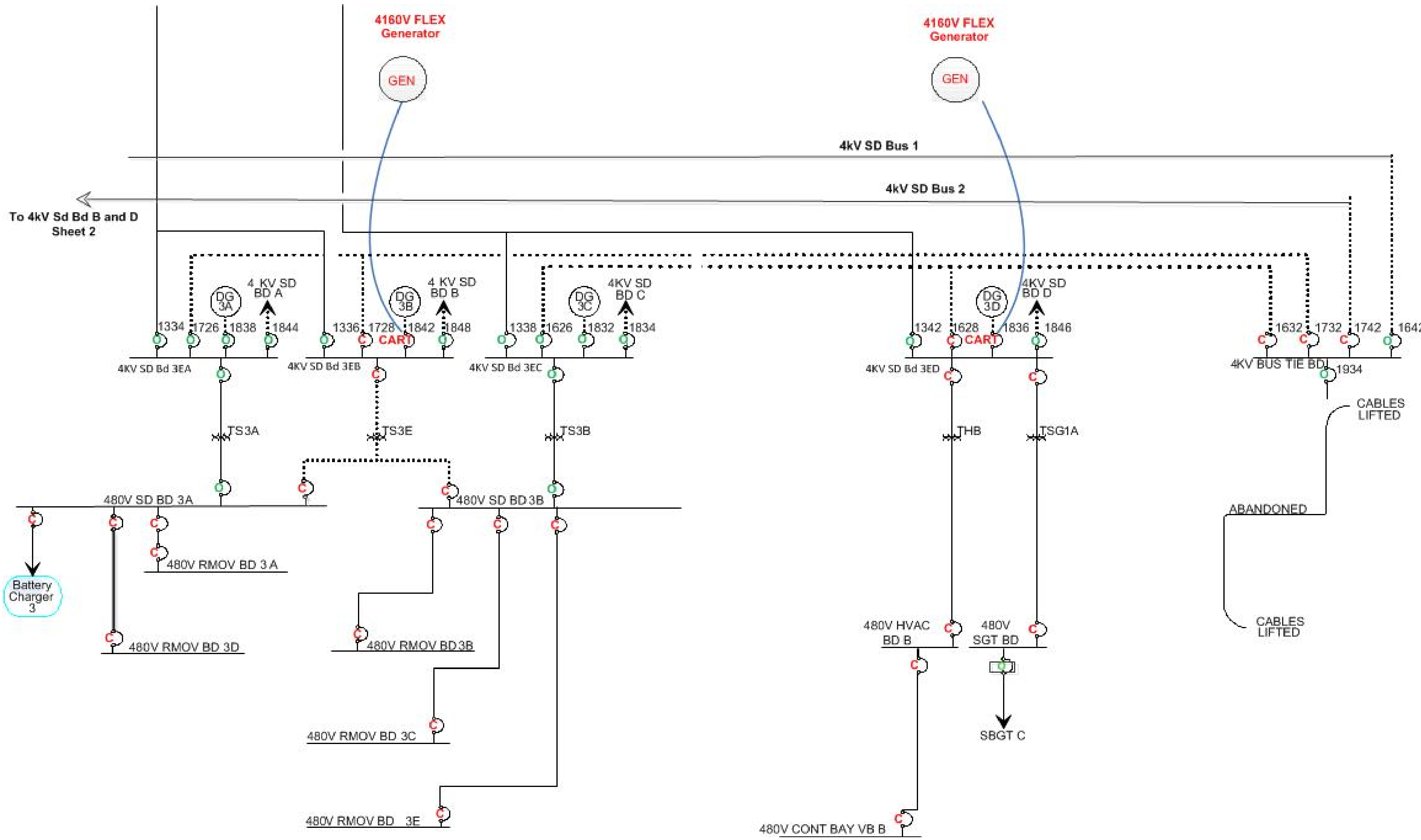
Attachment 3: HCVS Electrical Block Diagram



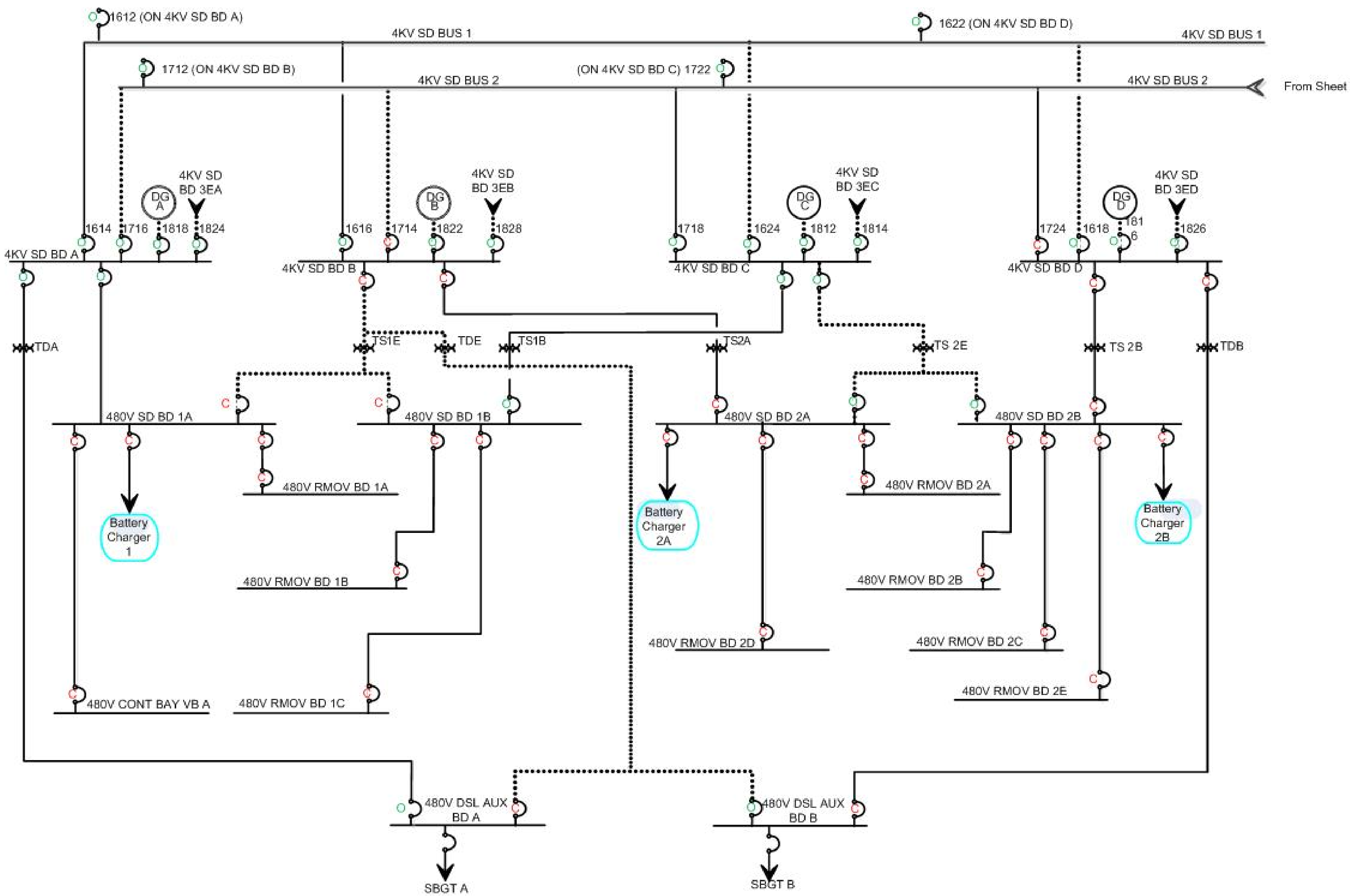
<u>Attachment 4</u>: One Line Diagram of SAWA Flowpath



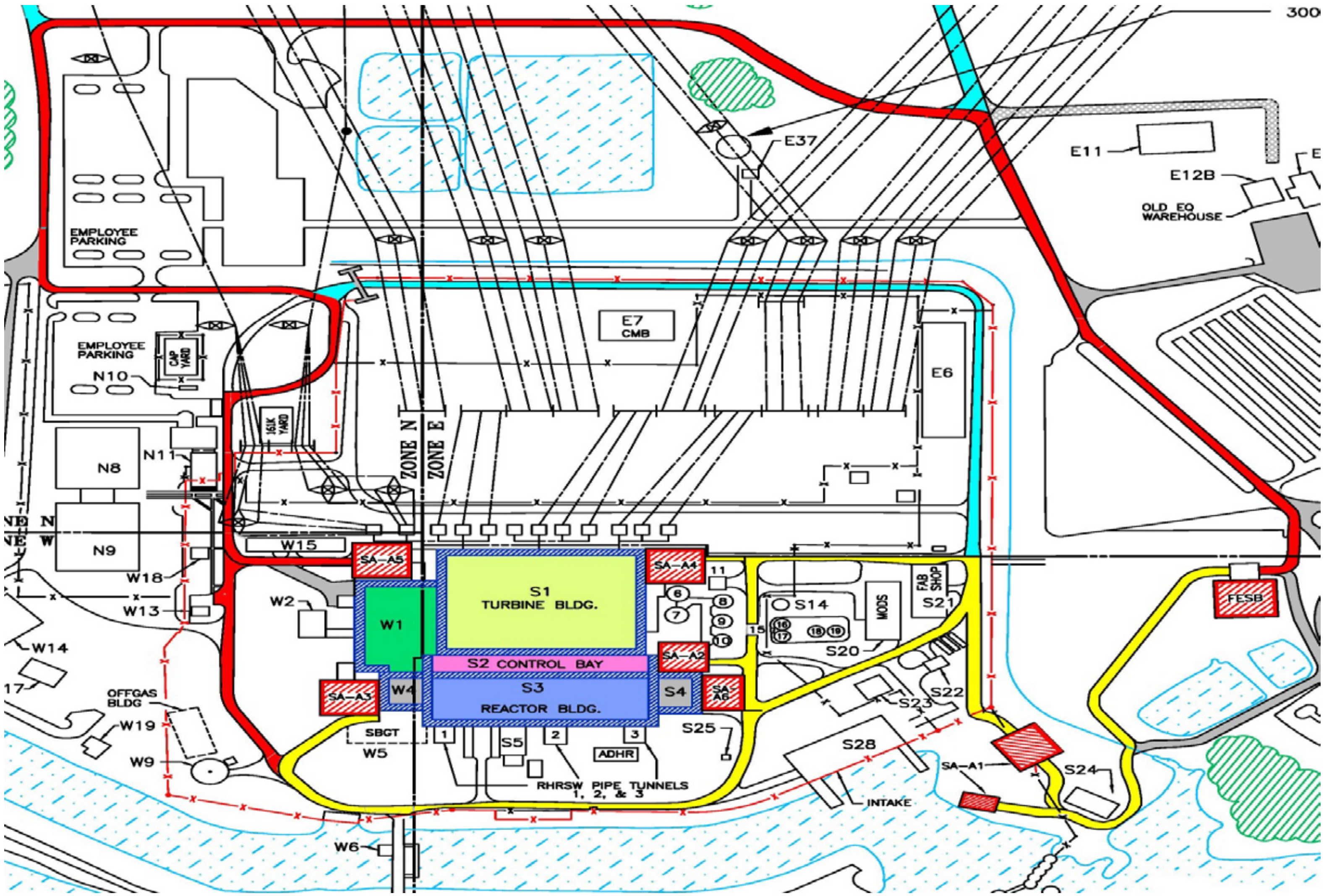
Attachment 5: One Line Diagram of SAWA Electrical Power Supply (Sheet 1)



Attachment 5A: One Line Diagram of SAWA Electrical Power Supply (Sheet 2)

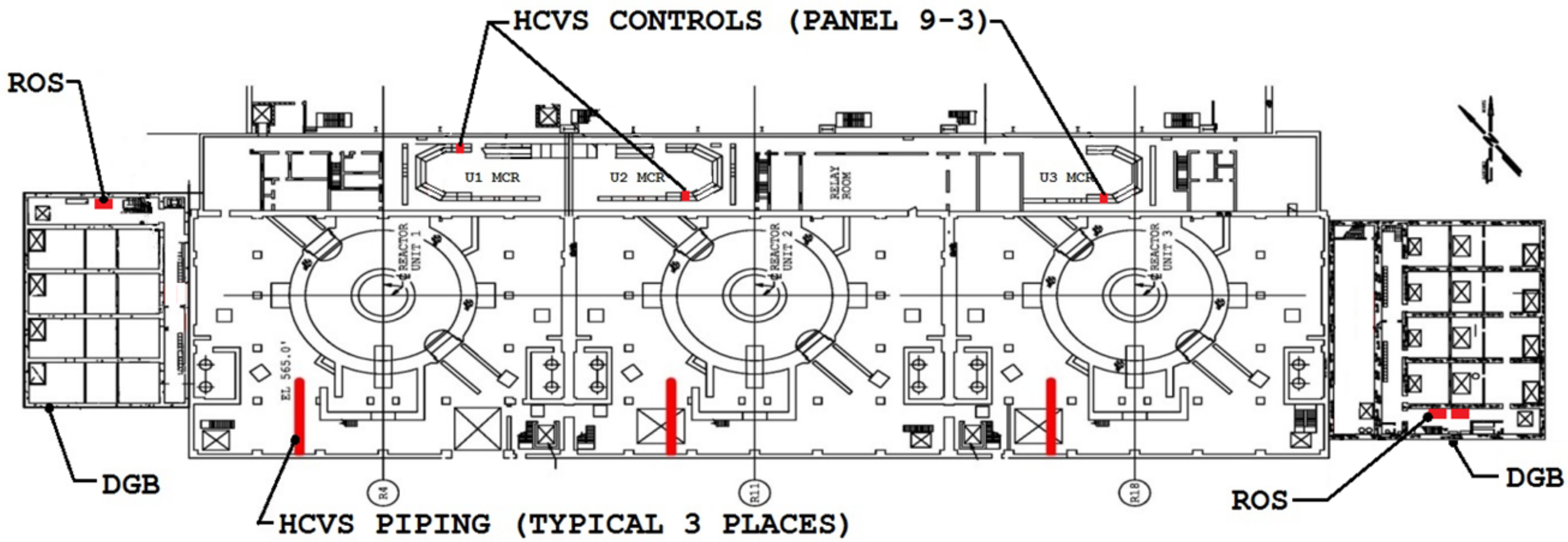


<u>Attachment 6</u>: Site Layout



Attachment 6A: Monitoring and Remote Operating Station Locations

Figure 7 - Monitoring Locations



HCVS PIPING REACTOR BUILDING: EL. 565.0'
ROS PANEL DIESEL GENERATOR BUILDING: EL. 583.5'
HCVS PANEL CONTROL BAY BUILDING: EL. 617.0'

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

Component Name	Equipment ID	Range	Location	Local Event Temp	Local Event Humidity	Local Radiation Level	Qualification	Qualification Temp	Qualification Humidity	Qualification Radiation	Power Supply
Wetwell Vent Instruments and Components											
HCVS Process Temperature Element	1,2,3-TE-064-0060A/B	0-400°F	565 Rx Bldg	170F	100%	7.42 E5 R/hr	IEEE 323-1974; IEEE 344-1975 06-8680-003	285°F	100%	3.06 E8 Rads	N/A
HCVS Process Temperature Indicator	1,2,3-TI-064-0060	0-400 F	Main Control Rooms	N/A	N/A	N/A	PR034998SEI-TR16	131°F	95%	1 .0 E3 Rads	Normal 480V RMOV Board Alternate HCVS Battery
HCVS Process Temperature Indicating Controller	1,2,3-TIC-064-0060	0-400 F	Main Control Rooms	N/A	N/A	N/A	PR034998SEI-TR16	131°F	95%	1 .0 E3 Rads	Normal 480V RMOV Board Alternate HCVS Battery
N2 SYSTEM BACKUP TO PCIV, PRESSURE INDICATOR	1, 2,3-PI-032-2727	0-200 PSI	DGB 583' - 6"	120F	N/A	N/A	Report S1619	140°F	No electronics, not susceptible	N/A	N/A
HCVS Radiation Indicator	1,2,3-RI-090-0062	0.01 - 10,000 R/Hr	MCR	N/A	N/A	N/A	Report QR-151004-1	131°F	95%	1.0 E3 Rads	HCVS Battery
HCVS Radiation detector signal Converter	1,2,3-CNV-090-0062A/B	N/A	Control Bldg, 593 computer room	N/A	N/A	N/A	0451890-QSR; S1619	131 °F	95%	1 .0 E3 Rads	Normal 480V RMOV Board Alternate HCVS Battery
HCVS Radiation Monitor	1,2,3-RM-090-0062		Control Bldg, 593 computer room	N/A	N/A	N/A	04518900-QSR	131 °F	95%	1 .0 E3 Rads	Normal 480V RMOV Board Alternate HCVS Battery

Component Name	Equipment ID	Range	Location	Local Accident Temp	Local Accident Humidity	Local Radiation Level	Qualification	Qualification Temp	Qualification Humidity	Qualification Radiation	Power Supply
HCVS RADIATION ELEMENT	1,2,3-RE-090-0062	0.01 - 10,000 R/Hr	565 Rx BLDG	170F	100%	7.42 E5 R/hr	Report 04518900-QSR	350°F	100%	2.0 E8 Rads	N/A
HCVS 250 VDC Distribution Panel	1,2,3-BDDD-064-0001	250 VDC	ROS - DGB 586	N/A**	N/A*	N/A	IEEE 344-1975	N/A	N/A	N/A	Normal 480V RMOV Board Alternate HCVS Battery
HCVS 250 VDC battery	0,1-BATA-064-0001	250 VDC	ROS - DGB 586	N/A	N/A	N/A	QR-351024565-2, QR351024565-4	N/A	N/A	N/A	HCVS Battery Charger
N2 SYSTEM BACKUP TO PCIV, PRESSURE INDICATOR	0,1-PI-032-2716	0 - 3000 psi	ROS - DGB 586	N/A	N/A	N/A	SQURTS IS008.0 Rpt 1T177ME	N/A	N/A	N/A	N/A
HCVS Battery Charger	0,1-CHGA-064-0002	N/A	ROS - DGB 586	N/A	N/A	N/A	QR-351025195-1, QR-351025195-2	131°F	95%	1.0 E3 Rads	480 VAC Diesel Aux BD
HCVS DC-DC Converter	1,2,3-CNV-064-0001	250 VDC	ROS - DGB 586	N/A	N/A	N/A	QR351024565-2	131°F	95%	1.0 E3 Rads	Normal 480V RMOV Board Alternate HCVS Battery
HCVS Isolation Diode	1,2,3-DIO-064-0222A/B	N/A	565 Rx Bldg	170F	100%	7.42 E5 R/hr	BFN0EQ-DIO-001 R06170825179	212°F	100%	2.75 E7 Mrads	N/A
HCVS Isolation Diode	1,2,3-DIO-064-0221A/B	N/A	565 Rx Bldg	170F	100%	7.42 E5 R/hr	BFN0EQ-DIO-001 R06170825179	212°F	100%	2.75 E7 Mrads	N/A
HCVS 250 VDC Instrumentation Transfer Switch	1,2,3-XSW-064-0006	0-250 VDC 30 Amps	ROS - DGB 586	N/A	N/A	N/A	S1607.0 R1	N/A	N/A	N/A	Normal 480V RMOV Board Alternate HCVS Battery
Nitrogen Tank Isolation valves	SHV-032-2706 - 2710	N/A	ROS - DGB 586	N/A	N/A	N/A	SA-B150912-2	N/A	N/A	N/A	Manual

Component Name	Equipment ID	Range	Location	Local Accident Temp	Local Accident Humidity	Local Radiation Level	Qualification	Qualification Temp	Qualification Humidity	Qualification Radiation	Power Supply
Nitrogen Shut off valves to FCV-064-0221/222	SHV-032-2712-2715	N/A	ROS - DGB 586	N/A	N/A	N/A	SA-B150912-1	N/A	N/A	N/A	Manual
Shuttle Valves to FSV-064-221/222	SPV-032-2719-2721	N/A	ROS - DGB 586	N/A	N/A	N/A	MA30714	N/A	N/A	N/A	N/A
SAWA/SAWM Instruments											
SAWA flow instrument and readout	N/A	40--1380 GPM	Outside, mounted on the Flowmeter Trailer	N/A	N/A	Outside, radiation not a concern	Commercial instrument qualified for over the road use, therefore qualified per NEI 12-06 FRC Digital Flowmeter Model DFA400	150°F	100%	N/A	FLEX Dominator Pump Battery
Drywell Pressure	1,2,3-PT-64-67B	-15-65 psig	Elevation 593 Reactor Building	204F	100%	3.03 E5 Rads	IEEE 232-1974: IEEE 344-1974	RG 1.97	RG 1.97	RG 1.97	Division II ECCS Inverter
Wetwell Level	1,2,3-LI-64-159A	0-20 ft	Elevation 523 Bay 8 Reactor Building	240F	100%	1.44 E6 Rads	IEEE 232-1974: IEEE 344-1974	RG 1.97	RG 1.97	RG 1.97	Division I ECCS Inverter

Table 2: Operator Actions Evaluation

Operator Action		Evaluation Time	Validation Time	Location	Thermal conditions	Radiological Conditions	Evaluation
1	SAWA manual valve alignment in Reactor Building	0-1 hour	55:47 minutes	Reactor Building	Done in the first hour, so no concerns.	Done in the first hour, so no concerns.	Acceptable
2	Open Reactor Building and refuel floor doors	0-1 hour	38 minutes	Reactor Building and refuel floor	Done in the first hour, so no concerns.	Done in the first hour, so no concerns.	Acceptable
3	HCVS Valves switch actuation and instrument monitoring	≤ 7 hours (approximate venting start)	<9 minutes	Main control room	Acceptable as documented in Phase 1 ISE Open Item 1 (Reference 39)	MCR is removed from the vent pipes and RP actions will provide protection from any airborne activity	Acceptable MCR is a preferred location based on HCVS-FAQ-1.
4	Backup HCVS valve operation (if primary method fails)	≤ 7 hours (approximate venting start)	9 minutes	Remote Operating stations in U1/2 and Unit 3 DGB	Acceptable as documented in Phase 1 ISE Open Item 1 (Reference 39)	Far from the Primary containment, shielded by intervening structures and concrete, no radiological concern	Acceptable
5	SAWA Pump Setup And Operation	≤ 7 hours	5 hours, 11 minutes	FLEX Pump Staging Area SA-A1	Outside, so ambient conditions	Shielded by distance.	Acceptable
6	FLEX Generator Staging and Operation	≤ 7 hours	6 hours, 10 minutes	Staging Area SA-A6 outside of Unit 3 DG Rooms	Outside, so ambient conditions	Shielded by structure and distance.	Acceptable