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U. S. Nuclear Regulatory Commission
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10 CFR 2.202

NOV 27 2018

**SUSQUEHANNA STEAM ELECTRIC STATION FINAL INTEGRATED PLAN TO COMPLY WITH JUNE 06, 2013 COMMISSION ORDER MODIFYING LICENSES WITH REGARD TO RELIABLE HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS (NRC ORDER EA-13-109), REVISION 1**
**PLA-7757**

**Docket No. 50-387**
**and No. 50-388**

*References:*

1. *NRC Order Number EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions, dated June 06, 2013.*
2. *Talen Letter (PLA-7711), "Susquehanna Steam Electric Station Report of Full Compliance with June 06, 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 26, 2018 (ML18179A221).*

On June 06, 2013, the Nuclear Regulatory Commission (NRC) issued Order EA-13-109 (Reference 1) to Susquehanna Nuclear, LLC (Susquehanna). EA-13-109 was immediately effective and directed licensees to take certain actions to ensure that facilities had a hardened containment vent system (HCVS) to remove decay heat from the containment, and to maintain control of containment pressure within acceptable limits following events that result in loss of active containment heat removal capability while maintaining the capability to operate under severe accident conditions resulting from an Extended Loss of Alternating Current Power. On June 26, 2018, Susquehanna reported full compliance with Phase 1 and Phase 2 of the EA-13-109 pursuant to Section IV, Condition D.4 of EA-13-109 (Reference 2). The compliance report included the Final Integrated Plan (FIP) for reliable hardened containment vent Phase 1 and Phase 2 strategies.

The purpose of this letter is to provide a revision to the Susquehanna HCVS FIP. This revision is a result of comments provided by the NRC during the review of the Susquehanna HCVS FIP that resulted in a revision to the industry HCVS FIP template. The revised HCVS FIP is provided in the Enclosure to this letter. Changes to the HCVS FIP are marked by a revision bar in the right margin.

This letter contains no new or revised regulatory commitments.

If you have any questions regarding this report, please contact Mr. Jason Jennings, Manager – Nuclear Regulatory Affairs, at (570) 542-3155.

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

Executed on: 11/27/2018

B. Berryman

Enclosure: Final Integrated Plan to Comply with NRC Order EA-13-109, Revision 1

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Ms. L. H. Micewski, NRC Sr. Resident Inspector
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# Enclosure to PLA-7757

# Final Integrated Plan to Comply with NRC Order EA-13-109, Revision 1

# Final Integrated Plan

# HCVS Order EA-13-109

# for

# Susquehanna Steam Electric Station (SSES)

November 2018

Revision 1

**The Final Integrated Plan HCVS Order EA-13-109 for Susquehanna Steam Electric Station (SSES) was reviewed and approved using the NDAP-QA-0101 process.**

| Title | Name | Signature | Date |
|---|---|---|---|
| **Preparer** | **Tony Borger** | **Per NDAP-QA-0101 form on File** | **11/26/18** |
| **Reviewer** | **John Emmett** | **Per NDAP-QA-0101 form on File** | **11/13/18** |
| **Reviewer** | **Frank Inserra** | **Per NDAP-QA-0101 form on File** | **11/13/18** |
| **Final Review/QADR** | **Ken Klass** | **Per NDAP-QA-0101 form on File** | **11/13/18** |
| **Approve** | **Doug LaMarca** | **Per NDAP-QA-0101 form on File** | **11/12/18** |

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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 Boiling Water Reactors (BWRs) with Mark I containments to encourage licensees to voluntarily install a hardened wetwell vent. In response, the affected 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. Generic Letter 89-16 did not and does not apply to Susquehanna.

On March 19, 2013, the Nuclear Regulatory Commission (NRC) Commissioners directed the staff per Staff Requirements Memorandum (SRM) for SECY-12-0157, *Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments* (References 2 and 3), to require licensees with Mark I and Mark II containments to "upgrade or replace the reliable hardened vents required by Order EA-12-050, *Order to Modify Licenses with Regard to Reliable Hardened Containment Vents* (Reference 4), with a containment venting system designed and installed to remain functional during severe accident conditions." In response, the NRC issued Order EA-13-109, *Issuance of Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accidents*, June 6, 2013 (Reference 5). NRC 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 Extended Loss of AC Power (ELAP).

Susquehanna is required by NRC Order EA-13-109 to have a reliable, severe accident capable hardened containment venting system (HCVS) for each unit. 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 a reliable, severe accident capable hardened vent to assist in preventing core damage and, if necessary, to provide venting capability during severe accident conditions. Susquehanna achieved Phase 1 compliance on April 30, 2018.

- Phase 2 provided additional protections for severe accident conditions through the development of a reliable containment venting strategy that makes it unlikely that Susquehanna would need to vent from the containment drywell during severe accident conditions. Susquehanna achieved Phase 2 compliance on April 30, 2018.

The Nuclear Energy Institute (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, Susquehanna submitted a Phase 1 Overall Integrated Plan (OIP) in June of 2014 (Reference 18) and subsequently submitted a combined Phase 1 and 2 OIP in December 2015 (Reference 19). These OIPs followed the guidance of 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 Interim Staff Guidance documents (ISGs) to evaluate licensee compliance as presented in the Order EA-13-109 OIPs. While the Phase 1 and the combined Phase 1 and 2 OIPs were written to different revisions of NEI 13-02, Susquehanna 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 Susquehanna with Interim Staff Evaluations (ISEs) (References 20 and 21) assessing the site's compliance methods. In the ISEs the NRC identified open items which the site needed to address before that phase of compliance was reached. Six-month progress reports (References 22 through 28) were provided consistent with the requirements of Order EA-13-109. These status reports were used to close many of the ISE open items. In addition, the site participated in NRC ISE Open Item audit calls where the information provided in the six-month updates and on the ePortal were used by the NRC staff to determine whether the ISE Open Items were addressed.

By submittal of this Final Integrated Plan Susquehanna has addressed all the elements of NRC Order EA-13-109 utilizing the endorsed guidance in NEI 13-02, Revision 1 and the related HCVS-FAQ and HCVS-WP documents. In addition, the site has addressed the NRC Phase 1 and Phase 2 ISE Open Items as documented in previous six month updates and within the HCVS Phase 1 and 2 Compliance Letter for Susquehanna (Reference 29).

Section III contains the Susquehanna Final Integrated Plan details for Phase 1 of the Order. Section IV contains the Final Integrated Plan details for Phase 2 of the Order. Section V details the programmatic elements of compliance.

## Section I.A: Summary of Compliance

### Section I.A.1: 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 either the Main Control Room (MCR) Primary Operating Station (POS), which will be treated as the main operating location for this order, or the Remote Operating Station (ROS) at the appropriate time based on procedural guidance in response to plant conditions from observed or derived symptoms.

- The venting operation 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 at least 24 hours with installed equipment. Replenishment of the motive force will be by use of portable equipment before 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 Susquehanna 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 stations. Attachment 2 contains a one-line diagram of the HCVS vent that depicts the vent flow path.

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

The Phase 2 actions can be summarized as follows:

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

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

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

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

- Parameters measured are Drywell pressure, Suppression Pool level, SAWA flow rate and the HCVS Phase 1 vent path parameters (pressure, temperature, and radiation).

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 (up to 7 days). 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 flow path is the same as the FLEX primary injection flow path (used for NRC Order EA-12-049 Mitigation Strategies compliance) with the addition of a second hose from the pumper truck to the ESSW Pump House (ESSWPH). The flow path is from the station’s Ultimate Heat Sink (Spray Pond), through the pumper truck mounted FLEX pump and flow meters, and then through hoses to the Residual Heat Removal Service Water (RHRSW) connection point(s) in the ESSWPH. The SAWA flow then passes through the RHRSW piping into the Reactor Building (RB). Inside the RB the SAWA flow path is from RHRSW to RHR and then into the Reactor Pressure Vessel. The implementation of this flow path has been successfully validated using the NEI Validation methodology. No changes to the FLEX strategies were required for the re-evaluated Flooding and Seismic hazards. Drywell (DW) pressure and Suppression Pool level are monitored in the Main Control Room and flow rate is adjusted by use of the FLEX pump controls at the pumper truck. Communication is established between the MCR and the FLEX pump location. Attachment 4 contains a one-line diagram of the SAWA flow path for each unit.

The SAWA electrical loads are included in the FLEX generator loading calculation used for EA-12-049 compliance (same valves as used for FLEX). The FLEX generators are located east of the RB and the ‘E’ Diesel Generator, and are a significant distance from the discharge of the HCVS on the east side of the RBs. See Attachment 6 for applicable locations. Refueling of the FLEX generators is accomplished from the Emergency Diesel Generator (EDG) fuel oil tanks as described in the EA-12-049 FIP.

Evaluations for projected Severe Accident (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.

The HCVS has dedicated batteries and battery chargers that can be powered by the FLEX generators. Other electrical equipment and instrumentation used for Mitigation Strategies and Phase 1 and Phase 2 compliance is powered from the existing station batteries, and from AC distribution systems that are powered from the FLEX generators. These battery chargers are also powered from the FLEX generators to maintain the battery capacities during the Sustained Operating period.

## Section II: List of Acronyms

| | |
|---|---|
| AC | Alternating Current |
| AOV | Air Operated Valve |
| BDBEE | Beyond Design Basis External Event |
| BWROG | Boiling Water Reactor Owners' Group |
| CAC | Containment Atmospheric Control System |
| CAP | Containment Accident Pressure |
| CIV | Containment Isolation Valve |
| DC | Direct Current |
| DW | Drywell |
| ECCS | Emergency Core Cooling Systems |
| EDG | Emergency Diesel Generator |
| ELAP | Extended Loss of AC Power |
| EOP | Emergency Operating Procedure |
| EPG/SAG | Emergency Procedure and Severe Accident Guidelines |
| EPRI | Electric Power Research Institute |
| ERO | Emergency Response Organization |
| ESSW | Engineered Safeguards Service Water |
| ESSWPH | Engineered Safeguards Service Water Pump House |
| FAQ | Frequently Asked Question |
| FIP | Final Integrated Plan |
| FLEX | Diverse & Flexible Coping Strategies |
| FSB | FLEX Storage Building |

| | |
|---|---|
| GPM | Gallons per minute (or gpm) |
| HCVS | Hardened Containment Vent System |
| ISE | Interim Staff Evaluation |
| ISG | Interim Staff Guidance |
| JLD | Japan Lessons Learned Project Directorate |
| MAAP | Modular Accident Analysis Program |
| MCR | Main Control Room |
| $N_2$ | Nitrogen |
| NEI | Nuclear Energy Institute |
| NPSH | Net Positive Suction Head |
| NRC | Nuclear Regulatory Commission |
| OIP | Overall Integrated Plan |
| PCPL | Primary Containment Pressure Limit |
| PCIV | Primary Containment Isolation Valve |
| POS | Primary Operating Station |
| RB | Reactor Building |
| RCIC | Reactor Core Isolation Cooling System |
| RHR | Residual Heat Removal System |
| RHRSW | Residual Heat Removal Service Water System |
| RM | Radiation Monitor |
| ROS | Remote Operating Station |
| RPV | Reactor Pressure Vessel |
| RTP | Rated Thermal Power |

| | |
|---|---|
| SA | Severe Accident |
| SAMG | Severe Accident Management Guidelines |
| SAWA | Severe Accident Water Addition |
| SAWM | Severe Accident Water Management |
| SAWV | Severe Accident Wetwell Vent |
| SBGT | Standby Gas Treatment System |
| SFP | Spent Fuel Pool |
| SRM | Staff Requirements Memorandum |
| SRV | Safety-Relief Valve |
| SSES | Susquehanna Steam Electric Station |
| UFSAR | Updated Final Safety Analysis Report |
| UHS | Ultimate Heat Sink |
| VAC | Voltage AC |
| VDC | Voltage DC |
| WP | White Paper |
| WW | Wetwell |

# Section III: Phase 1 Final Integrated Plan Details

## Section III.A: HCVS Phase 1 Compliance Overview

Both units at Susquehanna installed entirely new dedicated Hardened Containment Vent Systems with vent paths from the wetwell to comply with NRC Order EA-13-109.

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

Susquehanna is a Mark II containment design station and as such Generic Letter 89-16 Vent System was not applicable. Therefore, no Generic Letter 89-16 Vent system was required to be installed, and no Generic Letter 89-16 Vent system was installed at Susquehanna.

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

The EA-13-109 compliant HCVS system is a new dedicated wetwell vent system. The vent system is initiated, operated and monitored from the MCR using the switches described below. 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 location is in the Control Structure on the 686'-6" elevation, about 2 floors below the MCR. Table 2 contains the evaluation of the acceptability of the ROS location with respect to severe accident conditions.

Susquehanna installed Hardened Containment Wetwell Vents in response to NRC Order EA-13-109, under Plant Modifications EC1881050, EC1881053, EC1881047, and EC1672825 for Unit 1 and EC1881014, EC1881029, EC1881034, and EC1672802 for Unit 2. The description of the vent system below is common to both units. The Hardened Containment Wetwell Vent system allows venting of the wetwell by utilizing a newly installed wetwell vent line through Penetration X-201B and normally closed inboard Containment Isolation Valve (CIV) HV1/257113 and normally closed outboard CIV HV1/257114. Downstream of outboard CIV HV1/257114, the 12" diameter wetwell vent flow path continues through a rupture disk and then exits the Reactor Building at elevation 707' (which is greater than 30' above the exterior grade elevation). Exterior to the Reactor Building the wetwell vent pipe expands to 14" diameter, is supported from the Reactor Building wall, and then rises along the exterior of the Reactor Building. The vent line re-enters the Reactor Building at the skin area, passes through check valve 1/257319 and then exits the Reactor Building roof at Elevation 870'. There is a pipe end cover over the pipe discharge to prevent miscellaneous material from entering the pipe. The wetwell vent line is equipped with a rupture disk (PSE1/25701, burst pressure of 43 psig), just downstream of the outboard CIV (HV1/257114) to mitigate Secondary Containment Bypass Leakage considerations. The 43 psig burst pressure for rupture disk PSE1/25701 was selected as being greater than the maximum Loss of Coolant Accident containment pressure and less than the containment design pressure. The wetwell vent system and components are designed for 65 psig and 350 ºF. The vent line is equipped with a radiation monitor adjacent to the line for alerting the operators of a release through the vent line. The radiation monitor (RE1/25756) is equipped to provide a range of $10^{-2}$ to $10^{5}$ R/hour. Panels 1/2C644 are normally de-energized and are energized by a key-lock switch as two measures to prevent inadvertent operation. The ROS is in a locked room which is a third measure to prevent inadvertent operation of the HCVS wetwell vent. The pneumatic supply air bottles are normally closed to isolate the air from the system, which is a fourth measure to prevent inadvertent operation. These are acceptable methods of preventing inadvertent actuation per NEI 13-02.

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

The Main Control Room is the primary operating station for the HCVS. During an ELAP, electric power to operate the vent valves is provided by batteries with a capacity to supply required loads for at least the first 24 hours. Before the batteries are depleted, the FLEX generators will supplement and recharge the 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 HCVS containment isolation valves, the valve solenoids do not need any additional backup electrical power. Attachment 2 shows the HCVS wetwell vent flow path.

In the MCR, the operators can operate the HCVS containment isolation valves (if electrical power is available), monitor HCVS vent valve position, drywell pressure, wetwell level, and pneumatic supply pressure. Also in the MCR area are the HCVS Radiation Monitor indication, vent pipe temperature, vent pipe pressure, and battery voltage. The ROS consists of manual valves that directly port air to the valve actuators of the HCVS isolation valves. There is instrumentation for vent pressure, vent temperature, and vent radiation dose rate provided at the ROS. Table 1 contains a complete list of instruments available to the operators for operating and monitoring the HCVS.

The following are the final electrical design highlights:

1. The HCVS 125 VDC battery chargers are normally fed from station power and this power feed is also backed up by the FLEX generators.

2. The valves' limit switches provide valve position information via indicating lights in the MCR panels (1/2C644).

3. The Radiation Monitors are powered from the unit's HCVS 125 VDC battery and are located in 1/2D664. The Radiation Monitor output is indicated at both the POS (1/2C644) and the ROS (1/2D644).

4. The hardened vent Radiation Monitor uses a 24 VDC input power supplied from the HCVS 125 VDC battery system.

5. The 125 VDC battery voltage is indicated on 1/2C644.

Attachment 3 contains a one-line 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 (Q, Safety-Related, ASME Section III Class 2, Seismic Class 1). 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 second containment isolation valve and the Reactor Building roof is designed to 65 psig at 350 ºF (ASME Section III Class B). NEI 13-02 suggests a 350°F value for HCVS design temperature based on the highest Primary Containment Pressure Limit (PCPL) among the Mark I and II plants. Susquehanna implemented this guidance.

To prevent leakage of vented effluent to other parts of the Reactor Building or other systems Susquehanna uses dedicated piping systems from the wetwell penetration to the above RB release point. There are no vent piping connections to other plant systems or to the other unit. The containment isolation valves are normally closed, fail closed, and are not required to change state in order to perform their safety related containment isolation function; therefore, they can be assumed to be closed when required. Valves HV1/257113 and HV1/257114 are part of the IST program and are leak tested in accordance with 10 CFR 50, Appendix J. This is acceptable for prevention of inadvertent cross-flow of vented fluids per HCVS-FAQ-05.

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. Susquehanna's 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 (RM), which uses an ion chamber detector, is qualified for the ELAP and external event conditions. In addition to the RM, a temperature element is installed on the vent line to allow the operators to monitor operation of the HCVS. Electrical and control components are seismically qualified and include the ability to handle harsh environmental conditions (although they are not considered part of the site Environmental Qualification (EQ) program).

## Section III.B: HCVS Phase 1 Evaluation Against Requirements:

The functional requirements of Phase 1 of NRC Order EA-13-109 are outlined below along with an evaluation of the Susquehanna response to maintain compliance with the Order and guidance from JLD-ISG-2015-01. Due to the differences 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.

Evaluation:

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 32), 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 provided in the following table:

**Table 1.1.1-1: HCVS Remote Manual Operator Actions**

| Primary Action | Primary Location/ Component | Notes |
|---|---|---|
| 1. Power MCR HCVS Control Panel | Use key-locked switch at HCVS Control Panel in MCR. | Or unlock ROS door if operation is to occur at the ROS. |
| 2. Unlock ROS door and manually operate valves | Manual valves at ROS (simple operator action). | Required to provide gas supply to HCVS valves and rupture disk to initiate system operation. |
| 3. Open Suppression Chamber Primary Containment Isolation Valves (PCIVs) | Separate switches at HCVS Control Panel in MCR. | Alternate PCIV control via manual valves at ROS. |

| Primary Action | Primary Location/ Component | Notes |
|---|---|---|
| 4. Monitor electrical power status, gas pressure, and HCVS conditions. | HCVS Control Panel in MCR . | Monitor gas pressure and HCVS conditions at ROS, if needed. |
| 5. Connect/re-energize HCVS battery charger using portable FLEX Generators | Battery chargers in ROS will be re-energized via FLEX procedure that installs the 4160 VAC FLEX Generators. | The HCVS power supply is capable of operating the system for a minimum of 24 hours. This FLEX action is expected to occur within 6 hours of the initiating event. |
| 6. Replenish gas supply to HCVS PCIVs | At ROS in Control Structure – Elevation 686'-6". Connect backup gas supply to PCIVs. | Prior to depletion of the gas supply (no less than 7 days from initiation of event). |

Permanently installed electrical power and pneumatic supplies are available to support operation and monitoring of the HCVS for a minimum of 24 hours. No HCVS portable equipment needs to be moved support operation of Susquehanna's HCVS during the first 24 hours. FLEX equipment will be moved during the first 6 hours to support the sustained operating period.

After 24 hours, available personnel will be able to connect supplemental electric power and pneumatic supplies for sustained operation of the HCVS for a minimum of 7 days. The FLEX generators and HCVS compressed gas 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 supplemental equipment. The FLEX generator(s) will be functioning within 6 hours and the HCVS gas bottles have sufficient capacity for 7 days.

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 1.1.1-2: Failure Evaluation

| Functional Failure Mode | Failure Cause | Alternate Action | Failure with Alternate Action Impact on Containment Venting? |
|---|---|---|---|
| Failure of Vent to Open on Demand | Solenoid Valves fail to open due to loss of DC power to solenoid valves or complete loss of HCVS power supply | Open 2 manual valves at ROS to bypass solenoid valves. This action directs gas supply to the PCIVs. | No |
| Failure of Vent to Open on Demand | Solenoid Valve fails to open due to mechanical failure of solenoid valve | Open manual valves at ROS to bypass solenoid valves. This action directs gas supply to the PCIVs. | No |
| Failure of Vent to Open on Demand | Valves fail to open due to loss of HCVS power supply (long term) | Recharge HCVS batteries with 4160 VAC FLEX generators. | No |
| Failure of Vent to Open on Demand | Valves fail to open due to loss of gas supply (long term) | Connect portable gas supply to HCVS at backup gas supply connection in the ROS. Replace portable supply, as needed. | No |
| Failure of Vent to Open/Close on Demand | Valve fails to open/close due to valve or valve actuator failure | No alternate action credited since valves may not be accessible. | Yes |

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 (MCR). Alternate control of the HCVS is accomplished from the ROS at the 686'-6" elevation of the Control Structure. FLEX actions that will maintain the MCR habitable were implemented in response to NRC Order EA-12-049 (Reference 33). These actions include:

1. Opening MCR and Control Structure doors to the outside (if required).
2. Operating portable fans to move outside air through the MCR (if required).

Table 2 contains a thermal evaluation of all the operator actions that may be required to support HCVS operation. The relevant ventilation calculations (References 30 and 31) 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 control room is adequately protected from excessive radiation dose and no further evaluation of its use is required. Refer to HCVS-FAQ-06 in Reference 7.

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 ROS is located in a low dose area during normal operation. The ROS is outside of the Reactor Building and in the Control Structure. The distance and shielding from the core or core melt, combined with the short duration of actions required at the ROS show the ROS to be an acceptable location for alternate control.

Table 2 contains the results of 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 (Reference 7) 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 control room is adequately protected from excessive radiation dose and no further evaluation of its use is required (HCVS-FAQ-06, Reference 7).

Alternate control of the HCVS is accomplished from the ROS (Control Structure elevation 686'-6"). The ROS is 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 Susquehanna response to NRC Order EA-12-049 as stated in Reference 40.

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 ventilation calculations (References 30 and 31) 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 EC-073-1019 (Reference 39) contains the verification of 1% power steam flow capacity at the containment design pressure (53 psig). This calculation models all the piping elbows, valves and other components using industry standard flow coefficients to determine an equivalent length of piping. Since the piping consists of 12” and 14” sections, both are modeled. The model is input to the TRAC and MAAP codes which are industry standard programs for modeling compressible flow in piping. The codes also look for flow choking effects. The minimum flow at design pressure to pass 1% Rated Thermal Power (RTP) is 41.2 lbm/sec. EC-073-1019 (Reference 39)verifies that the piping can pass greater than 1% flow, 48.2 lbm/sec at 53 psig. Additional assumptions and modeling details are contained in EC-073-1019 (Reference 39).

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 (53 psig) or the PCPL (65 psig). This calculation of containment response is contained in MAAP calculation EC-073-1019 (Reference 39) that was provided to the NRC on the ePortal and which shows that containment pressure can be maintained below the design pressure once the vent is opened during ELAP conditions.

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 Suppression Chamber through Penetration X-201B and normally closed inboard Containment Isolation Valve (CIV) HV1/257113 and normally closed outboard CIV HV1/257114. Downstream of outboard CIV HV1/257114, the 12” diameter wetwell vent flow path continues through a rupture disk and then exits the Reactor Building at elevation 707’ (which is greater than 30’ above the exterior grade elevation). Exterior to the Reactor Building the wetwell vent pipe expands to 14” diameter, is supported from the Reactor Building wall, and then rises along the exterior of the Reactor Building. The vent line re-enters the Reactor Building at the skin area, passes through check valve 1/257319 and then exits the Reactor Building roof at Elevation 870’. There is a pipe end cover over the pipe discharge to prevent miscellaneous material from entering the pipe. All effluents are exhausted above each unit’s Reactor Building. This discharge point is above each unit’s Reactor Building parapet wall. Part of the HCVS-FAQ-04 (Reference 11) guidance is designed to ensure that vented effluents are not drawn immediately back into any ELAP emergency ventilation intakes. Per the HCVS-FAQ-04 (Reference 11) guidance such ventilation intakes should be below the level of the pipe discharge by 1 foot for every 5 horizontal feet (1:5) of discharge to intake separation. The MCR emergency air intake in the ELAP event is at the 670 feet elevation which is approximately 200 feet below the HVCS pipe outlet. This intake is less than 20 horizontal feet from either vent pipe discharge point, which would require the intake to only be approximately 4 feet below the vent pipe discharge point using the 1:5 guidance. Therefore, the vent pipe discharge point is appropriately placed relative to the ELAP air intake.

The vent pipe extends more than 3 feet above the parapet wall of the RB roof. This satisfies the guidance for height from HCVS-FAQ-04 (Reference 11).

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

Susquehanna evaluated the vent pipe robustness with respect to wind-borne missiles against the requirements contained in HCVS-WP-04 (Reference 11). 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, provide a description of how this portion of the pipe is protected or robust. Susquehanna does not have any exposed HCVS pipe external to the Reactor Building below 30 feet above grade. At Susquehanna, the grade elevation near the HCVS pipe external to the Reactor Building is ~ 670 feet and the HCVS pipe penetrated the Reactor Building wall at ~ 707 feet. This results in an elevation difference of ~ 37 feet.

2. The exposed piping greater than 30 feet above grade has the following characteristics:

  a. The total vent pipe exposed area for Unit 2 is ~ 205 square feet which is less than the 300 square feet. The total vent pipe exposed area for Unit 1 is ~ 350 square feet which is greater than the 300 square feet and has been evaluated as acceptable under AR/EWR-2016-18566 (Reference 44).

  b. The vent pipe thickness is at least that of schedule 40 carbon steel pipe. The pipe is made of steel not plastic. The exposed pipe is at least 12” in diameter. The exposed 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. Susquehanna maintains saws capable of cutting the HCVS pipe in the FLEX Building as part of the FLEX equipment. These saws are capable of cutting an opening into the vent pipe should it become damaged such that it restricts flow to an unacceptable level.

4. Susquehanna maintains severe weather preparedness procedures that require the plant to consider reducing reactor power prior to the arrival of sustained hurricane force winds on site.

Based on the above description of the vent pipe design, the Susquehanna 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 and 2 are fully independent of each other and other piping systems in each unit. Therefore, the status at each unit is independent of the status of the other unit. There are no HCVS piping connections between the two units at Susquehanna. There are no HCVS piping connections to other systems (except the Primary Containment) within the units at Susquehanna.

The wetwell vent exits the Primary Containment Suppression Chamber through Penetration X-201B and normally closed inboard Containment Isolation Valve (CIV) HV1/257113 and normally closed outboard CIV HV1/257114. These are both normally closed and failed close valves – they need air to open and are spring to close. Downstream of outboard CIV HV1/257114, the 12” diameter wetwell vent flow path continues through a rupture disk and then exits the Reactor Building at elevation 707’ (which is greater than 30’ above the exterior grade elevation). Exterior to the

Reactor Building the wetwell vent pipe expands to 14" diameter, is supported from the Reactor Building wall, and then rises along the exterior of the Reactor Building. The vent line re-enters the Reactor Building at the skin area, passes through check valve 1/257319 and then exits the Reactor Building roof at Elevation 870'. There is a pipe end cover over the pipe discharge to prevent miscellaneous material from entering the pipe. All effluents are exhausted above each unit's Reactor Building. This discharge point is above each unit's Reactor Building parapet wall.

Based on the above description, the Susquehanna 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 main control room or a remote but readily accessible location.

Evaluation

The HCVS wetwell vent will allow initiating and then operating and monitoring from the POS which is at a control panel located in the MCR. The HCVS valves can also be opened from the ROS without any electricity needed. The ROS is in the Control Structure only a short distance from 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.

Evaluation

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 pneumatic pressure to the HCVS flow path valve actuators so that these valves may be opened without power to the valve actuator solenoids. Susquehanna's HCVS CIVs are normally Closed and Fail Closed valves and require multiple actions to open the CIVs from either the POS or the ROS and therefore do not receive any containment isolation signals. This provides a diverse method of valve operation improving system reliability.

The ROS for both units is located in the southwest corner of the Control Structure 686'-6" elevation. The ROS is located within the Control Structure in an area shielded from the HCVS vent pipes by intervening structures, with a direct travel path from the ROS to the MCR. Refer to the sketch provided in Attachment 6a for the HCVS ROS location. 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 reactor building 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. Attachments 6 and 6a contain a plant layout and ROS layout that show the location of these non-MCR HCVS actions.

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

Evaluation

HCVS-WP-01 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 generators 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 generators 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 dedicated HCVS 125 VDC batteries for each unit. These batteries are permanently installed in the Control Building 686’-6” elevation (i.e. – in the ROS) where they are protected from screened-in hazards, and have sufficient capacity to provide this power without recharging. Calculation EC-002-1081 demonstrated that the 125 VDC battery capacity is sufficient to supply HCVS wetwell venting components for 24 hours. After 24 hours, FLEX generators can be credited to repower the station instrument buses and/or the battery charger to recharge the 125 VDC batteries, gas control during recharging and room temperature control is per the response to order EA-12-049. Calculation EC-FLEX-0015 included the 125 VDC HCVS battery chargers in the FLEX generator loading calculation. The FLEX generators are capable of carrying the HCVS wetwell venting component's electrical loads. The HCVS 125 VDC battery voltage status will be indicated in both the MCR and ROS so that operators will be able to monitor the status of the HCVS 125 VDC batteries. Attachment 3 contains a diagram of the HCVS electrical distribution system.

Pneumatic power for the HCVS valve actuators is provided by the dedicated HCVS compressed air system. Therefore, for the first 24 hours post-ELAP initiation, pneumatic force will be supplied from the dedicated HCVS compressed air system located in the ROS. Calculation EC-073-1018 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 greater than 24 hours without replenishment. Subsequent evaluation of the compressed air system determined that it will operate for at least 7 days without replenishment (action DPA-04-DI-2015-23844 disposition, Reference 42). HCVS compressed air system pressure indication is provided in the MCR and ROS.

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

Evaluation

Emergency operating procedures provide clear guidance that the HCVS is not to be used to defeat containment integrity during any design basis transients and accidents. In addition, the HCVS was designed to provide features to prevent inadvertent actuation due to equipment malfunction or operator error. Also, these protections are designed such that any credited containment accident pressure (CAP) that would provide net positive suction head to the emergency core cooling system (ECCS) pumps will be available (inclusive of a design basis loss-of-coolant accident, Susquehanna does not credit CAP for ECCS net positive suction head). 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 to energize the HCVS at panel 1/2C644 (the HCVS is normally deenergized) in the primary operating station (MCR),
- the ROS is locked closed,
- closed pneumatic supply valves in the locked closed ROS room, and

- Separate keylock switches for each unit's system.

These design features (isolated electrical and gas supply to the HCVS CIVs in access controlled rooms) 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 the HCVS battery voltage and pneumatic gas supply pressure.

This monitoring instrumentation provides the indication from the MCR per EA-13-109 Requirement 1.2.4. Until the FLEX generators energize the emergency buses, the wetwell HCVS and required containment instrumentation will be supplied by the HCVS and station 125 VDC batteries, respectively. The instrumentation is 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 in Table 1. These instruments include the ability to handle harsh environmental conditions (although they may not be considered part of the site Environmental Qualification (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 processing module. The processing module is mounted in ROS panel 1/2D644 in the Control Structure 686’-6” elevation. The RM detector is fully qualified for the expected environment at the vent pipe during accident conditions, and the processing module is qualified for the mild environment in the Control Structure 686’-6” elevation. Both components are qualified for the seismic requirements. Table 1 includes a description and qualification information for 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 HCVS vent piping, between the wetwell and the Reactor Building roof, including the CIVs is designed to 65 psig at 350 ºF. 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. DPA-11-DI-2015-23844 (Reference 43) contains the response to the NRC’s ISE open item 7 (Reference 20), by referencing the design information in the Engineering Change documents EC 1881014, EC 1881034, EC 1881029, and EC 1672802 that specify the design parameters for Susquehanna’s HCVS based on 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 (Reference 7). 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 reactor building or other buildings.

Evaluation

The response under EA-13-109 Requirement 1.2.3 explains how the potential for hydrogen migration into other systems, the reactor building 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.

Susquehanna has implemented the following operation, testing and inspection requirements for the HCVS to ensure reliable operation of the system. These requirements are based on NEI 13-02, Table 6.1 (Reference 7). The implementing modification packages contain these as well as additional testing required for post-modification testing. Susquehanna's HCVS has no interfacing system valves.

Table 3-3: Testing and Inspection Requirements

| Description | Frequency |
|---|---|
| Cycle the HCVS valves[1] and the interfacing system boundary valves not used to maintain containment integrity during Mode 1, 2 and 3. For HCVS valves, this test may be performed concurrently with the control logic test described below. | Once per every[2] operating cycle. |
| Cycle the HCVS check valves not used to maintain containment integrity during unit operations.[3] | Once per every other[4] operating cycle. |
| Perform visual inspections and a walk down of HCVS components | Once per every other[5] operating cycle. |
| Functionally test the HCVS radiation monitors. | Once per operating cycle. |
| Leak test the HCVS. | (1) Prior to first declaring the system functional;<br>(2) Once every three operating cycles thereafter; and<br>(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[6] valves move to their proper (intended) positions. | Once per every other operating cycle. |

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[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] 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.

[6] Interfacing system boundary valves that are normally closed and fail closed under ELAP conditions (loss of power and/or air) do not require control function testing under this section. Performing existing plant design basis function testing or system operation that reposition the valve(s) to the HCVS required position will meet this requirement without the need for additional testing.

2. HCVS Quality Standards:

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

Evaluation:

The HCVS penetration and containment isolation valves are designed and installed 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(s).

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.

## Section IV: HCVS Phase 2 Final Integrated Plan

### Section IV.A: EA-13-109 requirements, Attachment 2, Section B for Phase 2

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

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

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

B.1 HCVS Drywell Vent Functional Requirements (not chosen by Susquehanna)

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.

B.2 Containment Venting Strategy Requirements (chosen by Susquehanna)

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 Severe Accident Water Addition (SAWA) in conjunction with Severe Accident Water Management (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.

Susquehanna 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.

## Section IV.B: HCVS Existing System

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

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

The HCVS Phase 2 Severe Accident Water Addition (SAWA) system and Severe Accident Water Management (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.

Susquehanna has implemented the containment venting strategy utilizing SAWA and SAWM. The SAWA system consists of a FLEX (SAWA) pump injecting into the Reactor Pressure Vessel (RPV) and SAWM consists of flow control at or near 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 Severe Accident Management Guidelines (SAMG). This strategy has been shown via Modular Accident Analysis Program (MAAP) analysis to protect containment without requiring a drywell vent for at least seven days which is the guidance from NEI 13-02 for the period of sustained operation.

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

The SAWA flow path is the same as the FLEX primary injection path except that a second hose run has been added to the hose run from the FLEX(SAWA) pump to the ESSWPH FLEX connection points. The SAWA system, shown on Attachment 4, consists of a FLEX pump injecting into the Reactor Pressure Vessel (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 Ultimate Heat Sink (Spray Pond), goes to the FLEX pump via suction hoses, goes through the pumper truck mounted FLEX pump and flow meters to the discharge hoses that run to the ESSWPH, then to the FLEX connections into the RHRSW system in the ESSWPH. The hoses and pumps are stored in the FLEX Storage Building (FSB) which is protected from all hazards. From the RHRSW FLEX connection points, the FLEX (SAWA) flow path runs through the RHRSW system to the RHR system. This RHR connection allows the water to flow into the Reactor Pressure Vessel (RPV). BWROG generic assessment, BWROG-TP-15-008, provides the principles of Severe Accident Water Addition to ensure protection of containment. This SAWA injection path is qualified for the all the screened-in hazards (Section III of this FIP) in addition to severe accident conditions.

### Section IV.C.2: Severe Accident Assessment of Flow Path

Any manual actions required for FLEX (SAWA) inside the RB where there could be a high radiation field due to a severe accident will be performed before the dose is unacceptable, within 6 hours from the start of the ELAP. This time was validated as part of the Time Sensitive Action validation for EA-12-049. The other SAWA actions all take place outside the RB (or inside the RB at a safe location) at the MCR, ROS, ESSWPH, FSB, and near the ‘E’ emergency diesel generator 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 Primary Containment and 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 wetwell level or a slowly rising trend in wetwell level with SAWA at the minimum flow rate indicates water level on the drywell floor is up to or above 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 wetwell to the point where the wetwell vent is submerged.

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

Susquehanna 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.

Section IV.C.4: Available Freeboard Use

The freeboard between elevations 671' (normal suppression pool level) and 686.4' (bottom of HCVS wetwell vent penetration) in the wetwell provides over 560,000 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 Severe Accident Water Management 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 EC-FLEX-0021 and EC-016-1043, 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.

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

The upper range of wetwell level indication provided for SAWA/SAWM is 49 feet which corresponds to an elevation of 697'. This is well above the upper limit of wetwell volume that will preserve the wetwell vent function as shown in Attachment 1 (38.4' of level, elevation 686.4').

Section IV.C.6: Wetwell vent service time

Susquehanna calculations EC-073-1019, EC-FLEX-0021, and BWROG-TP-15-011, demonstrate 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.

Section IV.C.7: Strategy time line

The overall accident management plan for Susquehanna is developed from the BWR Owner's Group Emergency Procedure Guidelines and Severe Accident Guidelines (EPG/SAG). As such, the SAWA/SAWM implementing procedures are integrated into the Susquehanna 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 letter from Nicholas X. Pappas, Senior Project Manager of NEI to Industry Administrative Points of Contact, *Validation Document for FLEX Strategies* (Reference 41), dated July 18, 2014 Susquehanna 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.

Susquehanna calculation EC-073-1019 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 decreasing 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

Susquehanna will accomplish SAWA flow control by the use of throttle valves in the SAWA flow path or controlling the pump discharge flow rate. The operators at the SAWA pump will be in communication with the MCR via radios, runners, or satellite phones 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 those 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

Susquehanna uses one portable diesel-driven pump for FLEX and SAWA. One pump is capable of providing the total flow needs for one unit using FLEX and the other unit using SAWA and other needs that total 1330 gpm at the pressures required for RPV injection during an ELAP (~210 psid or ~485 feet of head). Susquehanna owns 2 portable diesel-driven pumps for this purpose (N+1). Each of these pumps has been shown to be capable of supplying the required flow rate to the RPVs and the SFP for FLEX and for SAWA scenarios (EC-013-1896). The pumps are stored in the FSB where they are protected from all screened-in hazards and are rugged, over the road units, and therefore will be available to function after a seismic event.

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

Susquehanna's initial 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. After 4 hours of the initial 500 gpm injection the flow rate can be throttled down to 100 gpm. Susquehanna calculations EC-073-1019 and EC-FLEX-0021 assume an initial SAWA flow of 500 gpm starting 8 hours after the loss of injection and demonstrate that the containment is protected at this initial flow rate and subsequent reduction in flow to 100 gpm.

### Section IV.C.9.3: SAWA Pump Hydraulic Analysis

Susquehanna calculations EC-013-1896, EC-FLEX-0021, and EC-073-1019 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 Susquehanna SAWA flow path includes methods to minimize exposure of personnel to radioactive liquids / gases and potentially flammable conditions by inclusion of backflow prevention. The RHR LPCI injection path has installed ECCS backflow prevention devices (HV151F050A/B, HV251F050A/B) qualified for design basis accident scenarios. The RHR backflow prevention valves are also Primary Containment Isolation Valves (PCIVs) 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 Table 6-1 Note 3. Thus, backflow is prevented by check valves in the SAWA flow path inside the RB.

### Section IV.C.9.5: SAWA Water Source

The initial source of water for SAWA is the UHS (Spray Pond) which can provide over 7 days of water injection without makeup based on the FLEX analysis. Before this initial supply of water is depleted, the N+1 FLEX pump, the NSRC-supplied pumps, or other pumps will be deployed to re-fill the UHS from the Cooling Tower basins or the Susquehanna River. The suction of the FLEX pumps could also be swapped to the Cooling Tower basins. 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 FSB where they are protected from all screened-in hazards. The SAWA pumps are commercial fire service type pumps rated for long-term outdoor use in emergency scenarios. The pumps are diesel-driven by an engine mounted on the truck 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: FLEX Generator loading calculation for SAWA/SAWM equipment

Table 1 shows the electrical power source for the SAWA/SAWM instruments. For the instruments powered by the dedicated HCVS 125 VDC batteries, calculation EC-002-1081 demonstrates that they can provide power until the FLEX generator restores power to the battery charger.

The FLEX and HCVS loads on the FLEX generators per EA-12-049 were evaluated in calculation EC-FLEX-0015. This calculation demonstrated over 200 kW of total margin to full load of the FLEX generators. There are no additional loads on the FLEX generators for SAWA and SAWM. The FLEX generators were qualified to carry 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 batteries for at least 8 hours and will be re-powered by FLEX generator systems for the sustained operating period. These instruments are on buses included in the FLEX generator loading calculations 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 paddlewheel type flow meter mounted in the pumper truck before the hose run to the ESSWPH and does not require any electrical power from outside the pumper truck.

No containment temperature instrumentation is required for compliance with HCVS Phase 2. However, the 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 2 (Reference 34) which is the Susquehanna committed version per UFSAR Section 7, Table 7.5-3 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 is not deployed on the same side of the RB as 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

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

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

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

Since the SAWA pump is stored in the FSB and will be operated from outside the RB, and is not deployed on the same side of the RB as 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 flow path consists of stainless steel pipe which will remain unaffected by the radiation or elevated temperatures inside the RB. Therefore, the SAWA flow path 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.9.3, 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 6 hours. The actions including access routes outside the Reactor Building 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, Susquehanna performed calculations of the temperature response of the Reactor Buildings and Control Structure 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. Attachment 6 shows the approximate locations of the actions.

After the SAWA flow path 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 and the SAWA pump is operated from outside the RB at ground level. The Susquehanna FLEX response ensures that the SAWA pump, FLEX generators, and other equipment can all be run for a sustained period by refueling. All the refueling locations are located in shielded or protected areas so that there is no radiation hazard from core material during a severe accident. The monitoring instrumentation includes SAWA flow at or near the 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 engineering design change documents contain instructions for developing the HCVS specific procedures.

The HCVS and SAWA procedures have been developed and implemented following Susquehanna'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.

Susquehanna implemented BWROG Emergency Procedures Committee Issue 1314 into procedure EP-DS-002 RPV and PC Water Addition (SAG-2). BWROG Emergency Procedures Committee Issue 1314 that implements the Severe Accident Water Management (SAWM) strategy in the Severe Accident Management Guidelines (SAMGs). 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. Several other issues that modified or enhanced Issue 1314 were also included.

A sample flowchart provided by the BWROG was utilized to develop the Susquehanna guidance as close to the generic BWROG guidance as possible. The procedure has been reprioritized so that Containment flooding is only used as a recovery action, or if the HCVS is lost. Priorities are first to attempt to restore and maintain RPV water level above TAF. If that cannot be done than an attempt is made to stabilize core debris in the RPV. If that fails than priority shifts to preserve containment function for the RPV breach. After the breach priority shifts to stabilization of core debris while preserving the HCVS. A focus is placed on actions throughout the procedure to minimize injection from external sources when possible to preserve the HCVS system. Once a Reactor Vessel breach occurs the procedure directs the use of SAWA water flow from sources external to containment until core debris has stabilized (approximately 4 hours). Then flow is reduced to the SAWM flowrates to remove decay heat while maintaining suppression pool level below the HCVS vent elevation. Target flowrates for SAWA (500 gpm) and SAWM (100 gpm) are included on the flowchart. Specific SAWA/SAWM implementation instructions are contained in implementing procedures DC-B5B-102 and DC-B5B-202. These procedures detail the pumper truck operations along with the hose layouts and flow measurements required. Injection flow path valve manipulations are included.

## <u>Section V.B</u>: HCVS Out of Service Requirements

Provisions for out-of-service requirements of the HCVS and compensatory measures have been added to EP-115 so that the HCVS equipment is included with the FLEX out-of-service program.

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

**<u>NOTE</u>:** 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, Section 6.3 (Reference 7).

- If for up to 90 consecutive days, the primary <u>or</u> alternate means of HCVS operation are non-functional, no compensatory actions are necessary.
- If for up to 30 consecutive days, the primary <u>and</u> alternate means of HCVS operation or SAWA operation are non-functional, no compensatory actions are necessary.

- If the out of service times exceed 30 or 90 days as described above, the corrective action system will be used to complete the following items:
    - Determine the cause(s) of the non-functionality,
    - Determine the actions to be taken and the schedule for restoring the system to functional status and prevent recurrence,
    - Initiate action to implement appropriate compensatory actions, and
    - Restore full HCVS functionality at the earliest opportunity not to exceed one full operating cycle.

The HCVS system is functional when piping, valves, instrumentation and controls including motive force necessary to support system operation are available to perform their design function. Since the system is designed to allow a primary control and monitoring or alternate valve control by Order Requirements 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.

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

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

## Section V.C: HCVS Training Requirements

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

Evaluation:

Personnel expected to perform direct operation 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 (SAT) process.

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

## Section V.D: Demonstration with other Post Fukushima Measures

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

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

### Evaluation

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

The use of the HCVS and SAWA capabilities will be demonstrated during drills, tabletops or exercises consistent with NEI 13-06 (Reference 37) and on a frequency consistent with 10 CFR 50.155(e)(4) (Reference 38). Susquehanna will perform the first drill, tabletop or exercise demonstrating at least one of the above capabilities by April 30, 2022 which is within four years of the first unit compliance with Phase 2 of Order EA-13-109, or consistent with the next FLEX strategy drill or exercise. Subsequent drills, tabletops or exercises will be performed to demonstrate the capabilities of different elements of Items 1, 2 and/or 3 above that is applicable to Susquehanna in subsequent eight year intervals.

## Section VI: References

| Number | Rev | Title | Location[7] |
|---|---|---|---|
| 1. GL-89-16 | 0 | Installation of a Hardened Wetwell Vent (Generic Letter 89-16), dated Sept 1, 1989. | ML031140220 |
| 2. SECY-12-0157 | 0 | Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments | ML12345A030 |
| 3. SRM-SECY-12-0157 | 0 | Staff Requirements – SECY-12-0157 – Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments | ML13078A017 |
| 4. EA-12-050 | 0 | Order to Modify Licenses with Regard to Reliable Hardened Containment Vents | ML12054A694 |
| 5. EA-13-109 | 0 | Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions | ML13143A321 |
| 6. NEI 13-02 | 0 | Industry Guidance for Compliance with Order EA-13-109, BWR Mark I & II Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions | ML13316A853 |
| 7. NEI 13-02[8] | 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<br>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<br>ML14358A040 |
| 10. HCVS-WP-03 | 1 | Hydrogen/Carbon Monoxide Control Measures Revision 1, October 2014 | ML14302A066<br>ML15040A038 |
| 11. HCVS-WP-04 | 0 | Missile Evaluation for HCVS Components 30 Feet Above Grade | ML15244A923<br>ML15240A072 |
| 12. JLD-ISG-2013-02 | 0 | Compliance with Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions | ML13304B836 |

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[7] Where two ADAMS accession numbers are listed, the first is the reference document and the second is the NRC endorsement of that document.

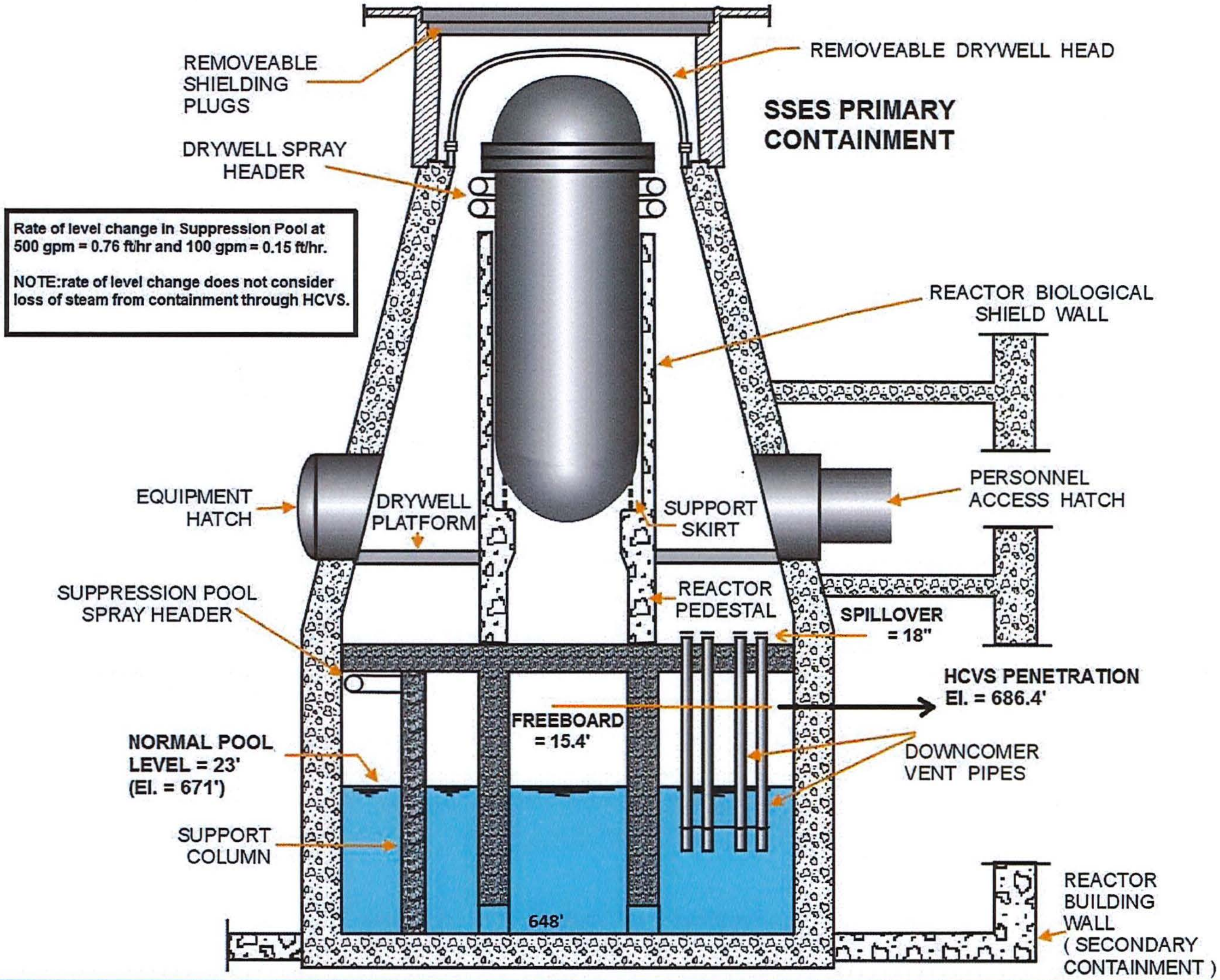
[8] NEI 13-02 Revision 1 Appendix J contains HCVS-FAQ-01 through HCVS-FAQ-09.

| Number | Rev | Title | Location[7] |
|---|---|---|---|
| 13. JLD-ISG-2015-01 | 0 | Compliance with 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<br>ML15271A148 |
| 15. HCVS-FAQ-11 | 0 | Plant Response During a Severe Accident | ML15273A141<br>ML15271A148 |
| 16. HCVS-FAQ-12 | 0 | Radiological Evaluations on Plant Actions Prior to HCVS Initial Use | ML15273A141<br>ML15271A148 |
| 17. HCVS-FAQ-13 | 0 | Severe Accident Venting Actions Validation | ML15273A141<br>ML15271A148 |
| 18. Phase 1 OIP | 0 | PLA-7180, OVERALL INTEGRATED PLAN IN RESPONSE TO JUNE 6, 2013 COMMISSION ORDER TO MODIFY LICENSES WITH REGARD TO RELIABLE HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS (ORDER NUMBER EA-13-109), Jun 26, 2014 | ML14177A349<br>ML14177A364<br>ML14177A731 |
| 19. Combined OIP | 0 | PLA-7421, COMBINED PHASE 1 AND PHASE 2 OVERALL INTEGRATED PLAN IN RESPONSE TO JUNE 6, 2013 COMMISSION ORDER MODIFYING LICENSES WITH REGARD TO RELIABLE HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS (ORDER NUMBER EA-13-109), Dec 23, 2015 | ML15362A528 |
| 20. Phase 1 ISE | 0 | HCVS Phase 1 Interim Staff Evaluation (ISE) | ML15090A300 |
| 21. Phase 2 ISE | 0 | HCVS Phase 2 Interim Staff Evaluation (ISE) | ML16231A509 |
| 22. 1st Update | 0 | HCVS First Six Month Update, PLA-7269, Dec 2015 | ML15040A155 |
| 23. 2nd Update | 0 | HCVS Second Six Month Update, PLA-7345, Jun 2015 | ML15174A052 |
| 24. 3rd Update | 0 | HCVS Third Six Month Update, PLA-7421, Dec 2015 | ML15362A528 |
| 25. 4th Update | 0 | HCVS Fourth Six Month Update, PLA-7488, Jun 2016 | ML16181A179 |
| 26. 5th Update | 0 | HCVS Fifth Six Month Update, PLA-7550, Dec 2016 | ML16355A294 |
| 27. 6th Update | 0 | HCVS Sixth Six Month Update, PLA-7612, Jun 2017 | ML17166A472 |
| 28. 7th Update | 0 | HCVS Seventh Six Month Update, PLA-7658, Dec 2017 | ML17348A049 |

| Number | Rev | Title | Location[7] |
|---|---|---|---|
| 29. PLA-7711 | 0 | Report of Full Compliance with June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (NRC Order EA-13-109) | TBD |
| 30. MCR SBO Heat-up Calc. | 0 | EC-030-1006, Rev. 14, Control Structure Temperature Response to a Station Blackout or Fire Induced Loss of Control Structure HVAC | N/A |
| 31. ROS Room Heat-up and Rad Calcs. | 0 | EC-030-1007, Appendix CC (Heat-up), EC-RADN-1180 (Radiation) | N/A |
| 32. NEI 12-06 | 0 | Diverse and Flexible Coping Strategies (FLEX) Implementation Guide | ML12221A205 |
| 33. 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 |
| 34. RG 1.97 | 2 | Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Conditions During and Following an Accident | ML060750525 |
| 35. 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 |
| 36. 9th 6 month MS Update | | Mitigation Strategies Seventh Six Month Update, PLA-7632, Aug 2017 | ML17237A055 |
| 37. NEI 13-06 | 1 | Enhancements to Emergency Response Capabilities for Beyond Design Basis Events and Severe Accidents | N/A |
| 38. SECY-16-0142 | | Draft Final Rule—Mitigation of Beyond-Design-Basis Events | ML16291A186 |
| 39. EC-073-1019 | | Flow Capacity of Unit 2 Hardened Containment Vent System Under ELAP Conditions | N/A |
| 40. PLA-7710 | | Report of Full Compliance with March 12, 2012 Commission Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events (NRC Order EA-12-049) | TBD |
| 41. NEI letter APC 14-17 | | NEI letter to Administrative Points of Contact (APC 14-17), Validation Document for FLEX Strategies, dated July 18, 2014. | |

| Number | Rev | Title | Location[7] |
|---|---|---|---|
| 42. DPA-04-DI-2015-23844 | | DPA-04-DI-2015-23844 contains the response to the pneumatic supply for the 7 days Sustained Operation Period in NEI 13-02 Revision 1 | SSES |
| 43. DPA-11-DI-2015-23844 | | DPA-11-DI-2015-23844 contains the response to the NRC’s ISE open item 7 (local conditions during ELAP and Severe Accident | SSES |
| 44. AR/EWR-2016-18566 | | AR/EWR-2016-18566 vent pipe exposed area evaluation | SSES |

## Attachment 1: Phase 2 Freeboard diagram



Rate of level change in Suppression Pool at 500 gpm = 0.76 ft/hr and 100 gpm = 0.15 ft/hr.

NOTE:rate of level change does not consider loss of steam from containment through HCVS.

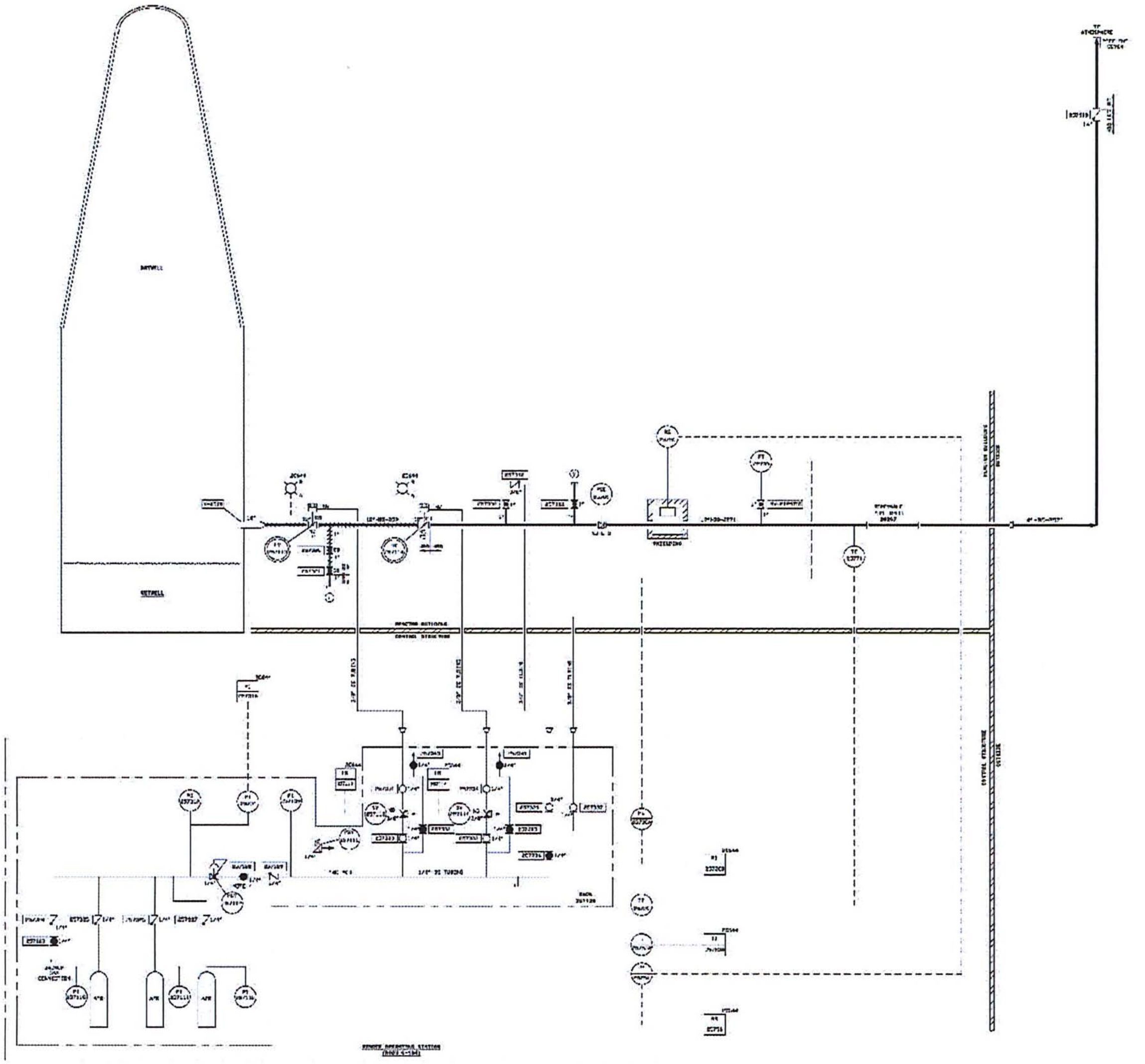
## Attachment 1: Phase 2 Freeboard diagram (continued)

| | **Susquehanna Data** |
|---|---|
| Wetwell water level instrument | UR15776A(B), UR25776A(B) Range 4.5 to 49 feet (Elevation 652.5' to 697')<br>Located in Main Control Room |
| Wetwell HCVS Penetration<br>X-201B-U2<br>X-201B-U1 | Centerline Elevation = 687'-1"<br>Elevation at bottom of penetration = 686.4 feet<br>Water level at bottom of penetration = 686.4 – 648 = 38.4 feet |
| Normal suppression pool water level | 23 feet (El. = 648 feet + 23 feet = 671 feet) |
| Elevation at bottom of suppression pool | 648 feet |
| Initial freeboard | 686.4 feet – 671 feet = 15.4 feet |
| SAWA flow rate | • Initiate 500 gpm to RPV at 8 hour (time of vessel breach).<br>• Maintain 500 gpm for 4 hour (Ref. BWROG-TP-15-011, Rev. 0, §2).<br>• At 12 hour, reduce flow to 100 gpm. (Ref. NEI 13-02, Rev. 1, p. C-5).<br>• Maintain injection at 100 gpm for up to 7 days.<br>Note: Timing based on ELAP with RCIC failure on demand and no credit for HPCI. Per Susquehanna EA-12-049 OIP Timeline (Ref. 36), FLEX (SAWA) injection to RPV would be available at 6 hour. Assumed 8 hours for start of SAWA in order to provide consistency with BWROG-TP-15-011, Rev. 0 and NEI 13-02, Rev. 1, §C.7.1.1. |
| Estimated suppression chamber level response during SAWA | Suppression pool level will be maintained below the wetwell vent elevation when using SAWA flow rates consistent with §C.7.1.1 of NEI 13-02, Rev. 1, (Initial 500 gpm flow rate for 4 hours which is then reduced to 100 gpm and maintained until t = 7 days. The rate of rise is 0.76 feet/hour at 500 gpm and 0.15 feet/hour at 100 gpm (neglects steam loss through vent). |

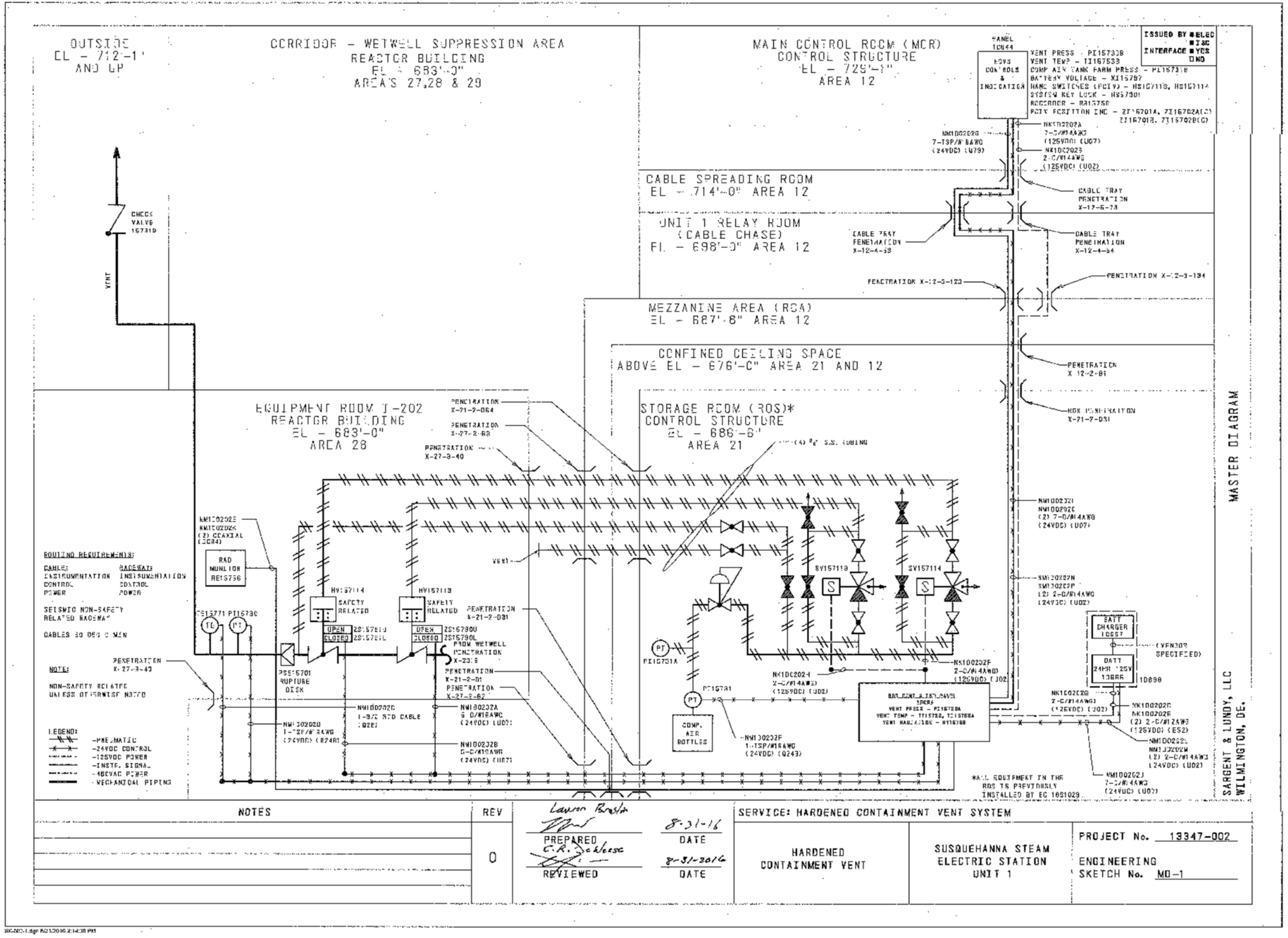
## Attachment 1: Phase 2 Freeboard diagram (continued)

<table>
<tr><th></th><th>Susquehanna Data</th></tr>
<tr><td>SP Water Level (feet)<br>22.0 (Tech. Spec Low Limit)<br>24.0 (Tech. Spec. High Limit)<br>38.4 (Bottom of HCVS Penetration)</td><td>Suppression Pool Water Volume (Gal.)<br>915,627<br>998,879<br>1,567,275<br>Ref. SSES Tech. Spec. Bases §3.6.2.2 and FSAR Table 6.2-23.</td></tr>
<tr><td>SAWA flow rate instrumentation</td><td>Two hoses will be routed to separate 5-inch FLEX hose connections in the ESSW Pumphouse. One connection will supply water to Unit 1 RHR loop through RHRSW-to-RHR cross-tie line, and the other connection will supply water to Unit 2 through an independent RHRSW-to-RHR cross-tie line. The hose to the SAWA unit begins at a pumper truck connection downstream of a pumper truck mounted flow meter that will be used to monitor the flow rate to the SAWA unit.</td></tr>
<tr><td>Reference Plant Comparison (for comparing to the evaluations in BWROG-TP-15-008 “Severe Accident Water Addition Timing”, and BWROG-TP-15-011, “Severe Accident Water Management Supporting Evaluations”)</td><td>Both units at Susquehanna are Mark II containments. The table below shows that the Susquehanna containment freeboard and SAWA flow rates are comparable to the reference plant evaluations.
<table>
<tr><th>Reference Plant</th><th>Susquehanna</th></tr>
<tr><td>Torus freeboard volume is 525,00[1] gallons</td><td>Suppression Pool freeboard volume is greater than 560,000 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 Susquehanna 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 Susquehanna makes it unlikely that a DW vent is needed to prevent containment overpressure related failure.</td></tr>
</table>
[1] The Reference Plant (Peach Bottom) available freeboard volume in gallons is estimated from nominal water level of 14.7 feet to 21 feet. 21 feet is the upper range of the wide range torus level instrument and the assumed loss of wetwell vent function. The Peach Bottom torus is 31 feet in diameter.</td></tr>
</table>

**Attachment 2: One Line Diagram of HCVS for Unit 2 (Unit 1 is similar, different component identifiers)**
(see Susquehanna drawings M-157, Sheet 9 and M-2157 Sheet 9 for full details)

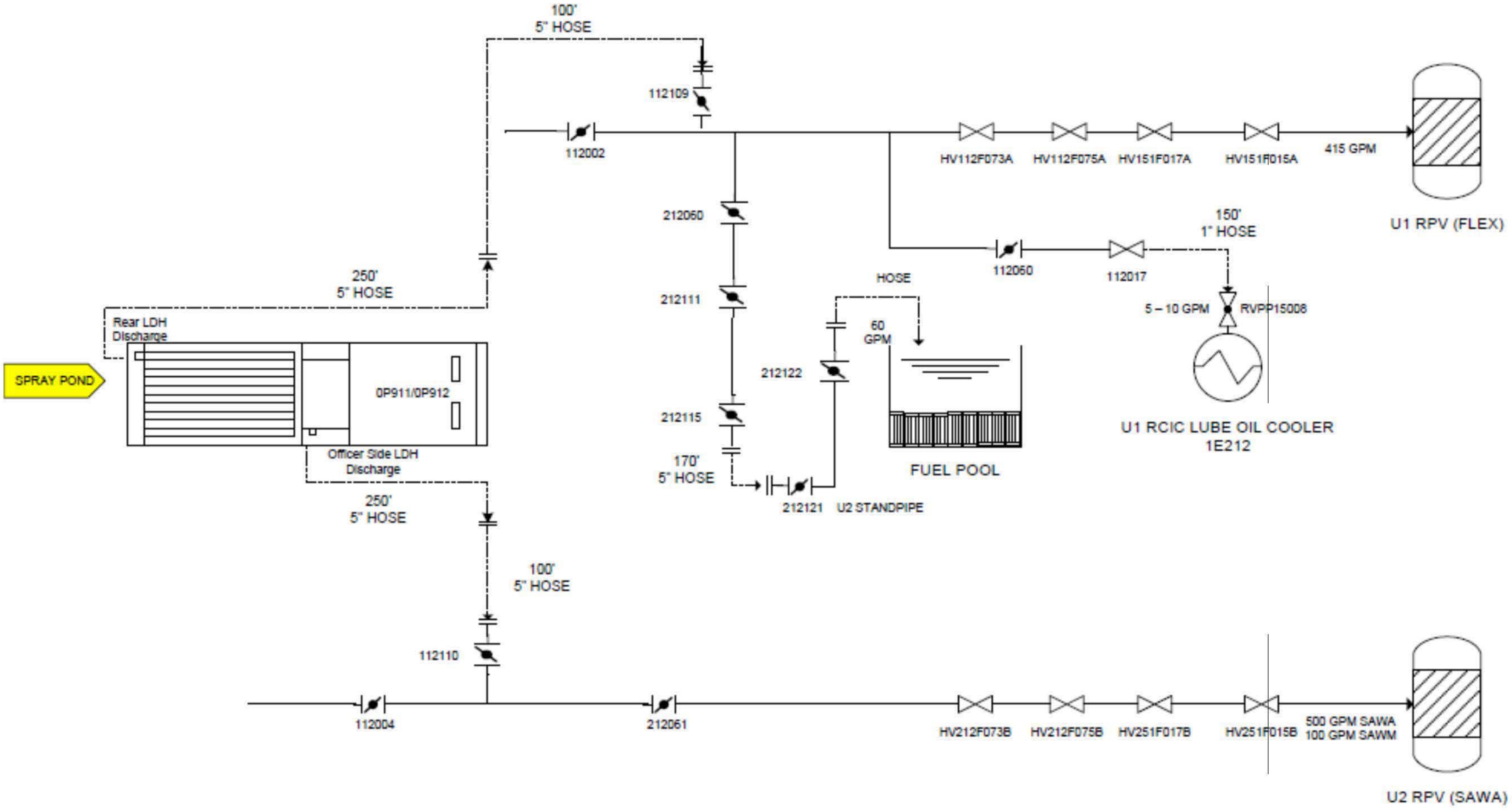


## **Attachment 3**: One Line Diagram of HCVS Electrical Power Supply - Unit 1 (Unit 2 is similar)

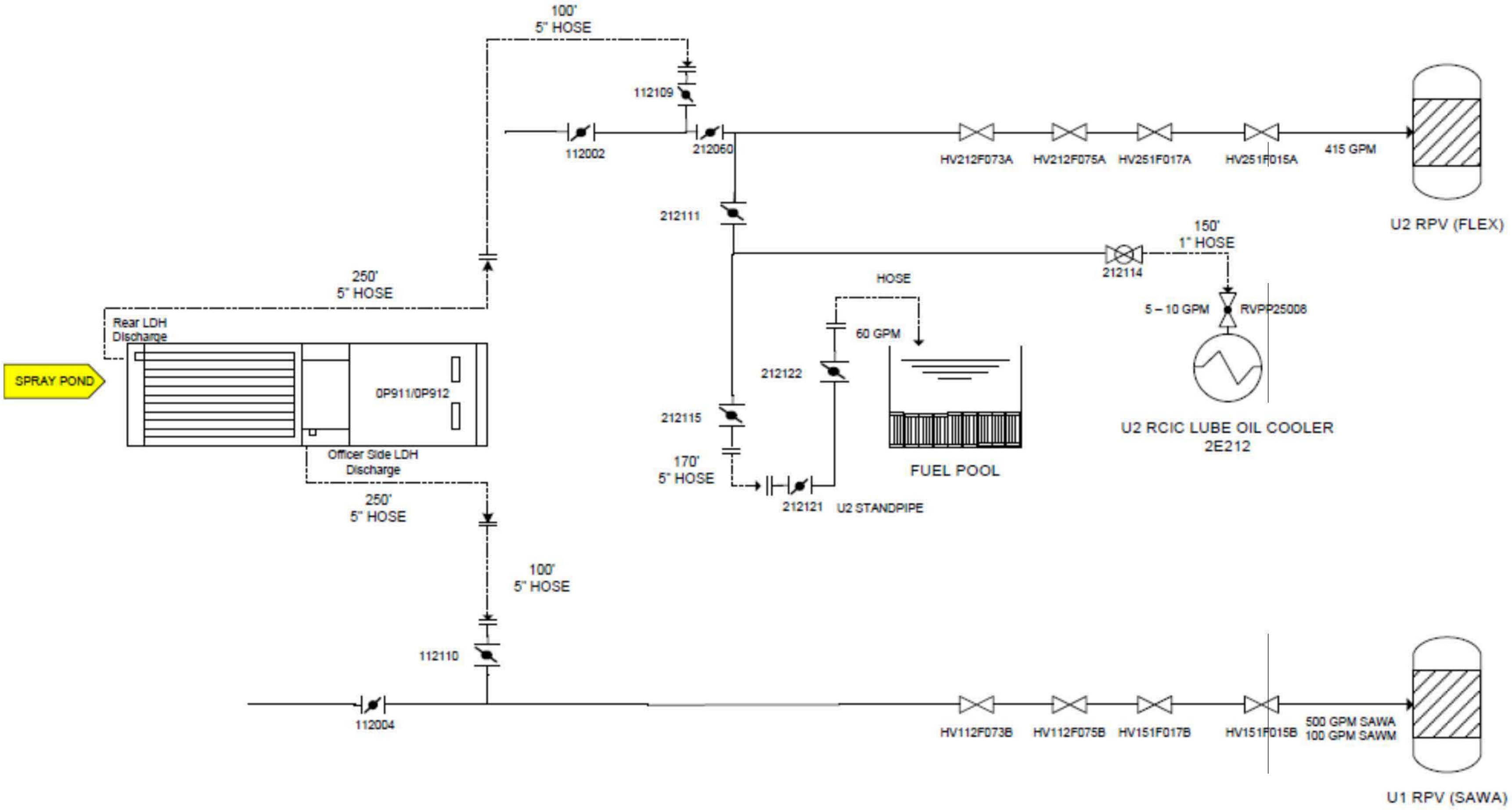


HCVS battery charger 277 VAC input power is supplied from panel 0EP2.
The ROS also has battery voltage and compressed gas supply pressure indication.

## Attachment 4: One Line Diagram of SAWA Flow Path (U1 FLEX and U2 SAWA)



## Attachment 4a: One Line Diagram of SAWA Flow Path (U2 FLEX and U1 SAWA)

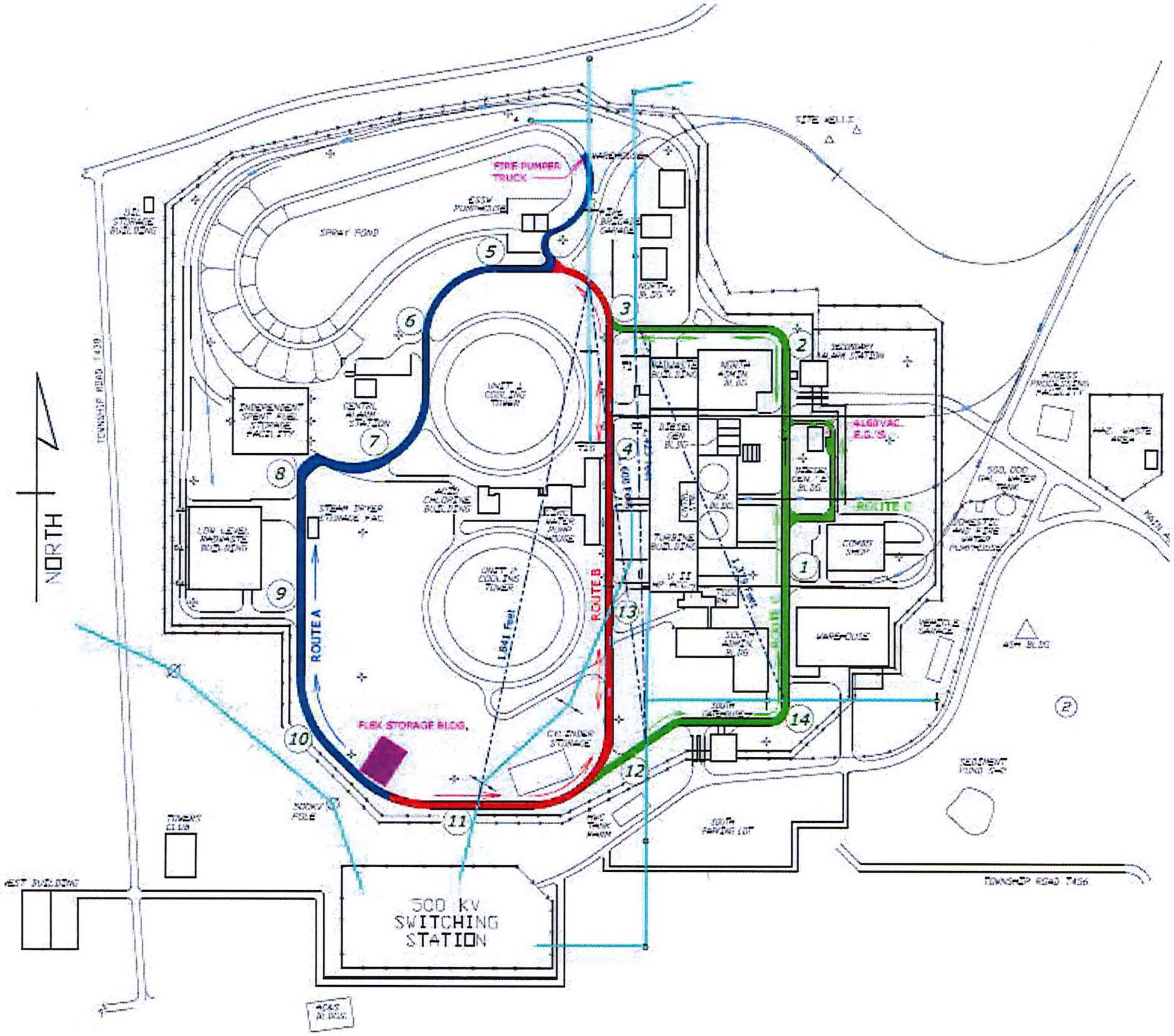


## Attachment 5: One Line Diagram of SAWA Electrical Power Supply

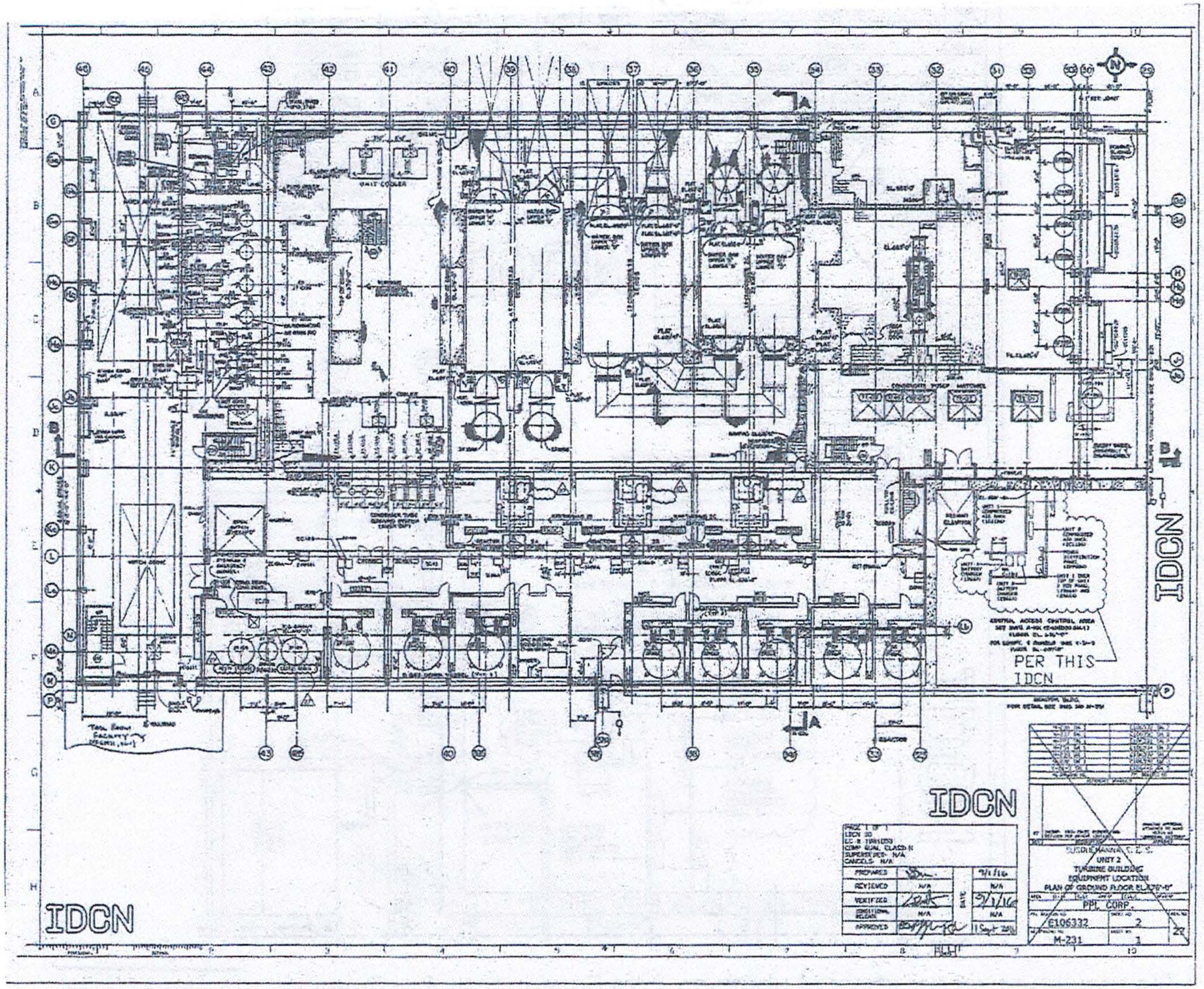
**N/A for Susquehanna**

**No additional electrical power needed for SAWA beyond that used for EA-12-049 Mitigation Strategies and EA-13-109 Severe Accident Capable Hardened Containment Vent System.**

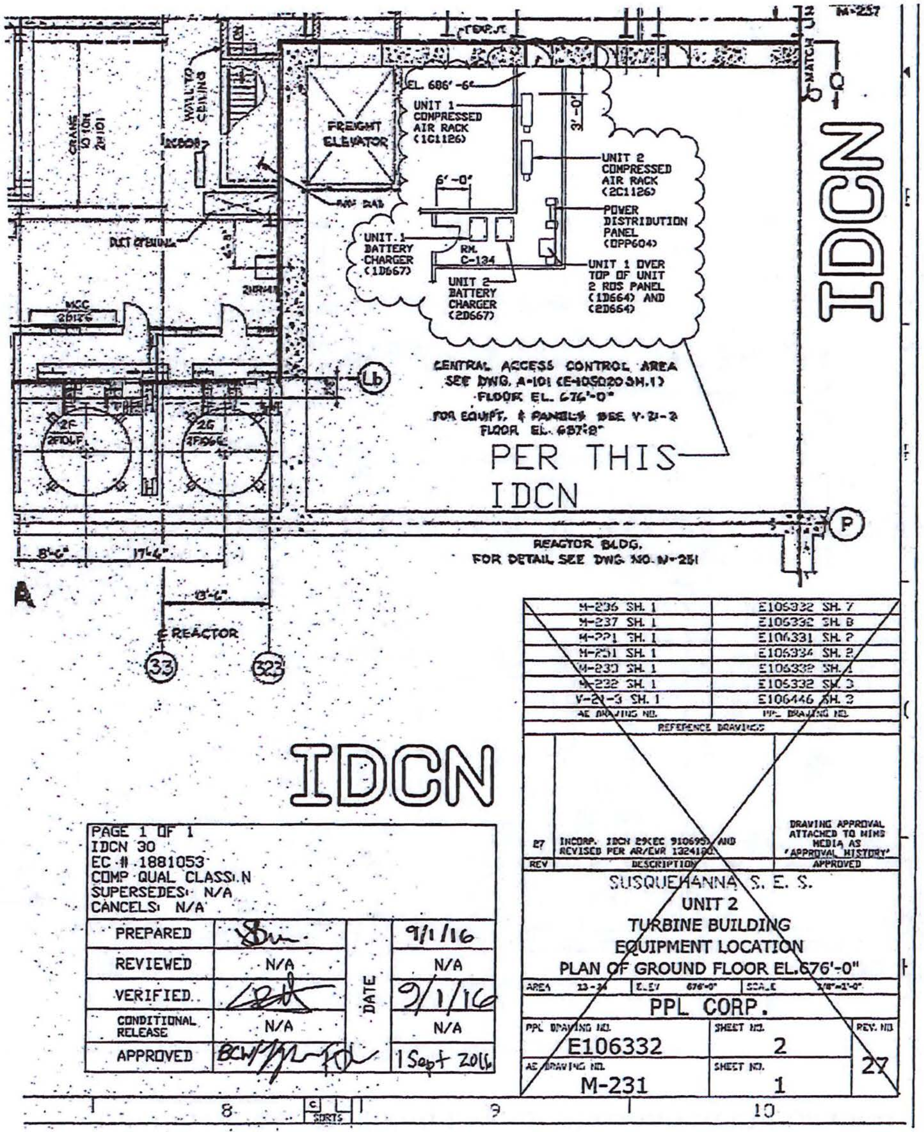
## **Attachment 6**: Plant Layout Showing Operator Action Locations



## Attachment 6a: Building Layout Showing ROS Location



## Attachment 6b: Building Layout Showing ROS Location (excerpt from Attachment 6a)



PAGE 1 OF 1
IDCN 30
EC # 1881053
COMP QUAL CLASS: N
SUPERSEDES: N/A
CANCELS: N/A

| | | DATE |
|---|---|---|
| PREPARED | | 9/1/16 |
| REVIEWED | N/A | N/A |
| VERIFIED | | 9/1/16 |
| CONDITIONAL RELEASE | N/A | N/A |
| APPROVED | BCW | 1 Sept 2016 |

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

| Component Name | Equipment ID | Range | Location | Local Event Temp[9] | Local Event Humidity | Local Radiation Level | Qualification[10] | Qualification Temp | Qualification Humidity | Qualification Radiation | Power Supply |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Wetwell Vent Instruments and Components** | | | | | | | | | | | |
| HCVS Effluent temperature indicator | TI15753B<br>TI25753B | 0 to 500 °F | MCR | 110°F | 55% | N/A | IEEE 344-1975 | 120 °F | 60 % | 3.00E+08 | HCVS power supply then FLEX generators |
| HCVS Effluent temperature indicator | TI15753A<br>TI25753A | 0 to 500 °F | ROS | 113°F | 60% | Use 1' TID of 9.13E+05 Rad | IEEE 344-1975 | 120 °F | 100 % | N/A | HCVS power supply then FLEX generators |
| HCVS Effluent temperature transmitter | TT15726<br>TT25726 | 0 to 500 °F | ROS | 113°F | 60% | Use 1' TID of 9.13E+05 Rad | IEEE 344-1975 | 120 °F | 100 % | N/A | HCVS power supply then FLEX generators |
| HCVS Effluent temperature element | TE15771<br>TE25771 | 0 to 900 °F | RB1-683<br>RB2-683 | <350°F*** | 100% | Use 1' TID of 2.77E+04 Rad | IEEE 344-1975 | 350 °F | 100 % | 4.20E + 06 Rad | HCVS power supply then FLEX generators |
| HCVS Effluent pressure indicator | PI15730B<br>PI25730B | 0 to 100 psig | MCR | 110°F | 55% | N/A | IEEE 344-1975 | 120 °F | 60 % | N/A | HCVS power supply then FLEX generators |
| HCVS Effluent pressure indicator | PI15730A<br>PI25730A | 0 to 100 psig | ROS | 113°F | 60% | Use 1' TID of 9.13E+05 Rad | IEEE 344-1975 | 120 °F | 100 % | N/A | HCVS power supply then FLEX generators |
| HCVS Effluent pressure transmitter | PT15730<br>PT25730 | -14.2 to 300 psig | RB1-683<br>RB2-683 | <350°F*** | 100% | Use 1' TID of 2.77E+04 Rad | IEEE 344-1975 | 350 °F | 100 % | 4.20E + 06 Rad | HCVS power supply then FLEX generators |

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[9] As part of the response to Order EA-12-049, Susquehanna performed calculations of the temperature response of the Reactor Buildings (RB) and Control Structure (CS) 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 CS 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. Refer to page 36 of this report, EC-030-1006 for the MCR, and EC-030-1007 for the ROS.

[10] See UFSAR for qualification code of record, usually IEEE-344-1975. Where other code years are referenced, this was reconciled in the design process.

| Component Name | Equipment ID | Range | Location | Local Event Temp[9] | Local Event Humidity | Local Radiation Level | Qualification[10] | Qualification Temp | Qualification Humidity | Qualification Radiation | Power Supply |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *HCVS Gas supply pressure indicator | PI15731B<br>PI25731B | 0 to 3000 psig | MCR | 110°F | 55% | N/A | IEEE 344-2004 | 120 °F | 60 % | N/A | HCVS power supply then FLEX generators |
| *HCVS Gas supply pressure transmitter | PT15731<br>PT25731 | -14.2 to 4000 psig | ROS | 113°F | 60% | Use 1' TID of 9.13E+05 Rad | IEEE 344-1975 | 120 °F | 100 % | N/A | HCVS power supply then FLEX generators |
| *HCVS Gas supply pressure indicator | PI15731A<br>PI25731A | 0 to 4000 psig | ROS | 113°F | 60% | Use 1' TID of 9.13E+05 Rad | IEEE 344-1975 | 120 °F | 100 % | N/A | HCVS power supply then FLEX generators |
| HCVS Radiation Level Recorder | RR15756<br>RR25756 | $1e^{-2}$ to $1e^{4}$ Rad/hr | MCR | 110°F | 55% | N/A | IEEE 344-2004 | 120 °F | 60 % | N/A | HCVS power supply then FLEX generators |
| HCVS Radiation Level Indication | RY15756<br>RY25756 | $1e^{-2}$ to $1e^{5}$ Rad/hr | ROS | 113°F | 60% | Use 1' TID of 9.13E+05 Rad | IEEE 344-1975 | 120 °F | 100 % | N/A | HCVS power supply then FLEX generators |
| HCVS Radiation Level Element | RE15756<br>RE25756 | $1e^{-2}$ to $1e^{4}$ Rad/hr | RB1-683<br>RB2-683 | <350°F*** | 100% | Use 1' TID of 2.77E+04 Rad | IEEE 344-1975 | 350 °F | 100 % | 4.20E + 06 Rad | HCVS power supply then FLEX generators |
| *HCVS 125 VDC battery voltage | XI25797 | 0-150 VDC | MCR | 110°F | 55% | N/A | IEEE 344-2004 | 120 °F | 60 % | N/A | HCVS 125 VDC Battery |
| HCVS 125 VDC battery | 1D698<br>2D698 | N/A | ROS | 113°F | 60% | Use 1' TID of 9.13E+05 Rad | IEEE 344-1975 | 120 °F | 100 % | N/A | Self for 24 hours, then FLEX generator powers charger |
| *HCVS valve position indication | ZI15701A, ZI15702A (Open)<br>ZI15701B, ZI15702B (Closed)<br>ZI25701A, ZI25702A (Open)<br>ZI25701B, ZI25702B (Closed) | N/A | MCR/ROS | 113°F | 60% | Use 1' TID of 9.13E+05 Rad | IEEE 344-1975 | 120 °F/120 °F | 60 %/100 % | N/A | HCVS power supply then FLEX generators |

| Component Name | Equipment ID | Range | Location | Local Event Temp[9] | Local Event Humidity | Local Radiation Level | Qualification[10] | Qualification Temp | Qualification Humidity | Qualification Radiation | Power Supply |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **SAWA/SAWM Instruments** | | | | | | | | | | | |
| Drywell and Suppression Chamber pressure (either LOCA range selected by a switch DW-Red, SC – Green)) | UR15701A / UR15701B<br>UR25701A / UR25701B | -15 to 65 psig | MCR | 110°F | 55% | Use 1' TID of 9.13E+05 Rad | IEEE 344-1975 | 120 °F | 60 % | N/A | Station batteries via EA-12-049 generator |
| Suppression Pool Water Temperature | TIAH15751 / TIAH15752<br>TIAH25751 / TIAH25752 | 0 to 750°F | MCR | 110°F | 55% | Use 1' TID of 9.13E+05 Rad | IEEE 344-1975 | 120 °F | 60 % | N/A | Station batteries via EA-12-049 generator |
| Suppression Pool Water level | UR15776A / UR15776B<br>UR25776A / UR25776B | 0 to 534" in (indicated)<br>4.5 to 49 ft (actual) | MCR | 110°F | 55% | **CB | IEEE 344-1975 | 120 °F | 60 % | N/A | Station batteries via EA-12-049 generator |
| SAWA flow instrument | N/A | 0-600 gpm | Outside, mounted in the FLEX flow path | 104°F | N/A | Outside, radiation not a concern | Commercial instrument qualified for over the road use, therefore qualified per NEI 12-06 | 120°F | 100% | N/A | Mechanical device. No electrical power required. |
| Reactor Pressure | PI-1/24202A/B | 0 to 1500 psig | MCR | 110°F | 55% | **CB | IEEE 344-1975 | 120 °F | 60 % | N/A | Station batteries via EA-12-049 generator |

* Denotes non-required item, added for site-specific design.
** Denotes Control Building where local radiation levels are not applicable. Building has no significant radiation sources.
*** 350°F is the maximum discharge temperature of the HCVS through the Reactor Building El. 683'. The expected room temperature would be a temperature below this value.

## **Table 2: Operator Actions Evaluation**

| Operator Action | | Evaluation Time[11] | Validation Time | Location | Thermal conditions | Radiological Conditions | Evaluation |
|---|---|---|---|---|---|---|---|
| 1 | Power MCR HCVS Control Panel | ≤ 5 hours (approximate venting start) | < 5 hours | Key-locked switch at HCVS Control Panel in Main Control Room (MCR). | Less than NUMARC 87-00 long-term habitability limit of 110 °F for > 36 hours. | MCR is removed from the vent pipes and RP actions will provide protection from any airborne activity. | Acceptable<br>MCR is a preferred location based on HCVS-FAQ-1. |
| 2 | Unlock ROS door and manually operate valves | ≤ 5 hours (approximate venting start) | < 5 hours | Manual valves at remote operating station (simple operator action). | Less than NUMARC 87-00 long-term habitability limit of 110 °F. | Shielded from the Primary Containment, by intervening structures and concrete. Less than 5 rem limit for 7 days. | Acceptable |
| 3 | Open Suppression Chamber Primary Containment Isolation Valves (PCIV) | ≤ 5 hours (approximate venting start) | < 5 hours | Separate switches at HCVS Control Panel in MCR. | Less than NUMARC 87-00 long-term habitability limit of 110 °F for > 36 hours. | MCR is removed from the vent pipes and RP actions will provide protection from any airborne activity. | Acceptable<br>MCR is a preferred location based on HCVS-FAQ-1. |
| 4 | Monitor electrical power status, gas pressure, and HCVS conditions. | ≤ 5 hours (approximate venting start) | < 5 hours | HCVS Control Panel in MCR. | Less than NUMARC 87-00 long-term habitability limit of 110 °F for > 36 hours. | MCR is removed from the vent pipes and RP actions will provide protection from any airborne activity. | Acceptable<br>MCR is a preferred location based on HCVS-FAQ-1. |

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[11] Evaluation timing is from NEI 13-02 to support radiological evaluations.

| Operator Action | | Evaluation Time[11] | Validation Time | Location | Thermal conditions | Radiological Conditions | Evaluation |
|---|---|---|---|---|---|---|---|
| 5 | Connect/re-energize HCVS battery charger using portable FLEX Generators | ≤ 6 hours | < 6 hours | Battery chargers in ROS will be re-energized via FLEX procedure that installs the 4160 VAC FLEX Generators. | Outside, so ambient conditions. | North end of the ‘E’ DG building, shielded by distance from the vent pipes, connected before severe accident venting would occur, so no radiological concern. | Acceptable |
| 6 | Replenish gas supply to HCVS PCIVs | >24 hours | N/A - >24 hours | At Remote Operating Station in Control Structure – Elevation 686’-6”. Connect backup gas supply to PCIVs. | Less than NUMARC 87-00 long-term habitability limit of 110 °F. | Shielded from the Primary Containment, by intervening structures and concrete. Less than 5 rem limit for 7 days. | Acceptable |
| 7 | Backup HCVS valve operation (if primary method fails) | ≤ 5 hours (approximate venting start) | < 5 hours | ROS in Control Structure (686’-6” elevation). | Less than NUMARC 87-00 long-term habitability limit of 110 °F. | Shielded from the Primary Containment, by intervening structures and concrete. Less than 5 rem limit for 7 days. | Acceptable |

| Operator Action | | Evaluation Time[11] | Validation Time | Location | Thermal conditions | Radiological Conditions | Evaluation |
|---|---|---|---|---|---|---|---|
| 8 | SAWA pump staging and hose connection | ≤ 6 hours | < 6 hours | Near ESSWPH. | Outside, so ambient conditions. | Shielded by RBs from the vent pipes, long distance from vent pipes to ESSWPH. Well shielded by structure and distance. | Acceptable |
| 9 | SAWA pump operation and refueling | ≤ 6 hours (maximum injection start time is 8 hours) | < 6 hours | Near ESSWPH. | Outside, so ambient conditions. | Shielded by RBs from the vent pipes, long distance from vent pipes to ESSWPH. Well shielded by structure and distance. | Acceptable |
| 10 | FLEX Generator connection and alignment | >24 hours | N/A - >24 hours | 'E' DG building. | Outside, so ambient conditions. | North end of the 'E' DG building, shielded by distance from the vent pipes, connected before severe accident venting would occur, so no radiological concern. | Acceptable |
| 11 | FLEX Generator operation and refueling setup | ≤ 6 hours | < 6 hours | 'E' DG building. | Outside, so ambient conditions. | Opposite side of the 'E' DG from the vent pipes, well shielded by structure and distance, no significant radiological concern. | Acceptable |

| Operator Action | | Evaluation Time[11] | Validation Time | Location | Thermal conditions | Radiological Conditions | Evaluation |
|---|---|---|---|---|---|---|---|
| 12 | Pneumatic hose connection | >24 hours (>7 days) | N/A - >24 hours | ROS in Control Structure (686'-6" elevation). | Less than NUMARC 87-00 long-term habitability limit of 110 °F. | Less than 5 rem limit for 7 days. | Acceptable |

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Figure 1: Sequence of Events Timeline – Wetwell HCVS

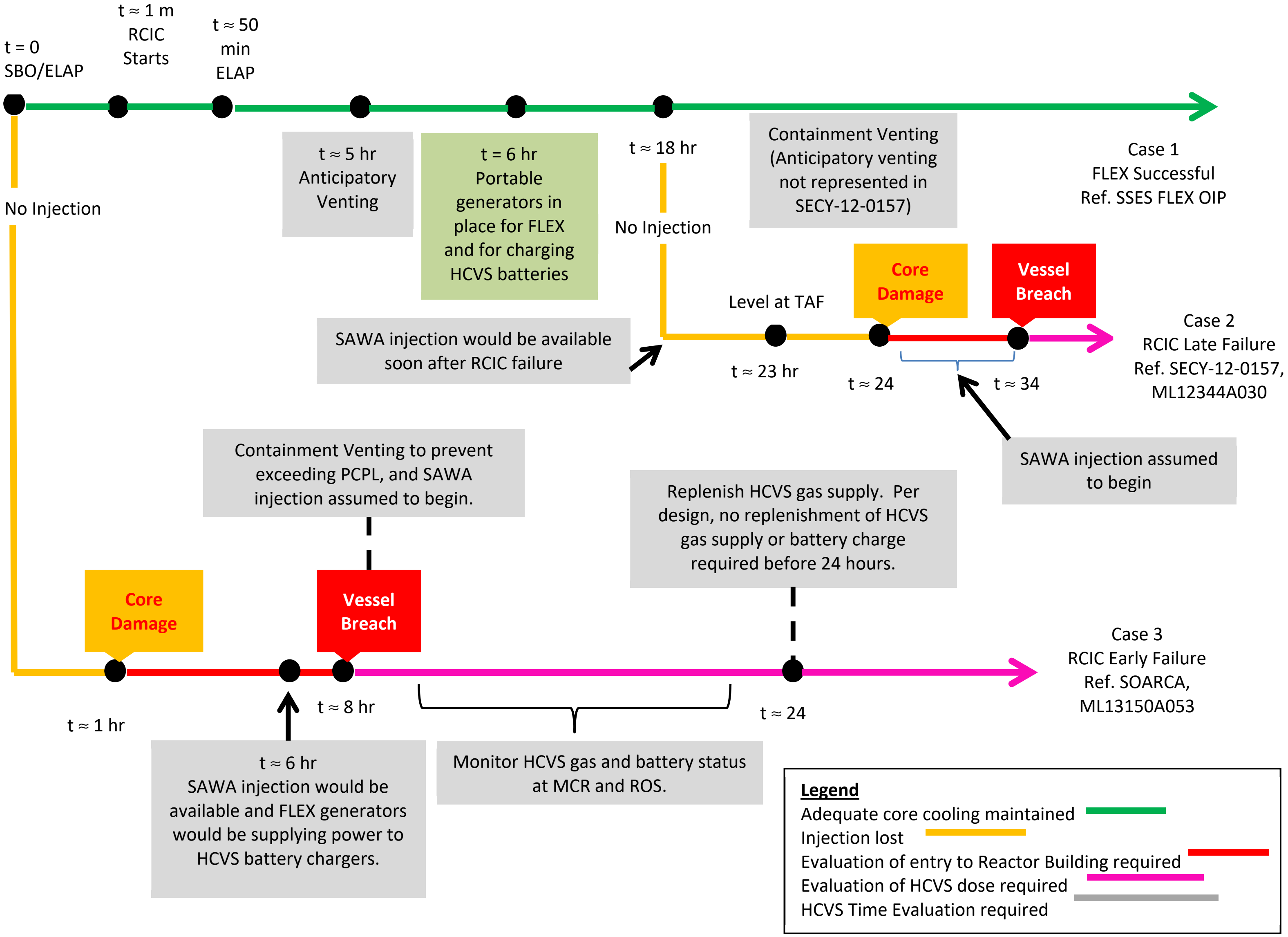

Figure 2: Sequence of Events Timeline – SAWA / SAWM