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10 CFR 50.4
EA-13-109
10 CFR 50.54(f)

August 20, 2019
GO2-19-100

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

Subject: COLUMBIA GENERATING STATION DOCKET NO. 50-397 REPORT OF FULL COMPLIANCE WITH PHASE 1 AND PHASE 2 OF JUNE 6, 2013 COMMISSION ORDER MODIFYING LICENSES WITH REGARD TO RELIABLE HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS (ORDER NUMBER EA-13-109)

References:

1. NRC Order Number EA-13-109, “Issuance of Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions,” dated June 6, 2013 (ADAMS ML13143A334)
2. Letter GO2-13-087 from D. A. Swank (Energy Northwest) to NRC "Energy Northwest's Response to NRC Order EA-13-109-Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions," dated June 24, 2013 (ADAMS ML13200A136)
3. NRC Interim Staff Guidance JLD-ISG-2015-01, “Compliance with Phase 2 of Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions,” Revision 0, dated April 2015 (ADAMS ML15104A118)
4. 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 1, dated April 2015 (ADAMS ML15113B318)
5. Letter GO2-14-107 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Phase 1 Response to NRC Order EA-13-109 - Overall Integrated Plan for Reliable Hardened Containment Vents under Severe Accident Conditions," dated June 30, 2014 (ADAMS ML14191A688)
6. Letter GO2-14-175 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's First Six-Month Status Update Report for the Implementation of NRC Order EA-13-109- Overall Integrated Plan for Reliable Hardened Containment Vents under Severe Accident Conditions," dated December 17, 2014 (ADAMS ML14357A069)

7. Letter GO2-15-093 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Second Six-Month Status Update Report for the Implementation of NRC Order EA-13-109 – Overall Integrated Plan for Reliable Hardened Containment Vents under Severe Accident Conditions," dated June 30, 2015 (ADAMS ML15181A436)
8. Letter GO2-15-175 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Response to NRC Order EA-13-109 –Overall Integrated Plan for Reliable Hardened Containment Vents under Severe Accident Conditions Phases 1 and 2, Revision 1," dated December 16, 2015 (ADAMS ML15351A363)
9. Letter GO2-16-098 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Fourth Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Order EA-13-109, Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions," dated June 30, 2016 (ADAMS ML16182A080)
10. Letter GO2-16-171 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Combined Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Orders EA-12-049 and EA-13-109," dated December 29, 2016 (ADAMS ML16364A245)
11. Letter GO2-17-118 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Second Combined Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Orders EA-12-049 and EA-13-109," dated June 27, 2017 (ADAMS ML17178A276)
12. Letter from M. K. Halter (NRC) to M. E. Reddemann (Energy Northwest) "Columbia Generating Station - Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Phase 1 of Order EA-13-109 (Severe Accident Capable Hardened Vents) (TAC No. MF4383)," dated March 25, 2015 (ADAMS ML14335A158)
13. Letter from J. F. Quichocho (NRC) to M. E. Reddemann (Energy Northwest) "Columbia Generating Station - Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Phase 2 of Order EA-13-109 (Severe Accident Capable Hardened Vents) (CAC No. MF4383)," dated September 29, 2016 (ADAMS ML16266A233)

Dear Sir or Madam,

On June 6, 2013, the Nuclear Regulatory Commission ("NRC" or "Commission") issued Order EA-13-109, ″Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions,″ (Reference 1) to Energy Northwest. Reference 1 was immediately effective and directs Energy Northwest to require Columbia Generating Station (Columbia) to take certain actions to ensure that Columbia has a hardened containment vent system (HCVS) to remove decay heat from the containment, and 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 (SA) conditions resulting from an extended loss of alternating current (AC) power (ELAP). Specific requirements are outlined in Attachment 2 of Reference 1. Reference 2 provided Energy Northwest's initial answer to the order.

Reference 3 provided the NRC interim staff guidance on methodologies for compliance with Phases 1 and 2 of Reference 1 and endorsed industry guidance document Nuclear Energy Institute (NEI) 13-02, Revision 1 (Reference 4) with clarifications and exceptions. Reference 5 provided Energy Northwest's Phase 1 Overall Integrated Plan (OIP) for Columbia, which was replaced with the Phase 1 and Phase 2 OIP (Reference 8). References 12 and 13 provided the NRC review of the Phase 1 and Phase 2 OIP, respectively, as an Interim Staff Evaluation (ISE).

Reference 1 required submission of a status report at six-month intervals following submittal of the OIP. References 6, 7, 8, and 9 provided the first, second, third, and fourth 6-month status reports, respectively. References 10 and 11 are combined 6-month updates for both orders EA-12-049 and EA-13-109, representing the fifth and sixth 6-month status reports pursuant to Section IV, Condition D.3, of Reference 1 for Columbia. The seventh through tenth 6-month updates focus on the Phase 2 activities and are referenced in the enclosure as References 10 through 13, respectively.

The purpose of this letter is to provide the report of full compliance with Phase 1 and Phase 2 of the June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109) (Reference 1) pursuant to Section IV, Condition D.4 of the Order for Columbia.

Correspondence and Reports

Milestone	Completion Date	Comments
6-month update for Order EA-13-109 Phase 2	Dec. 2017	Letter dated December 28, 2017
6-month update for Order EA-13-109 Phase 2	June 2018	Letter dated June 21, 2018
6-month update for Order EA-13-109 Phase 2	Dec. 2018	Letter dated December 13, 2018
6-month update for Order EA-13-109 Phase 2	June 2019	Letter dated June 24, 2019
Issuance of Energy Northwest's letter of compliance with NRC Order EA-13-109, Phase 2	Aug. 2019	This Letter

HCV Phase 1 Milestone Schedule:

Milestone	Completion Date
Hold preliminary/conceptual design meeting	June 2014
WW Design Engineering Complete	June 2017
WW Operation Procedure Changes Developed	June 2017
WW Training Complete	June 2017
WW Installation Complete	June 2017
WW Procedure Changes Active	June 2017
Site Specific WW Maintenance Procedure Developed	June 2017
WW Walk Through Demonstration/Functional Test	June 2017

HCV Phase 2 Milestone Schedule:

Milestone	Completion Date
Hold preliminary/conceptual design meeting	July 2017
Design Engineering On-site/Complete	May 2019
Operations Procedure Changes Developed	Jan. 2019[1]
Site Specific Maintenance Procedure Developed	Jan. 2019[1]
Training Complete	Apr. 2019
Implementation Outage	May 2019
Procedure Changes Active	May 2019[2]
Walk Through Demonstration/Functional Test	June 2019

[1] No new equipment was procured for Phase 2. Therefore, no new operational or maintenance procedures are required.

[2] Required maintenance procedures are approved and will be issued in accordance with station processes.

Enclosure 1 of this submittal provides Columbia's certification of full compliance with NRC Order EA-13-109 and Enclosure 2 provides Columbia's Final Integrated Plan (FIP).

No new commitments are being made by this letter or the enclosures. If you have any questions or require additional information, please contact Ms. D. M. Wolfgramm at (509) 377-4792.

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

Executed on this 20th day of August, 2019.

Respectfully,

A. L. Javorik
Vice President, Engineering Projects

Enclosures: As stated

cc: NRC RIV Regional Administrator
NRC NRR Project Manager
NRC Senior Resident Inspector/988C
CD Sonoda – BPA/1399 (email)
WA Horin – Winston & Strawn

Energy Northwest's Certification of Columbia Generating Station's Compliance with NRC Order EA-13-109

Energy Northwest has designed and installed a venting system at the Columbia Generating Station (Columbia) that provides venting capability from the wetwell during severe accident (SA) conditions in response to Phase 1 of the Nuclear Regulatory Commission's (NRC) Order EA-13-109. Energy Northwest has implemented a reliable containment venting strategy at Columbia that makes it unlikely that the plant would need to vent from the containment drywell before alternative reliable containment heat removal and pressure control is reestablished in response to Phase 2 of NRC Order EA-13-109.

Table 1 provides Columbia's Phase 1 and Phase 2 overall integrated plant (OIP) tracking items which have been addressed and closed as documented in the referenced letters and are considered complete pending NRC closure. Table 2 lists Columbia's Phase 1 request for additional information identified in Reference 1 which were closed in Reference 3. Table 3 provides Columbia's Phase 2 request for information responses identified in Reference 2. Energy Northwest has addressed the Table 3 items as documented in the referenced letters which are considered complete.

Table 1: List of Overall HCV Integrated Plan Open Items			
HCV OIP Open Item	**Action**	**Status**	**Comment**
OI-HCV-01	Provide resolution of the potential secondary containment bypass leakage path in the first 6-month update of the HCVS OIP	CLOSED	Closed in Letter dated December 16, 2015
OI-HCV-02	Evaluate the location of the ROS for accessibility.	CLOSED	Closed in letter dated June 27, 2017
OI-HCV-03	Determine the location of the portable air compressor and evaluate for accessibility under Severe Accident HCVS use. Including connection point(s) Including refueling operations	CLOSED	Closed in letter dated December 28, 2017
OI-HCV-04	Evaluate the location of the FLEX DG for accessibility under Severe Accident HCVS use. Including connection point(s) Including refueling operations	CLOSED	Closed in letter dated December 28, 2017
OI-HCV-05	Confirm suppression pool heat capacity	CLOSED	Closed in Letter dated December 17, 2014

Table 1: List of Overall HCV Integrated Plan Open Items			
HCV OIP Open Item	**Action**	**Status**	**Comment**
OI-HCV-06	Determine the method of qualification for each instrument	CLOSED	Closed in letter dated June 27, 2017
OI-HCV-07	Complete the evaluation to determine accessibility, habitability, staffing sufficiency, and communication capability of the ROS.	CLOSED	Closed in letter dated December 28, 2017
OI-HCV-08	Identify design codes after design is finalized.	CLOSED	Closed in letter dated June 27, 2017
OI-HCV-09	Equipment qualifications will include temperature, pressure, radiation level, and total integrated dose radiation from the effluent vent pipe at local and remote locations.	CLOSED	Closed in letter dated December 28, 2017
OI-HCV-10	Provide site-specific details of the EOPs when available. Develop procedures for SAWA and SAWM	CLOSED	Phase 1: No EOP procedure changes are required. Phase 2: Revised EOPs and FSGs as required. Available for review.
OI-HCV-11	FLEX air compressors need to be credited to recharge air lines for HCVS components after 24 hours.	CLOSED	Closed in letter dated December 29, 2016
OI-HCV-12	SAWA/SAWM flow is controlled using hose installed valves and mechanical flow elements (EA-12-049 actions). Location of these valves and flow elements will need to be considered per HCVS-FAQ-12.	CLOSED	Closed in letter dated June 24, 2019
OI-HCV-13	Reconcile the out-of-service provisions for HCVS/SAWA with the provisions documented in Columbia's PPM 1.5.18, Managing B.5.b, and FLEX Equipment Unavailability.	CLOSED	Closed in letter dated June 24, 2019
OI-HCV-14	Complete the evaluation to determine accessibility, habitability, staffing sufficiency, and communication capability during SAWA/SAWM	CLOSED	Closed in letter dated June 24, 2019

Table 1: List of Overall HCV Integrated Plan Open Items			
HCV OIP Open Item	**Action**	**Status**	**Comment**
OI-HCV-15	Perform MAPP analysis for NEI 13-02 figures C-2 through C-6 and determine the time sensitive SAWM actions	CLOSED	Closed in letter dated June 24, 2019
OI-HCV-16	Develop procedure for line-up and use of HCVS	CLOSED	Closed in letter dated December 28, 2017
OI-HCV-17	Add sound powered phone extension cable for instrument rack E-IR-85 to inventory procedure	CLOSED	Closed in letter dated December 29, 2016
OI-HCV-18	Evaluate deployment pathways for severe accident capable criteria	CLOSED	Closed in letter dated December 28, 2017
OI-HCV-19	Develop required training and frequency IAW the SAT process	CLOSED	Closed in letter dated August 17, 2017
OI-HCV-20	Incorporate approved language of OIP Attachment 2.1.D into site SAMG procedure(s)	CLOSED	Closed in letter dated June 24, 2019

Table 2: Response to the Phase 1 Request for Additional Information (These Items were closed in the NRC Audit Report dated August 6, 2018.)	
RAI Number	**Requested Information**
01	Make available for NRC staff audit the location of the ROSs.
02	Make available for NRC staff audit the location of the portable air compressor.
03	Make available for NRC staff audit the location of the portable diesel generators.
04	Make available for NRC staff audit an evaluation of temperature and radiological conditions to ensure that operating personnel can safely access and operate controls and support equipment.
05	Make available for NRC staff audit analyses demonstrating that HCVS has the capacity to vent the steam/energy equivalent of one percent of uprated licensed/rated thermal power (unless a lower value is justified), and that the suppression pool and the HCVS together are able to absorb and reject decay heat, such that following a reactor shutdown from full power containment pressure is restored and then maintained below the primary containment design pressure and the primary containment pressure limit.

Table 2: Response to the Phase 1 Request for Additional Information (These Items were closed in the NRC Audit Report dated August 6, 2018.)	
RAI Number	**Requested Information**
06	Make available for NRC staff audit the descriptions of local conditions (temperature, radiation and humidity) anticipated during ELAP and severe accident for the components (valves, instrumentation, sensors, transmitters, indicators, electronics, control devices, etc.) required for HCVS venting including confirmation that the components are capable of performing their functions during ELAP and severe accident conditions.
07	Make available for NRC staff audit documentation of the HCVS nitrogen pneumatic system design including sizing and location.
08	Make available for NRC staff audit the final sizing evaluation for HCVS batteries/battery charger including incorporation into FLEX DG loading calculation.
09	Make available for NRC staff audit documentation that demonstrates adequate communication between the remote HCVS operation locations and HCVS decision makers during ELAP and severe accident conditions.
10	Provide a description of the strategies for hydrogen control that minimizes the potential for hydrogen gas migration and ingress into the RB or other buildings.
11	Make available for NRC staff audit descriptions of all instrumentation and controls (existing and planned) necessary to implement this order including qualification methods.
12	Make available for NRC staff audit documentation of an evaluation verifying the existing containment isolation valves, relied upon for the HCVS, will open under the maximum expected differential pressure during BDBEE and severe accident wetwell venting.
13	Make available for NRC staff audit site specific details of the EOPs when available.
14	Provide justification for not leak testing the HCVS every three operating cycles and after restoration of any breach of system boundary within buildings.

Table 3: Response to the Phase 2 Request for Additional Information			
RAI Number ISE Report Section	**Action**	**Status**	**Comment**
1 Section 3.2.1	Licensee to determine the location of the FLEX hose installed valves and flow elements, which will be used to control SAWA/SAWM flow.	CLOSED	Closed in letter dated June 24, 2019
2 Section 3.3.2.3	Licensee to evaluate the SAWA equipment and controls, as well as ingress and egress paths for the expected severe accident conditions (temperature, humidity, radiation) for the sustained operating period.	CLOSED	Closed in letter dated June 24, 2019
3 Section 3.3.3	Licensee to demonstrate that containment failure as a result of overpressure can be prevented without a drywell vent during severe accident conditions.	CLOSED	Closed in letter dated June 24, 2019
4 Section 3.3.3.1	Licensee shall demonstrate how the plant is bounded by the reference plant analysis that shows the SAWM strategy is successful in making it unlikely that a drywell vent is needed.	CLOSED	Closed in letter dated June 24, 2019
5 Section 3.3.3.4	Licensee to demonstrate that there is adequate communication between the MCR and the operator at the FLEX pump during severe accident conditions.	CLOSED	Closed in letter dated June 24, 2019
6 Section 3.3.3.4	Licensee to demonstrate the SAWM flow instrumentation qualification for the expected environmental conditions.	CLOSED	Closed in letter dated June 24, 2019

Order EA-13-109 Compliance Elements Summary

The elements identified below as well as the Phase 1 and Phase 2 OIP response submittal (Reference 1), and the 6-Month Status Reports (References 5 through 13), demonstrate Columbia’s compliance with NRC Order EA-13-109.

HCVS Phase 1 and Phase 2 Functional Requirements and Design Features – Complete

The Columbia Phase 1 HCVS provides a vent path from the wetwell to remove decay heat, vent the containment atmosphere, and control containment pressure within acceptable limits. The HCVS will function for those accident conditions for which containment venting is relied upon to reduce the probability of containment failure, including accident sequences that result in the loss of active containment heat removal capability during an extended loss of alternating current power. This meets the Phase 1 requirements of NRC Order EA-13-109.

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

The Columbia Phase 1 and Phase 2 HCVS strategies are in compliance with Order EA-13-109. No additional plant modifications were required to support the HCVS strategies discussed in Enclosure 2 of this submittal.

HCVS Phase 1 and Phase 2 Quality Standards – Complete

The design and operational considerations of the Phase 1 and Phase 2 HCVS installed at Columbia comply with the requirements specified in the Order and described in Nuclear Energy Institute (NEI) 13-02, Revision 1, “Industry Guidance for Compliance with Order EA-13-109”. The Phase 1 and Phase 2 HCVS have been installed in accordance with the station’s design control process.

The Phase 1 and Phase 2 HCVS components from the wetwell vent up to, and including, the second containment isolation barrier is designed consistent with the design basis of the plant. These items include piping, piping supports, containment isolation valves, and the containment isolation valve actuators. The containment isolation valve position indication components are non-safety related, but meet the requirements for environmental and seismic qualification of safety related components. All other Phase 1 and Phase 2 HCVS components including electrical power supply, valve actuator pneumatic supply, and instrumentation have been designed for reliable and rugged performance that is capable of ensuring Phase 1 and Phase 2 HCVS functionality following a seismic event.

HCVS Phase 1 and Phase 2 Programmatic Features - Complete

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

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

Operating procedures for Columbia have been developed and integrated with existing procedures to ensure safe operation of the Phase 1 and Phase 2 HCVS. Operation procedures have been verified and are available for use in accordance with the station's procedure control program.

Site processes have been established to ensure the Phase 1 and Phase 2 HCVS is tested and maintained as recommended in NEI 13-02, Revision 1, Sections 6.1.2 and 6.2. Required maintenance procedures are approved and will be issued in accordance with station processes.

Columbia has completed validation in accordance with industry developed guidance to assure required tasks, manual actions and decisions for HCVS strategies are feasible and may be executed within the constraints identified in the HCVS Phase 1 and 2 OIP for Order EA-13-109 (References 14 and 15).

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

References

1. Letter from M. K. Halter (NRC) to M. E. Reddemann (Energy Northwest) "Columbia Generating Station - Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Phase 1 of Order EA-13-109 (Severe Accident Capable Hardened Vents) (TAC No. MF4383)," dated March 25, 2015 (ADAMS ML14335A158)
2. Letter from J. F. Quichocho (NRC) to M. E. Reddemann (Energy Northwest) "Columbia Generating Station - Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Phase 2 of Order EA-13-109 (Severe Accident Capable Hardened Vents) (CAC No. MF4383)," dated September 29, 2016 (ADAMS ML16266A233)
3. Letter from R. Auluck (NRC) to B. J. Sawatzke (Energy Northwest) "Columbia Generating Station - Report for the Audit of Licensee Responses to Interim Staff Evaluations Open Items Related to NRC Order EA-13-109 to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions," (CAC No. MF4383; EPID L-2014-JLD-0045) dated August 8, 2019 (ADAMS ML18215A204)
4. Letter GO2-15-175 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Response to NRC Order EA-13-109 –Overall Integrated Plan for Reliable Hardened Containment Vents under Severe Accident Conditions Phases 1 and 2, Revision 1," dated December 16, 2015 (ADAMS ML15351A363)
5. Letter GO2-14-175 from D. A. Swank (Energy Northwest) to NRC, "Energy Northwest's First Six-Month Status Update Report for the Implementation of NRC Order EA-13-109-Overall Integrated Plan for Reliable Hardened Containment Vents under Severe Accident Conditions," dated December 17, 2014 (ADAMS ML14357A069)

6. Letter GO2-15-093 from D. A. Swank (Energy Northwest) to NRC, "Energy Northwest's Second Six-Month Status Update Report for the Implementation of NRC Order EA-13-109 – Overall Integrated Plan for Reliable Hardened Containment Vents under Severe Accident Conditions," dated June 30, 2015 (ADAMS ML15181A436)
7. Letter GO2-16-098 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Fourth Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Order EA-13-109, Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions," dated June 30, 2016 (ADAMS ML16182A080)
8. Letter GO2-16-171 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Combined Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Orders EA-12-049 and EA-13-109," dated December 29, 2016 (ADAMS ML16364A245)
9. Letter GO2-17-118 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Second Combined Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Orders EA-12-049 and EA-13-109," dated June 27, 2017 (ADAMS ML17178A276)
10. Letter GO2-17-201 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Order EA-13-109, Phase 2 Only," dated December 28, 2017 (ADAMS ML18002A438)
11. Letter GO2-18-080 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's June 2018 Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Order EA-13-109, Phase 2 Only," dated June 21, 2018 (ADAMS ML18176A186)
12. Letter GO2-18-145 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's December 2018 Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Order EA-13-109, Phase 2 Only," dated December 13, 2108 (ADAMS ML18347B495)
13. Letter GO2-19-082 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Final Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Order EA-13-109, Phase 2 Only," dated June 24, 2019 (ADAMS ML19175A271)
14. Letter GO2-17-147 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Notification of Full Compliance with Order EA-12-049, 'Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond Design Basis External Events'," dated August 17, 2017 (ADAMS ML17229B506)
15. NEI APC 14-17, FLEX Validation Process, dated July 18, 2014

Final Integrated Plan
HCVS Order EA-13-109
For Columbia Generating Station

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 (BWR) with Mark I containments to encourage licensees to voluntarily install a hardened wetwell vent. In response, licensees installed a hardened vent pipe from the wetwell to some point outside the secondary containment envelope (usually outside the reactor building). Some licensees also installed a hardened vent branch line from the drywell. Columbia Generating Station's (Columbia) containment is a Mark II and was not affected by Generic Letter 89-16.

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 SA conditions." In response, the NRC issued Order EA-13-109, Issuance of Order to Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accidents, June 6, 2013 (Reference 5). The Order (EA-13-109) requires that licensees of BWR facilities with Mark I and Mark II containment designs ensure that these facilities have a reliable hardened vent to remove decay heat from the containment, and to maintain control of containment pressure within acceptable limits following events that result in the loss of active containment heat removal capability while maintaining the capability to operate under severe accident (SA) conditions resulting from an extended loss of alternating current (AC) power (ELAP).

Columbia is required by NRC Order EA-13-109 to have a reliable, severe accident capable hardened containment vent system (HCVS). Order EA-13-109 allows implementation of the HCVS order in two phases.

- Phase 1 upgraded the venting capabilities from the containment wetwell to provide reliable, severe accident capable hardened vent to assist in preventing core damage and, if necessary, to provide venting capability during severe accident conditions. Columbia reported Phase 1 compliance on August 17, 2017 (Refueling Outage 23) (Reference 37).
- Phase 2 provided additional protections for severe accident conditions through the development of a reliable containment venting strategy that makes it unlikely that Columbia would need to vent from the containment drywell during severe accident conditions. Columbia achieved Phase 2 compliance on June 21, 2019 and ended Refueling Outage 24.

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 (WP) (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 Japan Lessons Learned Project Directorate (JLD) Interim Staff Guidance (ISG) 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). 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) endorsed NEI 13-02 Revision 1 with some clarifications and exceptions and states that 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 WPs, HCVS-WP-01 through 04 (References 8 through 11), which cover broader or more complex topics than the FAQs.

As required by the order, Energy Northwest submitted Columbia's 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 NEI 13-02 Revisions 0 and 1, References 6 and 7 respectively. The NRC staff used the methods described in the ISGs to evaluate compliance as presented in the Order EA-13-109 OIPs. While the Phase 1 and combined Phase 1 and 2 OIPs where written to different revisions of NEI 13-02, Columbia 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 Energy Northwest with Interim Staff Evaluations (ISEs) (References 20 and 21) assessing the Columbia'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 31) were provided consistent with the requirements of Order EA-13-109. These status reports were used to close many of the ISE open items. In addition, the site participated in NRC ISE Open Item audit calls where the information provided in the six month updates and on the E-Portal were used by the NRC staff to determine whether the ISE Open Item appeared to be addressed.

By submittal of this final integrated plan (FIP), Energy Northwest has addressed all the elements of NRC Order EA-13-109 for Columbia utilizing the endorsed guidance in NEI 13-02, Rev 1 and the related HCVS-FAQs and HCVS-WPs documents. In addition, Energy Northwest has addressed Columbia's NRC Phase 1 and Phase 2 ISE Open Items as documented in this submittal and in previous six month updates.

Section III contains the Columbia FIP details for Phase 1 of the order and Section IV contains the FIP 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, SA capable venting scenario, can be summarized by the following:

Once the pneumatics are manually lined-up in the remote operating station (ROS), venting can be initiated via manual action from the main control room (MCR) or the ROS at the appropriate time based on procedural guidance in response to plant conditions from observed or derived symptoms.

- The operators utilize 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 has the capacity to operate for 24 hours with installed equipment and can be monitored locally at the ROS. As identified in Reference 28, replenishment of the motive force will initially be by the use of a fourth installed nitrogen bottle. Additional bottles are available inside the railroad bay if needed.
- The HCVS is powered by a dedicated battery with the capacity to provide power to the electrical components for 24 hours. Before HCVS battery depletion, a FLEX DG will have been connected and will provide power to the HCVS battery charger.
- 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 Columbia are seismic, external flooding, high winds, extreme high temperature, ice, snow, extreme cold temperatures, and volcanic ash. Initial actions of lining up the pneumatics are completed by plant personnel at the ROS inside the diesel generator (DG) building. Attachment 2 contains a one-line diagram of the HCVS vent flow path and pneumatics supply.

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 (SP) level to ensure the HCVS Phase 1 wetwell vent will remain functional for the removal of heat from the containment.
- Heat can be removed from the containment for at least seven (7) days using the HCVS or until alternate means of heat removal are established that make it unlikely the drywell vent will be required for containment pressure control.
- The SAWA and SAWM actions can be manually activated and controlled from areas

that are accessible during severe accident conditions.

- Parameters measured are drywell pressure, suppression pool level, SAWA flowrate and the HCVS Phase 1 vent path parameters.
- Establishing SAWA and the FLEX DG are completed prior to opening the HCV.

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

The SAWA flow path is the same as the diverse and flexible coping strategy (FLEX) primary injection flow path. The flow path of makeup cooling water will be from the spray ponds to the RPV. Implementation of the make-up function involves connecting hoses from the FLEX pump located near the spray ponds, across the yard area and enters the reactor building at the reactor building railroad bay and up the southwest reactor building stairwell. In the reactor building, the hose will supply the residual heat removal (RHR) piping at valve RHR-V-63A. A flow element and valves are installed on the 522 foot elevation of the reactor building to monitor and adjust flow as needed. Valves will be manually adjusted as necessary to control the flow. Cross flow into other portions of the residual heat removal (RHR) system will be precluded by the installed RHR system check valves and by verifying various RHR valves in the closed position (ABN-FSG-002). Drywell pressure and suppression pool level will be monitored and SAWA/SAWM flow rate will be monitored and adjusted by use of the installed valves and flow element. Communication is established between the MCR, the FLEX pump location, and the operator on the reactor building 522 foot elevation. Attachment 4 contains a one-line diagram of the SAWA flow paths.

The SAWA electrical loads are the same as the FLEX loads with the exception of adding the HCV battery charger. The HCV battery charger was included in the FLEX DG loading calculation. One of the FLEX DGs (E-GEN-DG4) is trailer mounted and is stationed near the diesel generator building. The other (FLEX-GEN-DG5) is trailer mounted, stored in building 600, and can be deployed to either of the locations shown in Attachment 6. Both locations will be in high dose fields when the HCV is initially opened. However, operators can stay in low dose fields when not directly monitoring or refueling the DGs. Analysis shows that the dose from the HCV will decrease over time. See Attachment 6 for applicable SAWA equipment locations and estimated radiation fields. Refueling of the FLEX DG is accomplished as described in Section A.6.5 of the EA-12-049 FIP and procedure SOP-FLEX-EQUIPMENT-REFUEL.

Evaluations of projected SA conditions (radiation/temperature) indicate that personnel can complete the initial and support activities without exceeding the ERO-allowable dose for equipment operation or site safety standards. The SAWA connections can be completed and water addition started before the HCV is opened.

Electrical equipment and instrumentation is powered by batteries which are recharged using one of the FLEX DGs. The battery chargers are repowered from the FLEX DG to maintain both the station and HCV battery capacities during the sustained operating period. One of the FLEX DGs can be made available before the HCV is opened.

Section II: List of Acronyms

ABN	Abnormal Operating Procedure
AC	Alternating Current
AOV	Air Operated Valve
BDBEE	Beyond Design Basis External Event
BWR	Boiling Water Reactor
BWROG	Boiling Water Reactor Owners' Group
CMS	Containment Monitoring System
DC	Direct Current
DFO	Diesel Fuel Oil
DG	Diesel Generator
EC	Engineering Change (modification)
ECCS	Emergency Core Cooling Systems
ELAP	Extended Loss of AC Power
EOP	Emergency Operating Procedure
EPG/SAG	Emergency Procedure and Severe Accident Guidelines
EPRI	Electric Power Research Institute
EQ	Equipment Qualifications
ERO	Emergency Response Organization
FAQ	Frequently Asked Question
FIP	Final Integrated Plan
FLEX	Diverse & Flexible Coping Strategy
FSAR	Final Safety Analysis Report
FSG	FLEX Support Guideline
GPM	Gallons per minute
HCV	Hardened Containment Vent
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
PCIV	Primary Containment Isolation Valve
PCPL	Primary Containment Pressure Limit
RCIC	Reactor Core Isolation Cooling System
RM	Radiation Monitor
ROS	Remote Operating Station
RPS	Reactor Protection System
RPV	Reactor Pressure Vessel
RHR	Residual Heat Removal
RWCU	Reactor Water Cleanup
SA	Severe Accident
SAMG	Severe Accident Management Guidelines
SAWA	Severe Accident Water Addition
SAWM	Severe Accident Water Management
SBGT	Standby Gas Treatment System
SFP	Spent Fuel Pool
SP	Suppression Pool
SPV	Solenoid Pilot Valves
SRM	Staff Requirements Memorandum
SRV	Safety-Relief Valve
SWSP	Service Water Spray Pond
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

Energy Northwest has installed a SA capable hardened containment vent at Columbia to comply with NRC Order EA-13-109.

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

Columbia has a Mark II containment. Therefore, NRC Generic Letter 89-16 does not apply.

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

The HCVS is lined-up from the ROS and operated and monitored from the MCR or ROS. The ROS is located in Room D113 on the 441 foot elevation of the DG building in a readily accessible location and provides a means to manually operate the wetwell vent. Manual operation of the HCVS from the ROS is functional under a range of plant conditions, including SA conditions. ME-02-17-09, R1 and ME-02-17-12, R1 evaluate habitability and ME-02-14-04 and ME-02-17-14 evaluate equipment acceptability in the ROS location with respect to severe accident conditions.

The HCVS utilization from the ROS does not contain any electrical circuitry requiring bypassing of isolation signals. The operator at the ROS opens the primary containment isolation valves (PCIV) directly with compressed nitrogen by manually bypassing the solenoid pilot valves (SPV). No electrical signal overrides are needed.

The MCR is the primary operating station for the HCVS. During an ELAP, electric power to operate the SPVs that position the vent's PCIVs will be provided by the HCVS batteries with a capacity to supply required loads for at least the first 24 hours. Before the HCVS batteries are depleted, a FLEX DG will supplement and recharge the HCVS batteries to support the sustained operating period of the HCVS. The ROS is designated as the alternate control location and method. Since the SPVs at the ROS can be manually bypassed, the valve solenoids do not need any additional backup electrical power. Attachment 2 shows the HCVS vent flow path.

At the MCR location, the operators can operate the HCVS using key locked switches. They can also monitor:

- HCVS vent valve position,
- drywell pressure and temperature,
- suppression pool level and temperature, and
- HCVS effluent radiation and temperature.

At the ROS operators can monitor:

- HCVS effluent radiation, and
- Nitrogen (N_2) pressure for PCIV operation and bursting of the rupture discs.

HCVS battery voltage and current are monitored at the HCVS battery charger in reactor protection system (RPS) Room No.2 which is readily accessible from either the MCR or ROS.

Attachment 7, Table 1 contains a list of instruments available to the operators for operating and monitoring the HCVS.

A 24-V battery system dedicated to the HCVS electrical loads consisting of batteries, a battery charger, 24-V DC distribution panels, wiring, cables, and raceways has been installed. The batteries are located in the Division 2 Battery Room (C215), and the charger is located in RPS Room 2 (C213). Both rooms are located in the radwaste building and the HCV battery charger is connected to power panel E-PP-8A. The battery sizing will sustain

operation for a minimum of 24 hours with no operator action. Before 24 hours, supplemental power from a FLEX DG will be available. The hydrogen generation as a result of the addition of these batteries has been evaluated in calculation ME-02-13-14 which confirmed that hydrogen accumulation does not approach the flammability limits during battery charging. The HCVS PCIV operation and position indication, as well as the radiation monitor, are powered by this battery system.

Attachment 3 contains one-line diagrams of the HCVS electrical distribution system.

A dedicated nitrogen bottle rack located in DG building Room D113 (ROS) provides the motive force for the air operated valves. Once valved in by an operator, the nitrogen supply will sustain operation for a minimum of 24 hours with no operator action. For sustained operation, a spare nitrogen bottle is provided in the bottle rack which can be supplemented by bottles in the railroad bay if needed.

Attachment 2 contains one-line diagrams of the HCV vent path and pneumatics.

The wetwell vent up to, and including, the second containment isolation barrier is designed consistent with the design basis of the plant. These items include piping, piping supports, containment isolation valves, and the containment isolation valve actuators. The containment isolation valve position indication components are non-safety related, but meet the requirements for environmental and seismic qualification of safety related components.

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. The hardened vent piping, between the wetwell and the reactor building roof is designed to 150 psig and 350ºF.

The HCVS is a stand-alone system without any intersystem connections. HCVS features to prevent inadvertent actuation include key lock switches in the MCR and a lock-closed valve in the nitrogen supply to the PCIV SPVs. The rupture discs in the nitrogen supply and discharge pipe prevent secondary containment bypass leakage.

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. Columbia's design includes a check valve near the discharge 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 uses an ion chamber detector and is qualified for the ELAP and external event conditions. Also, 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 withstand 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 Columbia response to maintain compliance with the order and guidance from JLD-ISG-2015-01. Due to the difference between NEI 13-02, Revision 0, and Revision 1, only Revision 1 is 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 ROS. A list of the remote manual actions performed by plant personnel to open the HCVS vent path is in Table 3-1 below.

Table 3-1: HCVS Operator Actions

Primary Action	Primary Location/ Component	Notes
Line-up the nitrogen supply to the HCVS valves (HCV-V-1 and HCV-V-2).	Open ROS Nitrogen bottle isolation valve. Unlock and open HCV-V-107	Nitrogen is lined up to the HCVS valves to make them operational.
Line-up the nitrogen supply to the HCVS rupture discs (HCV-RD-54 and HCV-RD-60).	ROS Nitrogen bottle isolation valve. Unlock HCV-V-102 Open HCV-V-102 and cycle HCV-V-104	Nitrogen is lined up to the rupture discs in order to breach (rupture) them. HCV-RD-60 allows the N_2 to be lined up to then burst HCV-RD-54 downstream of the PCIVs.
Open HCVS PCIVs HCV-V-1 and HCV-V-2.	Key-locked control switches located in the MCR or via manual SPV bypass valves located at the ROS.	Control containment pressure
Replenish pneumatics with spare bottle.	Bottle rack is located in the ROS	Action may be required to supplement the N_2 backup system beyond 24 hours.
Re-power the HCVS battery charger for sustained operations (post 24 hours).	FLEX diesels are located in an area that meets the requirements of EA-12-049 and is accessible to operators during a severe accident.	Action required to provide power to HCVS equipment after a minimum of 24 hours.

Permanently installed electrical power and pneumatic supplies are available to support operation and monitoring of the HCVS for a minimum of 24 hours.

During the event, a FLEX generator is connected prior to opening the HCV. This action not only supplies power to the battery charger supplying primary plant instrumentation used to monitor wetwell and drywell parameters, but will also supply the HCVS battery charger. This will ensure electrical power to the HCVS components through the sustained operation period of 7 days.

ME-02-15-08 R1 evaluated the pneumatics for the HCVS.

- One cylinder at 2400 psia is capable of opening both PCIVs initially, and supporting a minimum of 12 open/close cycles. There are three connected cylinders in the rack which provided considerable margin to meet the requirement for 8 cycles in 24 hours (36 cycles/8 cycles/d = 4.5 days). A fourth bottle was added to the bottle rack to provide additional capacity. If needed, additional bottles are available in the railroad bay and provide for a sustained operating period of 7 days.
- With a nominal initial cylinder pressure of 2900 psig, and a lower limit of 800 psig for PCIV opening, up to 19 PCIV cycles are possible when starting with a fully charged cylinder.

E/I-02-13-03 Battery Sizing Calculation for the HCV System

- The vented lead-acid cells defined by this calculation are capable of supplying the HGV system load for the 24 hours discharge cycle during an extended loss of AC power (ELAP). This meets the specified 24 hours following the loss of normal power required by the NRC Order EA-13-109 and SECY-12-0157.
- Throughout the duty cycle, the selected battery is capable of maintaining the DC voltage at or above the 1.75 volts per cell for twenty-four hours. For the specified battery duty cycle and the cell size selected, the average cell voltage will not drop below the specified minimum at any point in the duty cycle.

The above set of actions conform to the guidance in NEI 13-02 Revision 1 Section 4.2.6 for minimizing reliance on Operator actions and are acceptable for compliance with order element A.1.1.1.

Table 3-2: Failure Evaluation

Functional Failure Mode	**Failure Cause**	**Alternate Action**	**Failure with Alternated Action Impact on Containment Venting?**
Failure of Vent to OPEN/CLOSE on Remote Demand	Loss of HCV battery Power	Operate HCV PCIVs from remote operating station (ROS)	Not Credible - No electrical power is required for remote operation.
Failure of Vent to OPEN/CLOSE on Remote Demand	Loss of pneumatics	Connect spare nitrogen bottle station in ROS bottle rack	Not Credible - Remote operation remains available.
Failure of Vent to OPEN/CLOSE from ROS	Loss of pneumatics	Connect spare nitrogen bottle station in ROS bottle rack	Not credible – Manually operated bypass valves are used.
Spurious Opening	Not credible. 1. pneumatics are required to be lined up to breach rupture discs 2. Key locked control switches for PCIVs 3. Manual bypass valves	NA	No

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

Evaluation:

After initial system line up in the ROS, primary control of the HCVS is accomplished from the MCR. Alternate control of the HCVS is accomplished from the ROS in the DG building 441 foot level. FLEX actions that maintain the MCR habitable were implemented in response to NRC Order EA-12-049 (Reference 31). These include implementing the actions in PPM 5.6.2.

Habitability of the ROS does not require special actions as it is located in the DG building. The ROS is accessible from a pathway outside the reactor building which has been evaluated for habitability and radiological conditions to ensure operating personnel can safely access and operate the controls. The ROS is not expected to be continually manned.

Additionally, actions required in the reactor building to connect the SAWA injection hose can be completed before opening the HCV is required.

Attachment 7 Table 2 contains a thermal and radiological evaluation of the operator actions that may be required to support HCVS operation. The relevant calculation(s) (References 40 and 46 through 49) 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 (Reference HCVS-FAQ-06).

Initial system line up and 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 the DG building with significant intervening concrete walls between it and the HCVS piping. The distance and shielding combined with the short duration of actions required at the ROS show the ROS to be an acceptable location for alternate control.

Attachment 7, Table 2 contains a radiological evaluation of the operator actions that may be required to support HCVS operation in a severe accident. There are no abnormal radiological conditions present for HCVS operation without core damage. The evaluation of radiological hazards demonstrates that the final design meets the order requirements to minimize the plant operators' exposure to radiological hazards.

The HCVS vent is routed away from the MCR such that building structures provide shielding, thus per HCVS-FAQ-01, the MCR is the preferred control location.

1.1.4 The HCVS controls and indications shall be accessible and functional under a range of plant conditions, including SA conditions and an ELAP.

Evaluation:

Primary control of the HCVS is accomplished from the main control room. 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 (Reference HCVS-FAQ-06).

Alternate control of the HCVS is accomplished from the ROS located in the diesel generator building. The ROS in the DG building is in an area evaluated to be accessible before and during a severe accident.

For ELAP with reactor core isolation cooling (RCIC) injection, the HCVS wetwell vent will be opened to protect the containment and maintain RCIC operation. The operator actions and timing of those actions to perform this function under ELAP conditions were evaluated as part of the Columbia response to NRC Order EA-12- 049 as stated in References 37 and 38.

Attachment 7, Table 2 contains a thermal and radiological evaluation of the operator actions at the MCR or alternate location that may be required to support HCVS operation during a severe accident. The relevant calculations (References 40 and 46 through 48) demonstrate that the final design meets the order

requirements to minimize the plant operators' exposure to occupational and radiological hazards.

Attachment 7, 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 SA with a loss of AC power.

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 ME-02-13-03 contains the verification of 1 percent power flow capacity at design pressure (45 psig).

RELAP5/SCDAPSIM, Version 3.4, was used to determine the maximum amount of steady state flow that could be passed from primary containment through the HCVS to the atmosphere. The driving pressures modeled were 45 psig and 14.5 psig. 45 psig corresponds to the maximum internal design pressure of containment from the primary containment vessel design specification (Section 3.2.1) and 14.5 psig corresponds to the approximate maximum wetwell temperature of 240°F. RCIC operation is limited to 240°F because the RCIC turbine lube oil temperature is limited to 250°F, and there is approximately a 10°F temperature difference across the lube oil cooler (ME-02-14-13).

The RELAP5 input was developed based on station isometric drawings and was split into seven pipes and three valves. The size, length, orientations, and loss coefficients were used as the RELAP5 input. A transient case was then run until steady state conditions were reached. For the 45 psig case, RELAP5 directly outputs the steady state mass flow rate.

For the 14.5 psig case, it was desired to determine the vent piping loss coefficient to assure it was consistent with the limitation expressed in calculation ME-02-14-13. The loss coefficient limitation ($K \leq 4.6$) is needed to assure the suppression pool temperature remains below 240ºF (required for long term RCIC operability). The mass flow, velocity, density, and pressure of the fluid at different positions in the pipe were output by RELAP5. A manual calculation was then performed on these values to calculate the overall loss coefficient, which was determined to be $K = 3.36$.

Venting of Decay Heat

The flow rate required to dissipate 1 percent of decay heat at 45 psig primary containment pressure is 132,514 lbs./hr. Calculated flow rate at 45 psig primary containment pressure: 250,970 lbs./hr.

The calculation flow rate shows that a total margin of 89 percent exists above the required flow rate. The results show that the HCVS is able to remove the required 1 percent of 3556 MWt with 45 psig wetwell pressure. This ensures that the HCVS can remove the amount of energy required by EA-13-109.

System Loss Coefficient

The calculated total system loss coefficient at 14.5 psig wetwell pressure: K=3.36 for a reference diameter of 11.374 inches.

ME-02-14-13 requires the loss coefficient to be ≤ 4.6 with a thermal power of 3556 MWt. This represents a design margin of 37 percent for the resistance coefficient.

Based on the results of calculation ME-02-14-13, the loss coefficient of the hardened vent is sufficient to prevent wetwell temperature from exceeding 240°F during an ELAP with a licensed thermal power of 3556 MWt or less.

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 (45 psig) or the PCPL (121 psig).

This calculation of containment response is contained in MAAP calculation ME-02-14-13, and was identified as complete in Reference 37 and evaluated in Reference 38. It was concluded that the strategies indicated in the FIP will maintain the containment within the design pressure and temperature limits indicated in the FSAR Table 6.2-1. Containment is maintained below the design pressure once the vent is opened.

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

Evaluation

The HCVS discharge pipe runs in the abandoned stairwell in the southeast corner of the reactor building and exits at approximate elevation of 513 feet. The discharge pipe then runs up the outside south wall of the reactor building to release greater than 3 feet above the parapet wall resulting in a discharge point at an approximate elevation of 677 feet. The HCVS path release point is independent of the reactor building elevated release path and release point. All effluents are exhausted above the reactor building. This discharge point was extended approximately 3 feet above the unit's reactor building parapet wall such that the release point will vent away from emergency ventilation system intake and exhaust openings, main control room location, location of HCVS portable equipment, access routes required following an ELAP and BDBEE, and emergency response facilities. This satisfies the guidance for height from HCVS-FAQ-04 (Reference 50).

HCVS-FAQ-04 provides guidance on the placement of release point to ensure that vented fluids are not drawn immediately back into any emergency ventilation

intakes. A zone of influence is defined such that for every 1 foot of vertical separation, the acceptable zone includes all points within a circle centered on the release point extending 5 feet horizontally. The example provided in Reference 50 is that if a subject intake or exhaust is 100 feet away from the release point, the corresponding release point should be 20 feet or more above the level of the intake/exhaust. At Columbia, the elevation difference is about 230 feet from the HCVS release point to the MCR intake elevation. Based on the example, this indicates that the intake needs to be within a horizontal distance of 1150 feet of the release point. The MCR remote intakes are within that distance from the HCV. Therefore, the elevation of the release point is sufficient to preclude radiation issues from the vent effluent. The MCR emergency ventilation is not powered. As a result, no intake from the outside will occur until repowered. Therefore, the vent pipe is appropriately placed relative to this air intake.

EC 13094 was provided as part of the EA-12-049 compliance and contains the evaluation of the HCVS vent pipe protection from external events.

In FSAR Section 2.1.1.1 it states that the site is located at 46° 28' 18" North Latitude and 119° 19' 58" West Longitude. NEI 12-06, Figures 7-1 and 7-2 indicate the site is not in a region where the wind speed is expected to exceed 130 mph. Therefore, the plant screens out for an assessment for high winds (hurricanes and tornados) for the protection and deployment of FLEX equipment, including missiles produced by these events. This also applies to the design of the external portions of the HCVS.

As stated above, the HCVS exhaust pipe exits at approximate elevation of 513 feet. Grade elevation at the Reactor Building is approximately 441 feet. Therefore, the exposed HCVS exhaust pipe is greater than 30 feet above ground level which reduces the potential exposure to missile strike damage. Although the HCVS screens out for tornado loading concerns from a BDBEE, the system was designed to satisfy Columbia's design basis requirements for tornado missile loading in order to prevent any impact on adjacent safety related structures, systems, or components, such as the DG building. Specifically, the HCVS vent piping and associated pipe supports are designed to Seismic Category I requirements as documented in the supporting calculations of EC 13094.

The exterior vent piping, from the secondary containment penetration to the exhaust point is 16 inch Schedule 40 seamless ASTM A106 Grade B piping and is Seismic Category 1 in order to ensure that it will not fail in a seismic event and impact the safety related DG building below. ME-02-14-16 evaluated the HCVS outdoor piping from the secondary containment anchor HCV-4 to the vent exhaust.

Based on the above description of the vent pipe design, the Columbia HCVS vent pipe design meets the order requirement to be robust with respect to all external hazards. As stated in Reference 37, and acknowledged in Reference 38, Columbia is not susceptible to high-wind hazards.

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

Columbia is a single unit station and the HCVS was designed as a stand-alone system and is independent of other plant systems. Therefore, while the HCVS shares some robust, Seismic Category I structures with other systems, it has no mechanical or electrical interfaces with other systems.

Based on the above, the Columbia 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

Once the HCVS pneumatics are lined up, the HCVS will be initiated and then operated and monitored from a control panel located in the MCR.

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

Evaluation

To meet the requirements for an alternate means of operation, from a readily accessible alternate location, an ROS was added. The ROS has two functions, initial manual lineup of the pneumatics that allows remote operation of the PCIVs from the MCR and manual bypassing of the SPV valves allowing operation of the PCIVs from the ROS.

This provides a diverse method of valve operation improving system reliability.

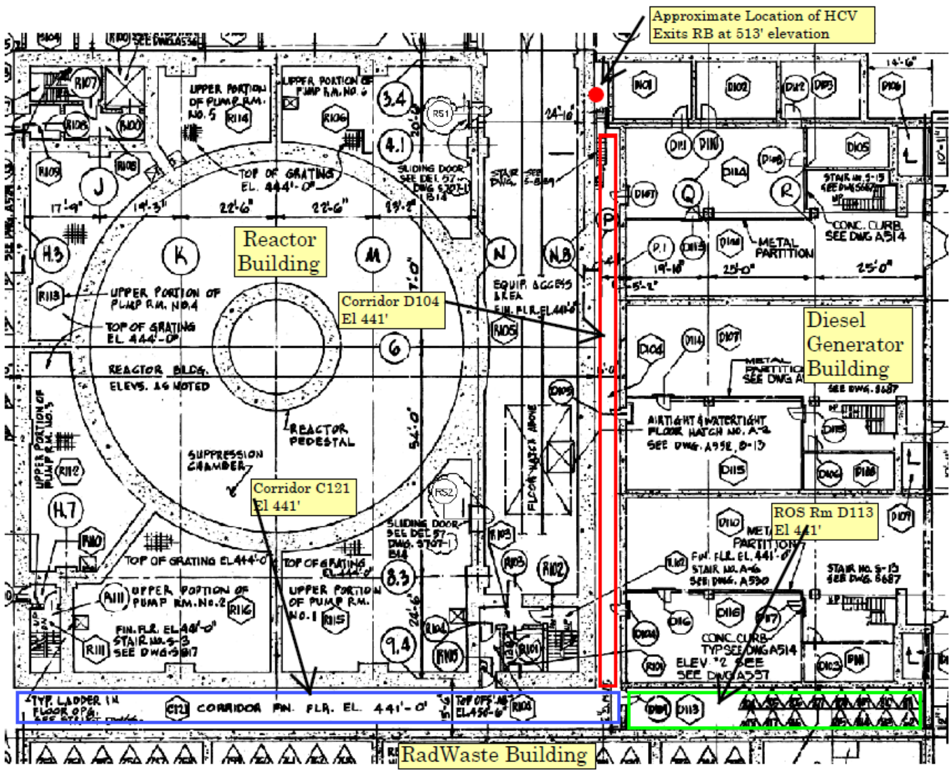
The general arrangement of the ROS (Room D113), the DG Corridor (D104) and the Radwaste Corridor (C121) are shown in the figure below. The location of the ROS is on the 441 foot level of the DG building (ground floor). The ROS location is in an area shielded from the HCVS vent pipe by intervening structures. No reactor building entry is required to access the ROS.

The ROS, provides reasonable assurance of protection from radiological consequences (radiation and contamination). The ROS location also provides reasonable assurance of protection from temperature and humidity. Because the location of the ROS in Room D113, there will be minimal thermal effects from the reactor building, the HCVS, or the spent fuel pool.

Analyses in NE-02-12-07 indicate that the maximum temperature in Room D113 is 104.2ºF. There are no significant sources of moisture in the room and the location is not expected to be continuously manned. In order to estimate the allowed action (stay) time in the room an initial humidity (RH) of 55 percent is used with a typical room temperature of 72ºF. If the room reaches 104.2ºF, the

RH is approximately 20 percent. At that point, Industrial Safety Program Manual 13 would limit the Action Time to approximately 60 minutes which provides ample time to lineup the pneumatics as shown in Validation Plan No.12.

The ROS is accessed via DG Corridor D104 or radwaste building corridor C121, as shown in Figure 5-1 below. Based on the radiation levels along the access pathways, access through corridor C121 is preferred, though both are viable.



Appendix 7, Table 1 contains an environmental and radiological evaluation of the instruments that are required for severe accident response and demonstrates that these will be functional during a loss of AC power and severe accident. Appendix 7, Table 2 contains an environmental and radiological evaluation of the operator actions that may be required to support HCVS operation during a loss of AC power and severe accident, and demonstrates that these actions will be possible without undue hazard to the operators. Attachment 6 contains a site layout showing the location of the FLEX equipment where operator actions take place and the expected radiation fields during the event.

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 ELAP.

Evaluation

HCVS-WP-01 (Reference 8) contains clarification of 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 Columbia HCVS is a stand-alone system designed to operate during the first 24 hours of an ELAP without support from other plant systems or FLEX equipment.

The HCVS battery calculation E/I-02-13-03 R1 concluded that:

- The battery evaluated by this calculation is capable of supplying the HCVS load for the 24 hours discharge cycle during an ELAP. This meets the specified 24 hours following the loss of normal power required by the NRC Order EA-13-109.
- Throughout the duty cycle, the selected battery is capable of maintaining the direct current (DC) voltage at or above the 1.75 volts per cell for 24 hours. For the specified battery duty cycle and the cell size selected, the average cell voltage will not drop below the specified minimum (e.g. 1.75 V) at any point in the duty cycle.

Calculation E/I-02-91-03 R21 evaluated the addition of the HCVS battery charger to the FLEX diesel generator loads.

One of the two FLEX DGs will be available to supply the HCVS battery changer within the 24 hour capacity of the HCVS batteries.

The pneumatics calculation ME-02-15-08 evaluated the HCVS compressed nitrogen supply used to burst rupture discs HCV-RD-60 and 54, and to operate PCIVs HCV-V-1 and 2. The analysis concluded that the pneumatics used to operate the HCV system contains sufficient nitrogen in the HCVS bottle rack to meet the requirements of functioning for 24 hours.

A spare nitrogen bottle is installed in the pneumatics rack.

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.

The HCV PCIVs must be opened to permit vent flow. The physical features that prevent an inadvertent actuation are the key lock switch for HCV-V-1 and HCV-V-2 in the MCR and lock-closed nitrogen supply valve HCV-V-107 isolating the pneumatics for PCIV operation.

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 ELAP.

Evaluation

The HCVS includes indications for HCVS valve position, vent pipe temperature and effluent radiation levels in the MCR. This monitoring instrumentation provides the indication in the MCR per Requirement 1.2.4.

The HCVS battery voltage and current can be monitored in RPS Room No.2 which is readily accessible from either the MCR or ROS.

As stated in Section 1.2.6 above, the first 24 hours of operation are supported by the dedicated HCVS battery which has been shown to be capable of supporting that time requirement. Prior to exceeding the 24 hours, one of the FLEX DGs will have been placed in service which will supply the HCVS battery charger.

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 vent pipe temperature, radiation monitoring, and support system monitoring, are qualified as indicated on Appendix 7, Table 1 and they include the ability to handle extreme 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 ELAP.

Evaluation

HCV-RIS-RAD/1 radiation monitoring system consists of single-channel ion chamber detector connected to the HCVS 24 volt power supply.

The detection device uses a gas-filled gamma ionization chamber to produce a DC electrical current output. Gamma photons generate ion pairs, collected by high-voltage charged electrodes, producing the current signal representing the gamma photon level. The current is measured and converted to a digital signal that indicates the radiation level within the chamber area.

The detector assembly mounts adjacent to the containment vent line for radiation dose rate measurement and the detector assembly includes a built-in “keep-alive” source to maintain a minimum signal output. The process and data acquisition module is located in the ROS and an indication is available in the MCR. The radiation monitor detector is fully qualified for the expected environment at the vent pipe during accident conditions, and the process and data acquisition module is qualified for the mild environment in the ROS. Both

components are qualified for the seismic requirements. Appendix 7, Table 1 includes qualification information on the radiation monitor.

1.2.10 The HCVS shall be designed to withstand and remain functional during SA 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, and containment isolation valve actuators. The containment isolation valve position indication components are non-safety related, but meet the requirements for environmental and seismic qualification of safety related components.

The hardened vent piping, between the wetwell and the reactor building roof is designed to 150 psig at 350ºF. The HCVS does not interface with any other plant systems. 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 SA conditions using the guidance provided in HCVS-FAQ-08 and HCVS-WP-02. The August 6, 2018 NRC audit report (Reference 41) closed Phase 1 ISE OI 6 which requested the local conditions anticipated during ELAP and SA for the components required for the HCVS venting including confirmation that the components are capable of performing their functions during ELAP and SA conditions.

Refer to EA-13-109, requirement 1.2.11 for a discussion on designing for combustible gas (Reference 5).

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

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

Evaluation

As a stand-alone system, the response under order element 1.2.3 explains how the potential for hydrogen migration into other systems is minimized. Integrity of the reactor building is assured by the piping design in accordance with Quality Group D (B31.1), Seismic Category 1, Quality Class 1 to ensure the piping will remain functional during and following a design basis seismic event. Secondary containment bypass leakage is precluded by the installation of Quality Class 1, Seismic Category 1, Quality Group B, rupture discs in accordance with NRC BTP 6-3.

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 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 outside of the containment boundary shall be tested to ensure that vent flow is released to the outside with minimal leakage, if any.

Columbia has implemented the following operation, testing, and inspection requirements for the HCVS to ensure reliable operation of the system. These are from NEI 13-02, Table 6.1. The implementing modification packages contain these as well as additional testing required for post-modification testing.

Table 3-3: Testing and Inspection Requirements

Description	Frequency
Cycle the HCVS and installed SAWA valves[1] and the interfacing system 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 operating cycle[2].
Cycle the HCVS and installed SAWA 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 and installed SAWA components	Once per operating cycle.
Functionally test the HCVS radiation monitors.	Once per operating cycle.

Description	Frequency
Leak test the HCVS.	(1) Prior to first declaring the system functional; (2) Once every three operating cycles thereafter; and (3) After restoration of any breach of system boundary within the buildings.
Validate the HCVS operating procedures by conducting an open/close test of the HCVS control logic from its control location and ensuring that all HCVS vent path and interfacing system boundary[5] valves move to their proper (intended) positions.	Once per every other operating cycle.

[1] Not required for HCVS check valves.

[2] After two consecutive successful performances, the test frequency may be reduced to a maximum of once per every other operating cycle.

[3] Not required if integrity of check function (open and closed) is demonstrated by other plant testing requirements.

[4] After two consecutive successful performances, the test frequency may be reduced by one operating cycle to a maximum of once every fourth operating cycle.

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

2 HCVS Quality Standards:

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

Evaluation:

The HCVS penetration and containment isolation valves are designed and installed consistent with the design basis of the primary containment including pressure, temperature, radiation, and seismic loads. The containment isolation valve position indication components are non-safety related, but meet the requirements for environmental and seismic qualification of safety related components.

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 are routed in seismically qualified structures or supported from seismically qualified structure(s). The HCVS does not interface with other plant systems.

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.

Appendix 7, Table 1 contains a list of components, controls, and instruments required to operate the 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

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

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

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

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

1. HCVS Drywell Vent Functional Requirements

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

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

2. Containment Venting Strategy Requirements

Licensees choosing to develop and implement a reliable containment venting strategy that does not require a reliable, SA 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 SA 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 SA 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, as endorsed by NRC in JLD-ISG-2015-01, provides the guidance for the containment venting strategy (B.2) of the Order. NEI 13-02, Revision 1, provides SAWA in conjunction with SAWM, which is designed to maintain the wetwell vent in service until alternate reliable containment heat removal and pressure controls are established, as the means for compliance with part B of the order.

Columbia has implemented containment venting strategy (B.2), as the compliance method for Phase 2 of the order and conforms to the associated guidance in NEI 13-02 Revision 1 for this compliance method.

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

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

<u>Section IV.C: HCVS Phase 2 SAWA System and SAWM Strategy</u>

The HCVS Phase 2 SAWA system and SAWM strategy utilize the FLEX mitigation equipment and strategies to the extent practical. This approach is reasonable because the external hazards and the event initiator (ELAP) are the same for both FLEX mitigation strategies and HCVS. For SAWA, it is assumed that the initial FLEX response actions are unsuccessful in providing core cooling such that core damage contributes to significant radiological impacts that may impede the deployment, connection, and use of FLEX equipment. These radiological impacts, including dose from containment and HCVS vent line shine, were evaluated. As a result, adjustments were made in the mitigation response timeline to facilitate establishing SAWA and repowering essential instrumentation prior to opening the HCV. These changes to the response timeline 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. This approach facilitates the transition from FLEX to SAWA strategies if the station initially implements FLEX actions, but the event progresses to a severe accident. This approach further enhances the feasibility of SAWA under a variety of event sequences including timing and provides a singular response to FLEX or SA.

Columbia 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 of the FLEX (SAWA) pump discharge 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 SA 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 the SAWA connection point has been designated as RHR-V-63A to meet the requirement prohibiting the use of ladders in the response. The SAWA system, shown on Attachment 4, consists of a FLEX pump injecting into the RPV and SAWM consists of control of the FLEX pump flow along with wetwell level indication to ensure that the wetwell vent is not submerged (SAWM). In the SAWA injection path, a FLEX pump takes suction from the service water spray ponds, discharging to a fire hose which traverses across the yard area and enters the reactor building at the reactor building railroad bay and up the southwest reactor building stairwell. The discharge hose is routed in the stairwell to the RHR piping at valve RHR-V-63A. A flow element and manual valves are installed in the line to allow operators to monitor and adjust flow as needed. The flow element and valves are located at the reactor building 522 foot elevation. Valves will be manually aligned as necessary to control the flow. Cross flow into other portions of the RHR system is precluded by RHR system check valves and verifying various RHR valves closed. The hoses and pumps are stored in FLEX buildings 82 and 600 which are protected from all hazards. Some hoses are also stored in the B.5.b stairwell cabinets in the reactor building. The RHR system piping is used to provide the SAWA to the RPV. BWROG generic assessment, BWROG-TP-15-008, provides the principles of SAWA to ensure protection of containment. This SAWA injection path is qualified for the screened in hazards (Section III) in addition to SA conditions.

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

The FLEX pump deployment time was reassessed for SAWA use and it was determined that to meet the starting injection time, adjustments were made in the FLEX timeline to initiate SAWA earlier in the event. In case of severe accident, it is necessary to have the flow path established before the HCV is opened. The new deployment time was time validated as part of the EA-13-109 response.

The actions inside the reactor building were time validated to assure they can be performed before the dose in the RHR valve room is unacceptable. Even with the earliest possible core failure, the connections and initiation of injection can be accomplished before the HCV is opened. This time was validated as part of the Time Sensitive Action validation for EA-13-109. Procedure ABN-FSG-002 has been restructured to provide a singular water addition whether for FLEX mitigation or SAWA. PPM 5.1.1, RPV Control provides direction to the operators (Table 3 ABN-FSG-002) when attempting to restore level during a SA event where there is a loss of all AC power and a loss of all high-pressure injection to the core. In this event, core damage is not expected for at least one hour. The habitability concerns of temperature, humidity, and dose have been assessed. There are no excessive radiation levels or heat related concerns in the reactor building areas where the operators are establishing the SAWA flow path before the HCV is opened. The other SAWA actions

all take place outside the reactor building at the MCR, ROS, spray ponds, and the deployment pathways. Since the actions required to initiate SAWA are completed before the HCV is opened, the operators in those locations outside the reactor building are not exposed to the SA dose rates while setting up the SAWA response. Once SAWA is initiated, the operators will monitor the response of containment from the MCR to assure that venting and SAWA are operating satisfactorily, maintaining containment pressure low to avoid containment failure. A stable or slowly rising trend in wetwell level with SAWA at the minimum flow rate indicates water on the drywell floor up to the vent pipe or downcomer openings. After some period of time, as decay heat levels decrease, the operators will be able to reduce SAWA flow to keep the core debris cool while avoiding overfill of the suppression pool to the point where the wetwell vent is submerged.

Operators monitoring the SAWA equipment can make use of low dose areas identified in associated procedures to minimize exposure.

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

Columbia 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 466' 2.75" (normal suppression pool level) and 491' (HCVS penetration centerline) in the wetwell provides approximately 815,900 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 SAWA 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 calculation ME-02-14-02 Appendix H, the wetwell level will not reach the wetwell vent for at least seven days. A diagram of the available freeboard is shown in Attachment 1.

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

The upper range of wetwell level indication provided for SAWA/SAWM is 487’3” elevation. This defines the upper limit of wetwell volume that will preserve the wetwell vent function as shown in Attachment 1.

Section IV.C.6: Wetwell vent service time

Reference 27 in NEI 13-02, Revision 1 and BWROG-TP-15-011, demonstrates 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 Columbia 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 Columbia SAMGs. In particular, EPG/SAG Revision 3, 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.

Energy Northwest changed the Columbia mitigation response to fit the SA scenario by moving the water addition steps to earlier in the event timeline. This allows Columbia to have a single response for any BDBEE, even if it degrades to a SA. Using the NEI letter from Nicholas X. Pappas, Senior Project Manager of NEI to Industry Administrative Points of Contact (Reference 45), Energy Northwest revalidated Columbia's response. Validation Plan No. 13 shows that the SAWA pump can be deployed and commence injection in prior to the HCV being opened. 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 450 gpm. After a period of time, estimated to be about 4 hours, in which the maximum flow rate is maintained, the SAWA flow will be reduced. The reduction in flow rate and the timing of the reduction will be based on stabilization of the containment parameters of drywell pressure and wetwell level.

NEI 13-02 generic analysis per NEI 13-02 Reference 27 demonstrated that, SAWA flow could be reduced to 90 gpm after four hours of initial SAWA flow rate and containment would be protected. At some point wetwell level will begin to rise indicating that the SAWA flow is greater than the steaming rate due to containment heat load such that flow can be reduced. While this is expected to be 4-6 hours, no time is specified in the procedures because the SAMGs are symptom based guidelines.

Section IV.C.8: SAWA Flow Control

The Columbia response will accomplish SAWA flow control by throttling valves located on the reactor building 522 foot elevation. The operator at the valve will be in communication with the MCR via sound powered phones or radios. 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 would become submerged. The communications capabilities that will be used for communication between the MCR and the SAWA flow control location are the same as that evaluated and found acceptable for FLEX strategies. The communications capabilities are verified 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

Columbia uses one of two available portable diesel-driven FLEX pumps for the FLEX and SAWA response. Calculation ME-02-12-06 demonstrates that either pump is capable of supplying the required 450 gpm at the pressures required for RPV injection during an

ELAP if the RCIC pump fails (SAWA). Each of these pumps has been shown to be capable of supplying the required flow rates to the RPV and the SFP for the FLEX response. The pumps are stored separately in FLEX buildings 82 and 600 where they are protected from all screened-in hazards and are rugged, over the road, trailer-mounted or truck-mounted units, and therefore will be available to function after a seismic event.

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

Calculation ME-02-14-02 determined that the initial Columbia SAWA flowrate is 450 gpm, which is the site-specific flow rate when the site's rated thermal power is compared to the reference power level of NEI 13-02. The initial SAWA flow (450 gpm) will be injecting to the RPV within 8 hours of the loss of injection. The reference plant flow rate is 500 gpm with a reactor reference power level of 3951 MWt, equivalent to the reference plant rated thermal power level used in NUREG-1935, State of the Art Reactor Consequence Analysis (SOARCA). NUREG-1935 is Reference 9 of NEI 13-02 Revision 1. Calculation ME-02-14-02 also shows that by reducing flow to 90 gpm after 4 hours, there is sufficient margin to the upper limit of the suppression pool level instrumentation to allow level to be maintained below the vent opening.

Section IV.C.9.3: SAWA Pump Hydraulic Analysis

Calculation ME-02-12-06 analyzed the FLEX pumps and the lineup for RPV injection that would be used for SAWA. This calculation shows that either pump has adequate capacity to meet the SAWA flow rate required to protect containment.

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

The Columbia 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 line has installed ECCS backflow prevention devices qualified for accident scenarios.

Section IV.C.9.5: SAWA Water Source

The source of water for SAWA is either spray pond and together they can provide approximately 18 days of water injection without makeup based on a minimum capacity of 11,920,000 gallons and a flow rate of 450 gpm with no reduction in flow. 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 FLEX buildings where they are protected from all screened-in hazards. The SAWA pumps are commercially available pumps. Pump B5B-P-1 is a fire pumper truck rated for long-term outdoor use in emergency scenarios and meets the B.5.b requirements. FLEX-P-1 is a Godwin model HL130M, powered by a Caterpillar C9 engine. The pump and diesel are mounted on a trailer. The pump is stored dry and the diesel engine has block heaters for cold weather starting. 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 SA conditions in

Attachment 7, Table 2, and demonstrated to be acceptable. Since the pumps are stored in a protected structure(s), are qualified for the environment in which they will be used, and will be refueled by a qualified refueling strategy, they will perform their function to maintain SAWA flow needed to protect primary containment per EA-13-109.

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

Attachment 7, Table 1 shows the electrical power source for the SAWA/SAWM instruments. For the instruments powered by the station battery, calculation 2.05.01 has been supplemented by E/I-02-18-01 R0 for the sizing of the 250 volt and 125 volt DC Division I batteries. The new calculation continues to demonstrate that they can provide power until the FLEX DG restores power to the station's battery chargers. For instruments powered by the HCVS battery, calculation E/I-02-13-03 demonstrates that battery power is available until the FLEX DG restores power to the HCVS battery charger.

The FLEX load on the FLEX DGs per EA-12-049 was initially evaluated in calculation E/I-02-91-03 which has been updated and demonstrates a minimum of 114.3 kW of margin when repowering the 480 volt buses. The loads on the FLEX DGs for SAWA and SAWM consist of only the previously identified instrumentation and portable fans identified for the FLEX response. The FLEX generators are qualified to carry the FLEX loads as part of Order EA-12-049 compliance.

Section IV.C.10: SAWA/SAWM Instrumentation

1) Section III.A.2 provides a complete listing of the specific instruments used in the SAWA response. The installed plant instrumentation is repowered by the FLEX DG. The HCV instrumentation is powered by a system battery rated for 24 hours. However, this instrumentation is also repowered by the FLEX DG when connected and started within 8 hours.
2) The SAWA flow meters (FLEX-FE-7 and 8) are 50-600 gpm propeller flow meters with mechanical read-outs. The flow meter will be positioned on the 522 foot elevation of the reactor building where it will not be exposed to extreme low temperatures.
3) Qualifications of instrumentation (temperature/radiation/seismic).

   See Table 1 of Attachment 7.

Section IV.C.10.1: SAWA/SAWM instruments

Attachment 7, 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 instruments used to monitor the condition of containment are the currently installed pressure and differential pressure detectors used during normal operations. They are safety-related and qualified for post-accident use. These instruments are referenced in SA guidelines for control of SAWA flow to maintain the wetwell vent in service while maintaining containment protection. These instruments are powered for up to 8 hours from the station batteries and will be re-powered by a FLEX DG for the sustained operating

period. These instruments were included in the FLEX DG loading calculation reviewed for EA-12-049.

The SAWA flow meter is a 50 to 600 gpm flow meter. When needed, the flow meter is installed with a 4 inch x 4 inch x 4 inch tee located in the stairwell at the 522 foot elevation of the reactor building. The tee will be connected to hoses with Storz connections and a globe isolation valve in each branch. One 4 inch line which will be used to control flow to the RPV. The other 4 inch outlet line will provide flow to the reactor building 606 foot elevation for SFP makeup.

No containment temperature instrumentation is required for compliance with HCVS Phase 2. However, Columbia's 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 SA 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 identified in FSAR Table 7.5-1 as Technical Specification post-accident instrumentation. These instruments are qualified per RG-1.97 Revision 2 (Reference 34) which is the Columbia committed version and are therefore qualified for EA-13-109 events.

Once installed and placed in service, the SAWA flow meter is expected to provide a continuous flow indication under the expected ambient conditions. The flow meter will be available for the entire period of sustained operation. The flow meter and valves used to adjust flow to the RPV and SFP have been relocated inside the reactor building at the 522 foot level to address equipment operating temperature concerns and lower expected dose fields after venting operations commence. See Attachment 7, Table 1.

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

Columbia FLEX strategies will maintain the containment instruments, containment pressure and wetwell level, necessary to successfully implement SAWA. The strategy involves the use a FLEX DG to re-power battery chargers before the batteries supplying the instruments are depleted. Since the FLEX DG is refueled in accordance with FLEX strategies for a sustained period of operation, the instruments will be powered for the sustained operating period. ABN-FSG-001 provides instructions for obtaining readings if the station suffers a total loss of AC power.

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

The most important SA consideration is the radiological dose as a result of the accident and operation of the HCVS. NE-02-15-06 (Reference 43) analyzed the expected dose at different locations outside of the reactor building and times where operator actions will take place during FLEX/SAWA/SAWM activities. Key locations outside of the reactor building are the MCR, ROS, areas where equipment is operated, and the travel paths for FLEX equipment refueling activities. Procedures used by the operators performing functions in

these areas have been updated with SA dose maps to guide the operators in identifying the lowest dose areas when performing SAWA activities.

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

The SAWA pumps are stored in the FLEX buildings and will be operated from outside the reactor building near the spray ponds. The SAWA response has the water addition pathway established before the HCV is opened. Once the HCV is opened, operators will use the dose maps provided to stay in low dose fields until changes in flow or pump refueling are required.

The SAWA flow path consists of hoses that have been evaluated for the integrated dose effects over the period of sustained operation. These hoses are qualified for the temperatures expected in the areas in response to FLEX and a SA response does not change the temperature conditions. Therefore, the SAWA flow path will not be affected by radiation or temperature effects due to a SA. To preclude freezing of water in the hoses, in addition to maintaining flow, the floating suction strainers have been replaced with submerging strainers to take advantage of the warmer water nearer the bottom of the spray ponds.

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 the SA effects.

Section IV.C.11.3: Severe Accident Effect on personnel actions

Section IV.C.2 describes the reactor building actions within the first 6 hours. The required actions including access routes outside the reactor building will be completed before the first use of the vent during SA conditions (assumed to be 7 hours per HCVS-FAQ-12). Operators will be able to use SA dose maps in various procedures to minimize their exposure when not directly monitoring, adjusting, or refueling the equipment so that expected dose is maintained below the ERO exposure guidelines.

As part of the response to Order EA-12-049, Columbia performed GOTHIC calculations to evaluate the expected temperature response of the reactor and control buildings during the ELAP event. Since, in the SA, the core materials are contained inside the primary containment, the temperature response of the control building is driven by the loss of ventilation and ambient conditions and therefore will not change as a result of the severe accident itself. However, as a result of consideration of the radiological conditions in the reactor building during a severe accident, some changes were made to the actions taken in the reactor building during an ELAP. Thus, while the FLEX GOTHIC calculations are acceptable for the SA response in the radwaste building and outside areas, changes were made to the calculations for the Reactor Building. New GOTHIC temperature and humidity analysis cases were included in ME-02-18-12 which superseded CVI 1201-00,2 GOTHIC Analysis of CGS Reactor Building Response to SBO. Calculation ME-02-14-04, Reactor Building Accessibility and Equipment Operability during an ELAP was updated to document the effects of the new GOTHIC cases.

Attachment 7, Table 2 provides a list of SAWA/SAWM operator actions as well as an evaluation of each for suitability during a SA. Attachment 6 shows the approximate locations of the actions.

After the SAWA hose is aligned and connected inside the reactor building, the operators can observe the flow meter and adjust flow in or near the stairwell on the 522 foot elevation. When the HCV is first opened, the dose rate at the location of the flow meter and valves is about 12 mrem/hour, and it decreases with time. Once flow is set at 450 gpm, if desired the operators may move to a low dose area until monitoring or adjusting the SAWA flow is necessary. Therefore, all SAWA controls and indications are accessible during SA conditions.

The SAWA pump is located by one of the spray ponds and the flow monitoring and adjustments are made in the reactor building stairwell at the 522 foot level. The monitoring instrumentation includes SAWA flow at the 522 foot elevation of the reactor building, and wetwell level and containment pressure in the MCR. The dose rate at the 522 foot level in the reactor building has been assessed (Reference 46).

The Columbia FLEX response ensures that the SAWA pump, FLEX generator, and other equipment can all be run for the sustained period by refueling. Due to the high dose rates that are expected near the underground DFO tanks used for equipment refueling in the FLEX strategies, diesel fuel oil tank FLEX-TK-2 will be used. This tank is located on the opposite side of the reactor building away from the HCV exhaust pipe. It will be used for the initial refueling after which the dose rates at the underground tanks are expected to be significantly reduced. Using FLEX-TK-2 first will reduce the exposure of the operator assigned the refueling activities.

Dose maps have been provided in key procedures to aid operators in identifying low dose areas to apply ALARA when not performing a required activity such as refueling or monitoring of the equipment.

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 ELAP.

Evaluation:

Procedures have been established for system operations when normal and backup power is unavailable during ELAP conditions.

The HCVS and SAWA procedures have been developed and implemented following Columbia's process for initiating and/or revising procedures which 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

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

Actual language that is incorporated into site SAMGs.

<u>Cautions</u>

- Addressing the possible plant response associated with adding water to hot core debris and the resulting pressurization of the primary containment by rapid steam generation.
- Addressing the plant impact that raising suppression pool water level above the elevation of the suppression chamber vent opening elevation will flood the suppression chamber vent path.

<u>Priorities</u> – With significant core damage and RPV breach, SAMGs prioritize the preservation of primary containment integrity while limiting radioactivity releases as follows:

- Core debris in the primary containment is stabilized by water addition (SAWA).
- Primary containment pressure is controlled below the Primary Containment Pressure Limit (Wetwell venting)
- Water addition is managed to preserve the Mark I/II suppression chamber vent paths, thereby retaining the benefits of suppression pool scrubbing and minimizing the likelihood of radioactivity and hydrogen release into the secondary containment (SAWM)

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

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

Section V.B: HCVS Out of Service Requirements

Provisions for out-of-service requirements of the HCVS and compensatory measures have been added to PPM 1.5.18. FLEX out-of-service time is controlled by Licensee Controlled Specification 1.11.1.

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

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

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

- If for up to 90 consecutive days, the primary or alternate means of HCVS operation are non-functional, no compensatory actions are necessary.
- If for up to 30 days, the primary and alternate means of HCVS operation or SAWA are non-functional, no compensatory actions are necessary.
- If the out of service times projected to exceed 30 or 90 days as described above, the following actions will be performed through the corrective action system determine:
  - The cause(s) of the non-functionality,
  - The actions to be taken and the schedule for restoring the system to functional status and prevent recurrence,
  - Initiate action to implement appropriate compensatory actions, and
  - Restore full HCVS functionality at the earliest opportunity not to exceed one full operating cycle.

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

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

The system functionality basis is for coping with beyond design basis events and therefore plant shutdown to address non-functional conditions is not warranted. However, such conditions should be addressed by the corrective action program and compensatory actions to address the non-functional condition should be established. These

compensatory actions may include alternative containment venting strategies or other strategies needed to reduce the likelihood of loss of fission product cladding integrity during design basis and beyond design basis events even though the SA 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 ELAP.

Evaluation:

Personnel expected to perform direct execution of the HCVS have received necessary training in the use of plant procedures for system operations when normal and backup power is available and during ELAP conditions. The training will be refreshed on a periodic basis and 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

Energy Northwest will follow the requirements for training of personnel as identified in the final rule, 10 CFR 50.155.

Section VI: References

Number	Rev	Title	Location[1]
1. GL-89-16	0	Installation of a Hardened Wetwell Vent (Generic Letter 89-16), dated September 1, 1989.	ML031140220
2. SECY-12-0157	0	Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments	ML12345A030
3. SRM-SECY-12-0157	0	Staff Requirements – SECY-12-0157 – Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments	ML13078A017

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

Number	Rev	Title	Location[1]
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[2]	1	Industry Guidance for Compliance with Order EA-13-109, BWR Mark I & II Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions	ML15113B318
8. HCVS-WP-01	0	Hardened Containment Vent System Dedicated and Permanently Installed Motive Force, Revision 0, April 14, 2014	ML14120A295 ML14126A374
9. HCVS-WP-02	0	Sequences for HCVS Design and Method for Determining Radiological Dose from HCVS Piping, Revision 0, October 23, 2014	ML14358A038 ML14358A040
10. HCVS-WP-03	1	Hydrogen/Carbon MonoxideControl Measures Revision 1, October2014	ML14302A066 ML15040A038
11. HCVS-WP-04	0	Missile Evaluation for HCVS Components 30 Feet Above Grade	ML15244A923 ML15240A072
12. JLD-ISG-2013- 02	0	Compliance with Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions	ML13304B836
13. JLD-ISG-2015- 01	0	Compliance with Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions	ML15104A118
14. HCVS-FAQ-10	1	Severe Accident Multiple Unit Response	ML15273A141 ML15271A148
15. HCVS-FAQ-11	0	Plant Response During a Severe Accident	ML15273A141 ML15271A148
16. HCVS-FAQ-12	0	Radiological Evaluations onPlant Actions Prior to HCVS Initial Use	ML15273A141 ML15271A148
17. HCVS-FAQ-13	0	Severe Accident Venting Actions Validation	ML15273A141 ML15271A148
18. Phase 1 OIP	N/A	GO2-14-107, Energy Northwest's Phase 1 Response to NRC Order EA-13-109 - Overall Integrated Plan for Reliable Hardened	ML14191A688

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

Number	Rev	Title	Location[1]
		Containment Vents under Severe Accident Conditions	
19. Combined OIP	N/A	GO2-15-175, Energy Northwest's Response to NRC Order EA-13-109 – Overall Integrated Plan for Reliable Hardened Containment Vents under Severe Accident Conditions Phases 1 and 2, Revision 1	ML15351A363
20. Phase 1 ISE	N/A	HCVS Phase 1 Interim Staff Evaluation (ISE)	ML14335A158
21. Phase 2 ISE	N/A	HCVS Phase 2 Interim Staff Evaluation (ISE)	ML16266A233
22. 1st Update	N/A	GO2-14-175, Energy Northwest's First Six-Month Status Update Report for the Implementation of NRC Order EA-13-109 - Overall Integrated Plan for Reliable Hardened Containment Vents under Severe Accident Conditions	ML14357A069
23. 2nd Update	N/A	GO2-15-093, Energy Northwest's Second Six-Month Status Update Report for the Implementation of NRC Order EAa-13-109 – Overall Integrated Plan for Reliable Hardened Containment Vents under Severe Accident Conditions	ML15181A436
24. 3rd Update	N/A	Third Six Month Update (Included in Reference 19)	ML15351A363
25. 4th Update	N/A	GO2-16-098, Energy Northwest's Fourth Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Order EA-13-109, Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions	ML16182A080
26. 5th Update	N/A	GO2-16-171, Energy Northwest's Combined Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Orders EA-12-049 and EA-13-109	ML16364A245
27. 6th Update	N/A	GO2-17-118, Energy Northwest's Second Combined Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Orders EA-12-049 and EA-13-109	ML17178A276
28. 7th Update	N/A	GO2-17-201, Energy Northwest's Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Order EA-13-109, Phase 2 Only	ML18002A438
29. 8th update	n/a	GO2-18-080, Energy Northwest's June 2018 Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Order EA-13-109, Phase 2 Only	ML18176a186
30. 9th Update	N/A	GO2-18-145, Energy Northwest's December 2018 Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Order EA-13-109, Phase 2 Only	ML18347B495
31. 10th Update	N/A	Letter GO2-19-082 from A. L. Javorik (Energy Northwest) to NRC, "Energy Northwest's Final Six-Month Status Update Report for the Implementation of Nuclear Regulatory Commission (NRC) Order EA-13-109, Phase 2 Only," dated June 24, 2019	
32. NEI 12-06	20	Diverse and Flexible Coping Strategies (FLEX) Implementation Guide	ML16005A625
33. EA-12-049		Issuance of Order to Modify Licenses With Regard to Requirements for Mitigation Strategies for Beyond-Design-Basis External Events, dated March 12, 2012.	ML12054A735
34. RG 1.97	2	Instrumentation for Light-Water-Cooled Nuclear Power Plants to Assess Conditions During and Following an Accident	ML003740282

Number	Rev	Title	Location[1]
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. ME-02-15-08	1	Evaluation oh HCVS N_2 Supply System for HCV-RD 54 & 60 and HVC-V- & 2	N/A
37. GO2-17-147	N/A	Energy Northwest's Notification of Full Compliance with Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigation Strategies for Beyond Design Basis External Events"	ML17229B506
38. NRC Safety Evaluation	N/A	Safety Evaluation Regarding Implementation of Mitigating Strategies and Reliable Spent Fuel Pool Instrumentation Related to Orders EA-12-049 and EA-12-051	ML17333A888
39. EPA-400-R-92-001	May 1992	Manual of Protective Action Guides and Protective Actions for Nuclear Incidents	NA
40. NE-02-12-07	1	Room Temperatures for DG Corridors [D104, D113), RW Corridor C121, and Cable Chase [C230]	NA
41. NRC Audit Report	NA	Columbia Generating Station - Report for the Audit of Licensee Responses to Interim Staff Evaluations Open Items Related to NRC Order EA-13-109 To Modify Licenses With Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions	ML18215A204
42. NRC Audit Report	NA	Peach Bottom Atomic Power Station, Units 2 and 3 - Report for the Audit of Licensee Responses to Interim Staff Evaluations Open Items Related to NRC Order EA-13-109 to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions	ML17328A163
43. NE-02-15-06	2	Estimate of Dose Rate from Wetwell Vent Piping Outside the Reactor Building	NA
44. HCV-FAQ-6	3	HCV FLEX and Generic Assumptions	ML14120A289
45. NEI APC 14-17,	0	FLEX Validation Process, dated July 18, 2014 is contained in HCVS-FAQ-13 and NEI 13-02 R1	ML15273A187
46. ME-02-17-12	1	Habitability and Access with Radiological Conditions Expected During an Extended Loss of AC Power with Severe Accident Conditions	NA
47. ME-02-14-04	2	Reactor Building Accessibility and Equipment Operability During an Extended Loss of AC Power (ELAP)	NA
48. ME-02-17-14	0	Functionality of Equipment and Instrumentation During an Extended Loss of AC Power with Severe Accident	NA
49. ME-02-17-09	1	Radwaste Building and Remote Operating Station (ROS) Habitability and Equipment Operability During Extended Loss of AC Power (ELAP)	NA

Attachment 1: Phase 2 Freeboard diagram

Drywell Net Free Volume = 200,540 ft^3.
Wetwell Free Volume = 142,500 ft^3.
Suppression Pool Water Volume at Normal Water Level = 127,197 ft^3 = 952,000 gal. Approximate Suppression Pool volume per foot = 30,700 gal/ft.

Estimated rate of level change* in Suppression Pool at:

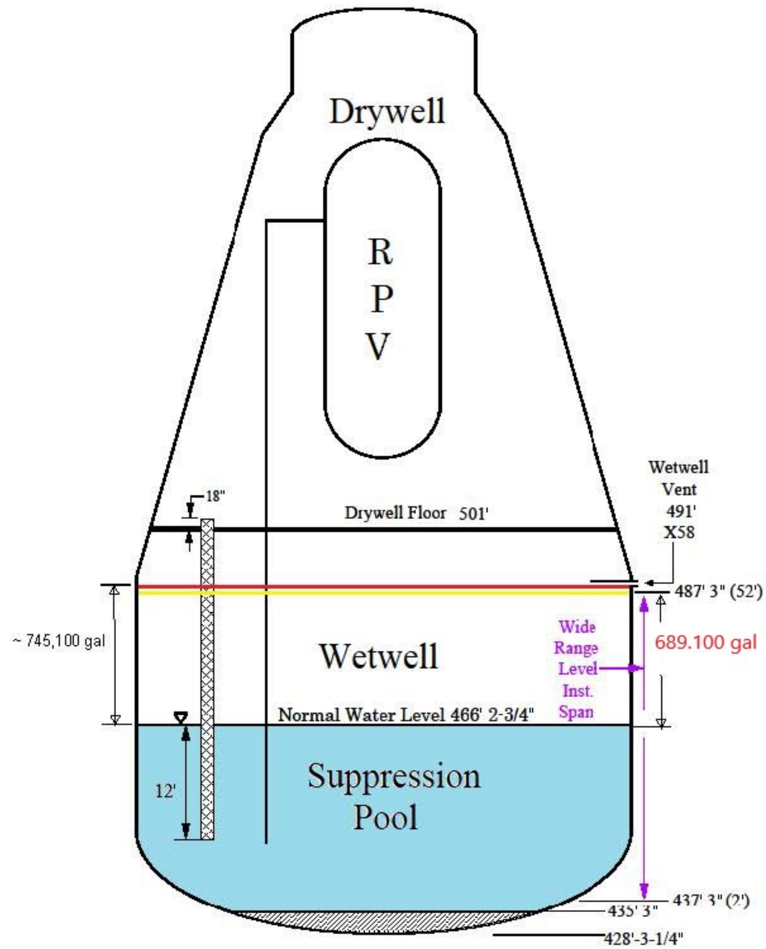
450 gpm = 1 ft/hr (450 gpm x 60 min/hr x 1/30700 gal/ft) and

90 gpm = 0.2 ft/hr (90 gpm x 60 min/hr x 1/30700 gal/ft)

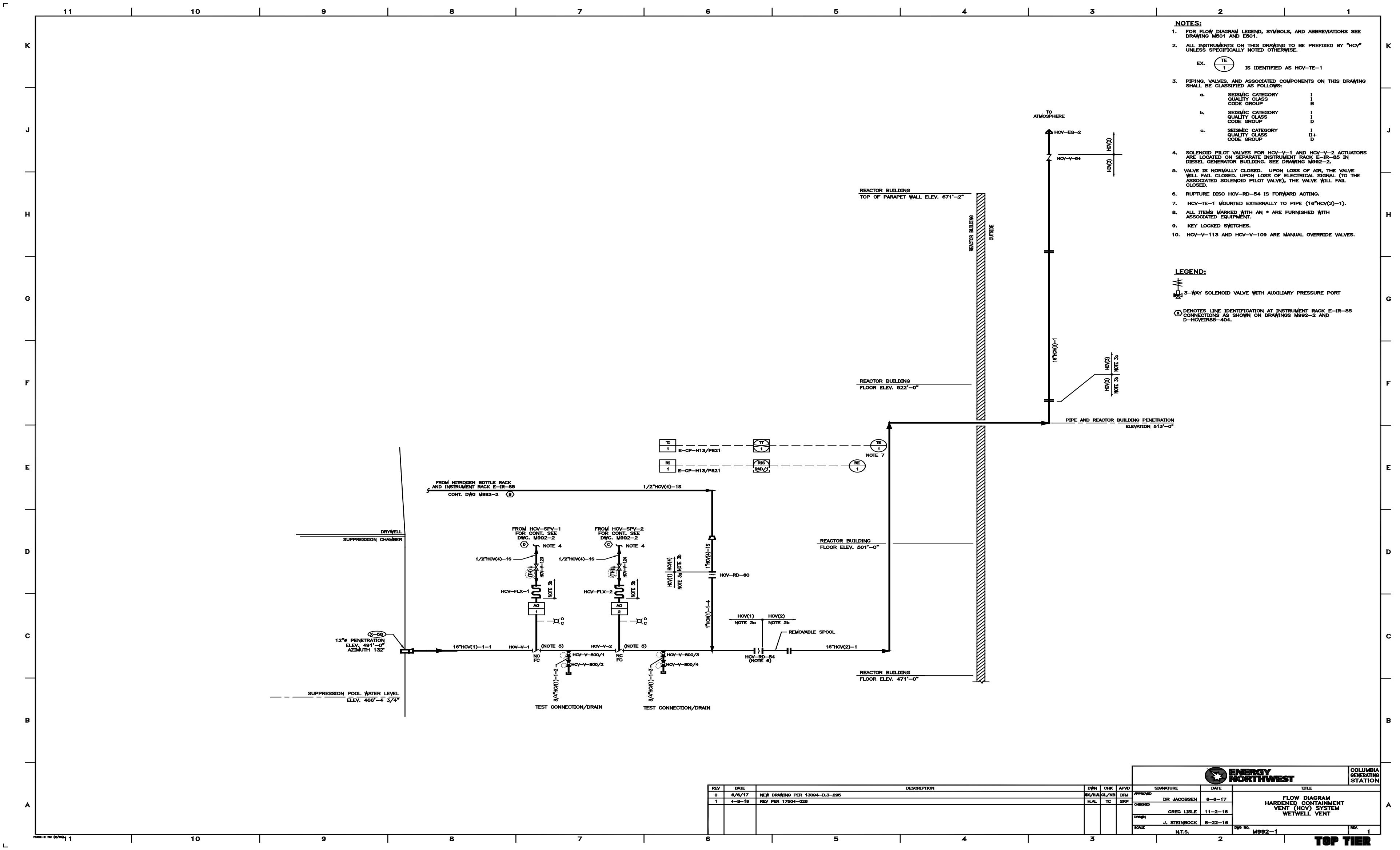
***NOTE:** the estimated rate of level change in the Suppression Pool does not consider water mass loss rates of steam leaving containment through the HVCVS vent.

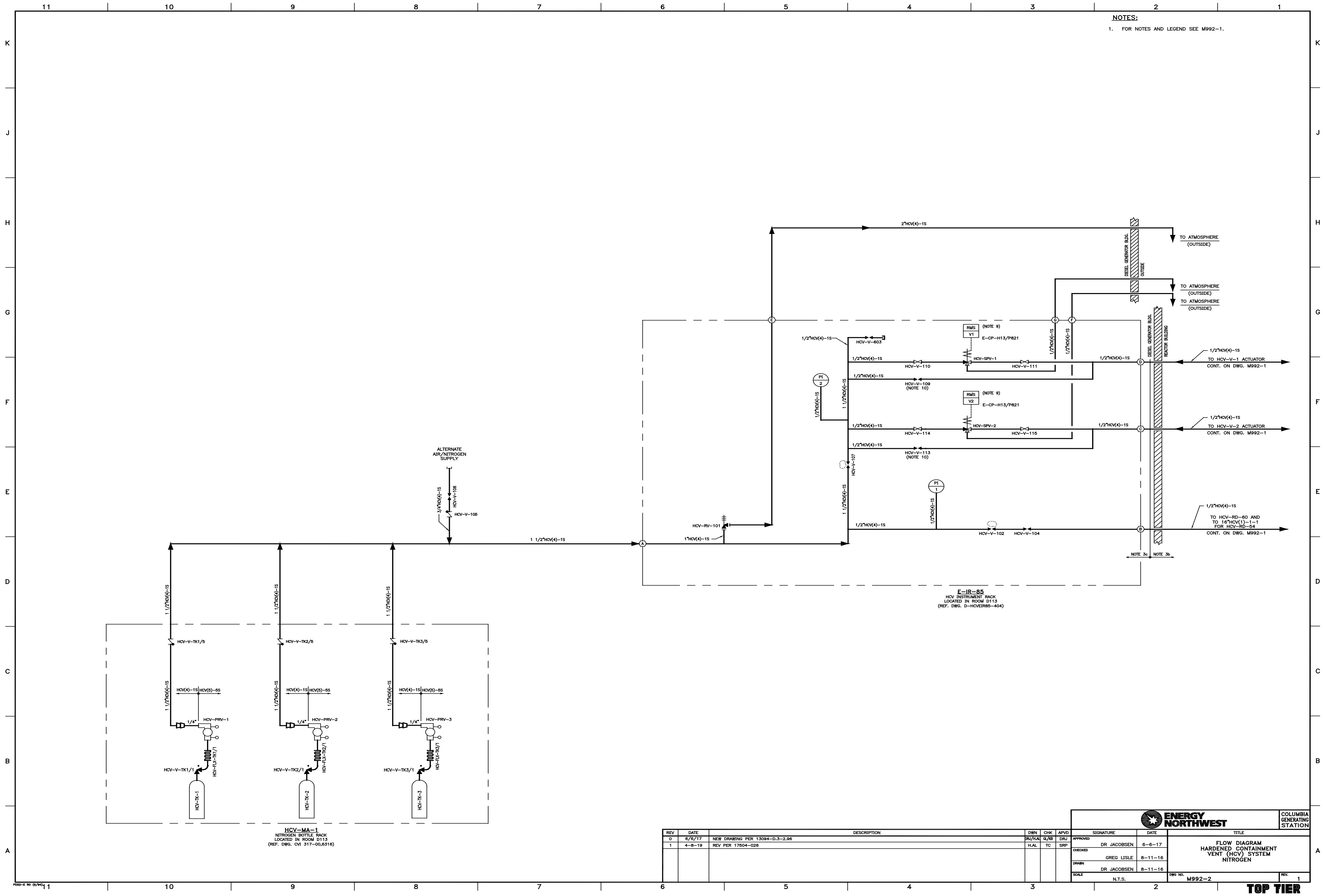
(red line) = Elev. 490' 6" = Loss of Wetwell Vent Function (Bottom of 12" Vent Penetration at Elev 491'), Suppression Pool Water Volume ~ 1,697,000 gal.

(yellow line) = Elev. 487' 3" = Top of Wetwell Level Instrumentation, Suppression Pool Water Volume ~ 1,597,000 gal.



Attachment 2: One Line Diagram of HCVS Vent Path

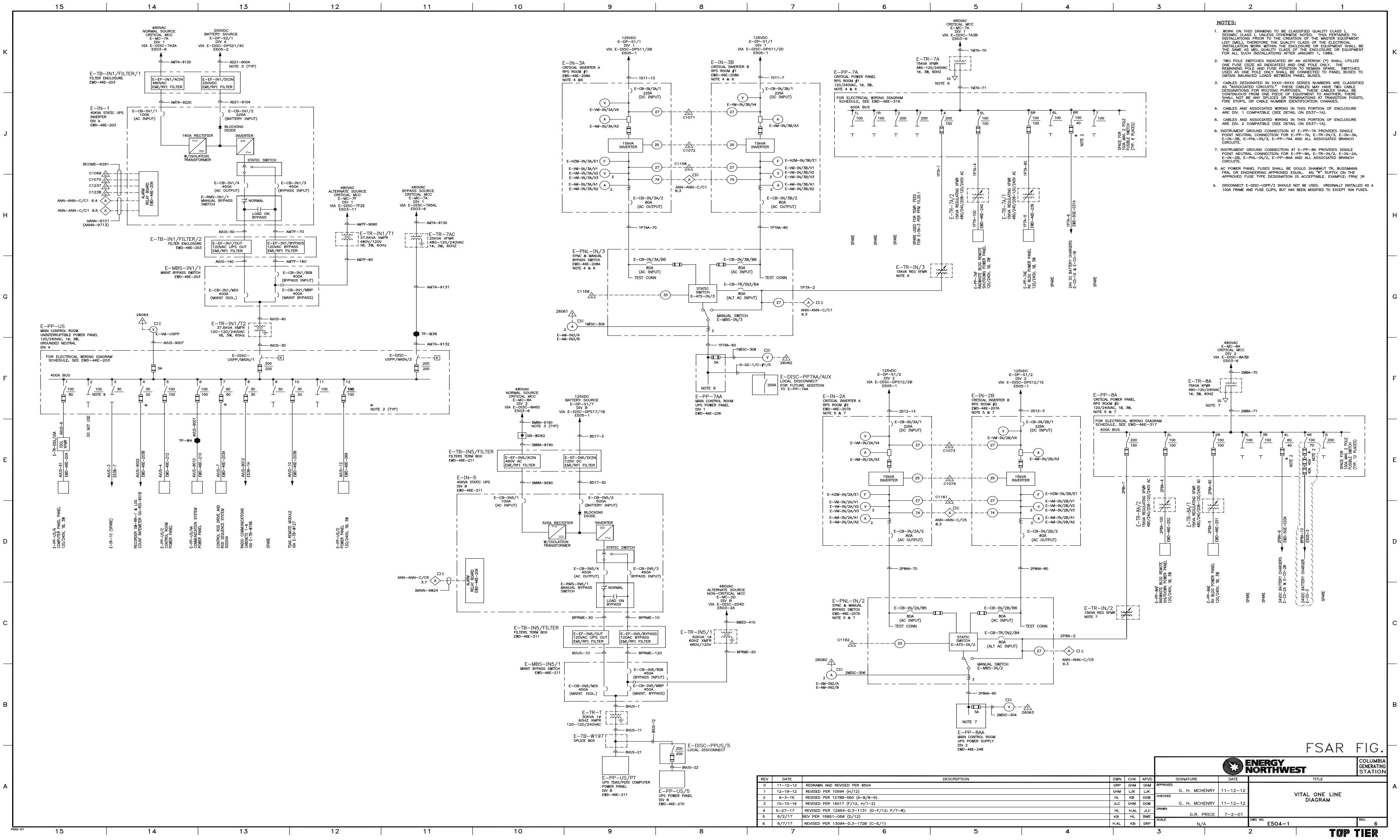


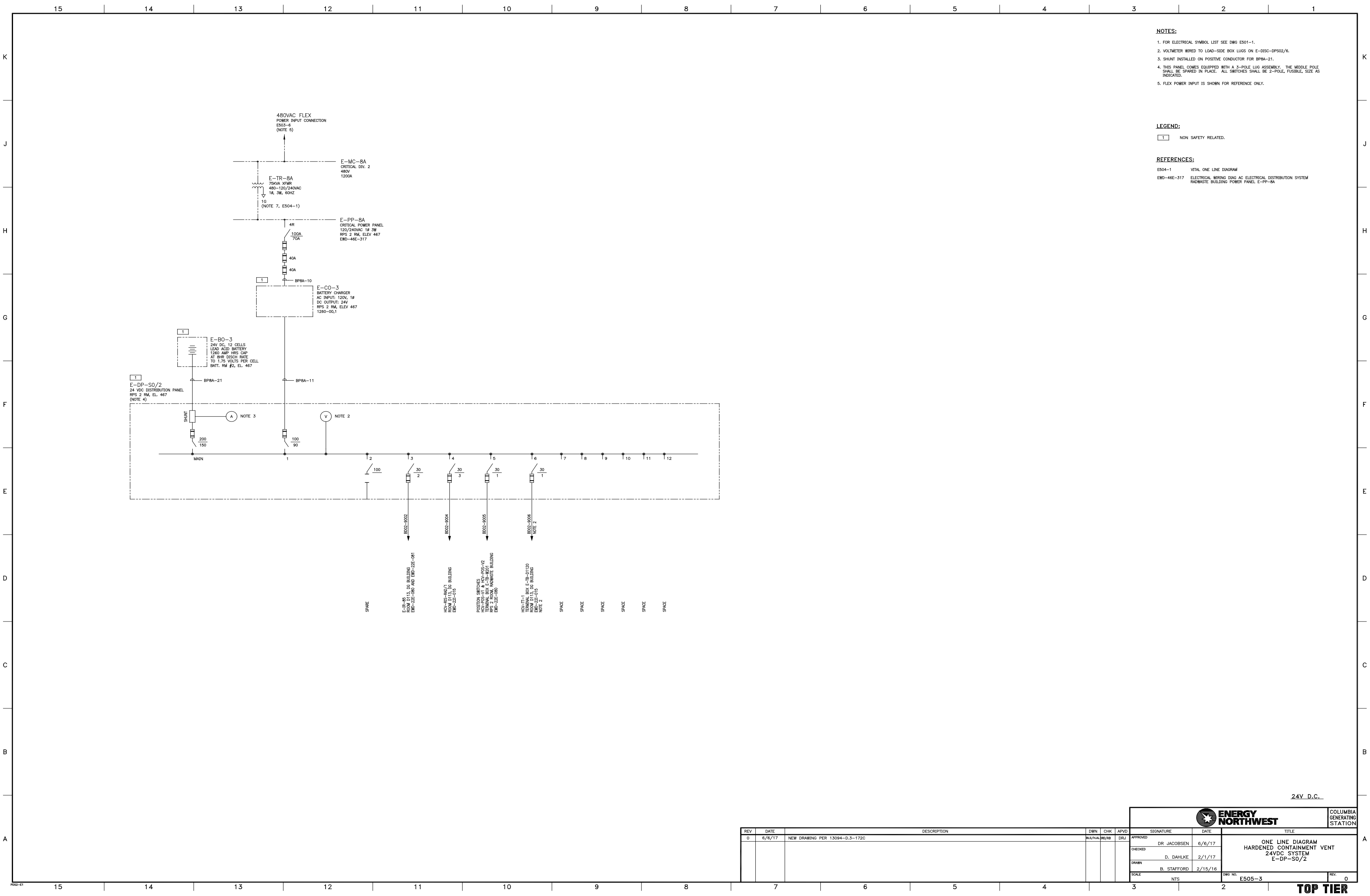


REV	DATE	DESCRIPTION	DWN	CHK	APVD
0	6/6/17	NEW DRAWING PER 13094-D.3-2.96	DRJ/H.AL	GL/KB	DRJ
1	4-8-19	REV PER 17504-026	H.AL	TC	SRP

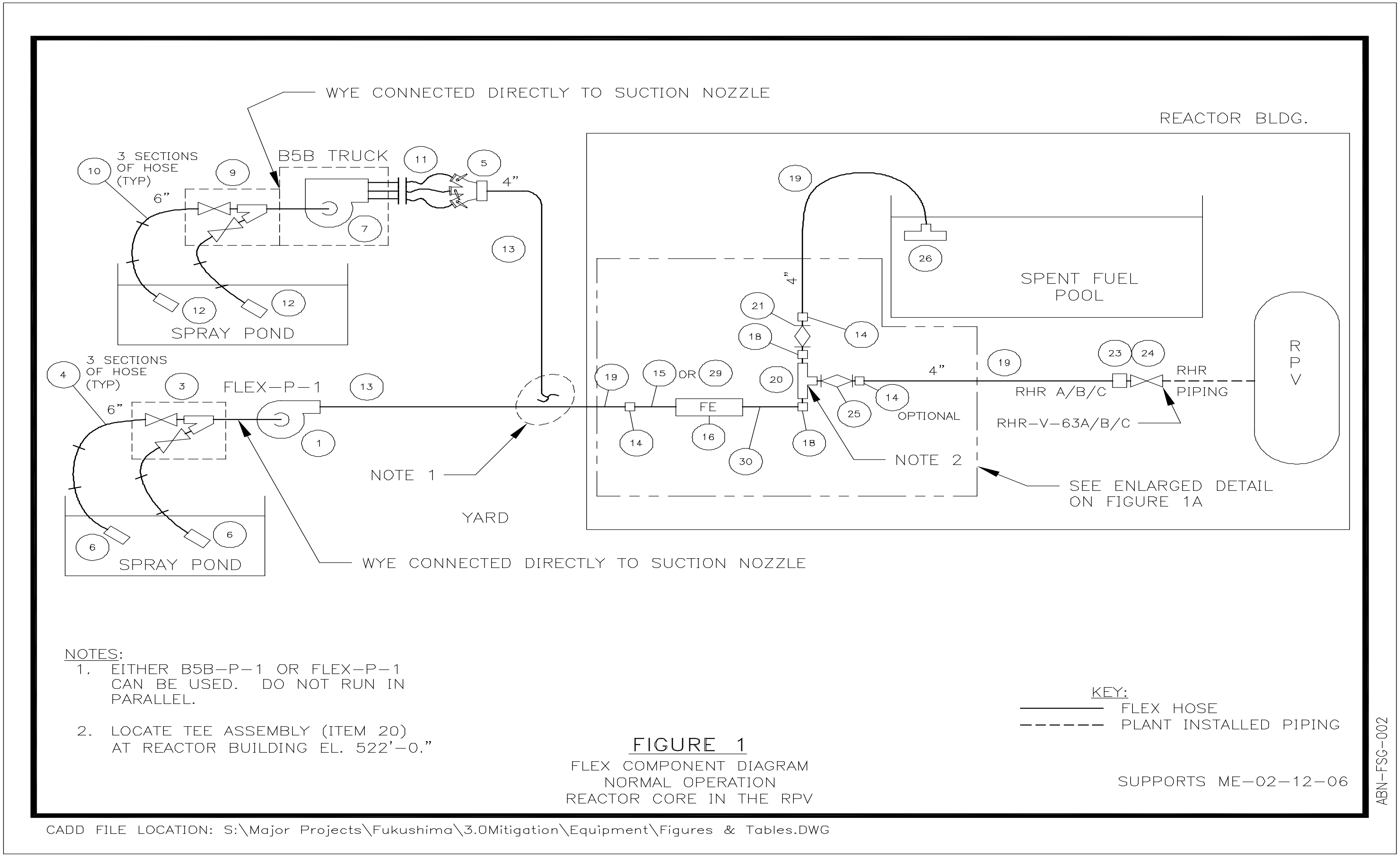
	SIGNATURE	DATE
APPROVED	DR JACOBSEN	6-6-17
CHECKED	GREG LISLE	8-11-16
DRAWN	DR JACOBSEN	8-11-16

Attachment 3: One Line Diagrams of HCVS Electrical Power Supply

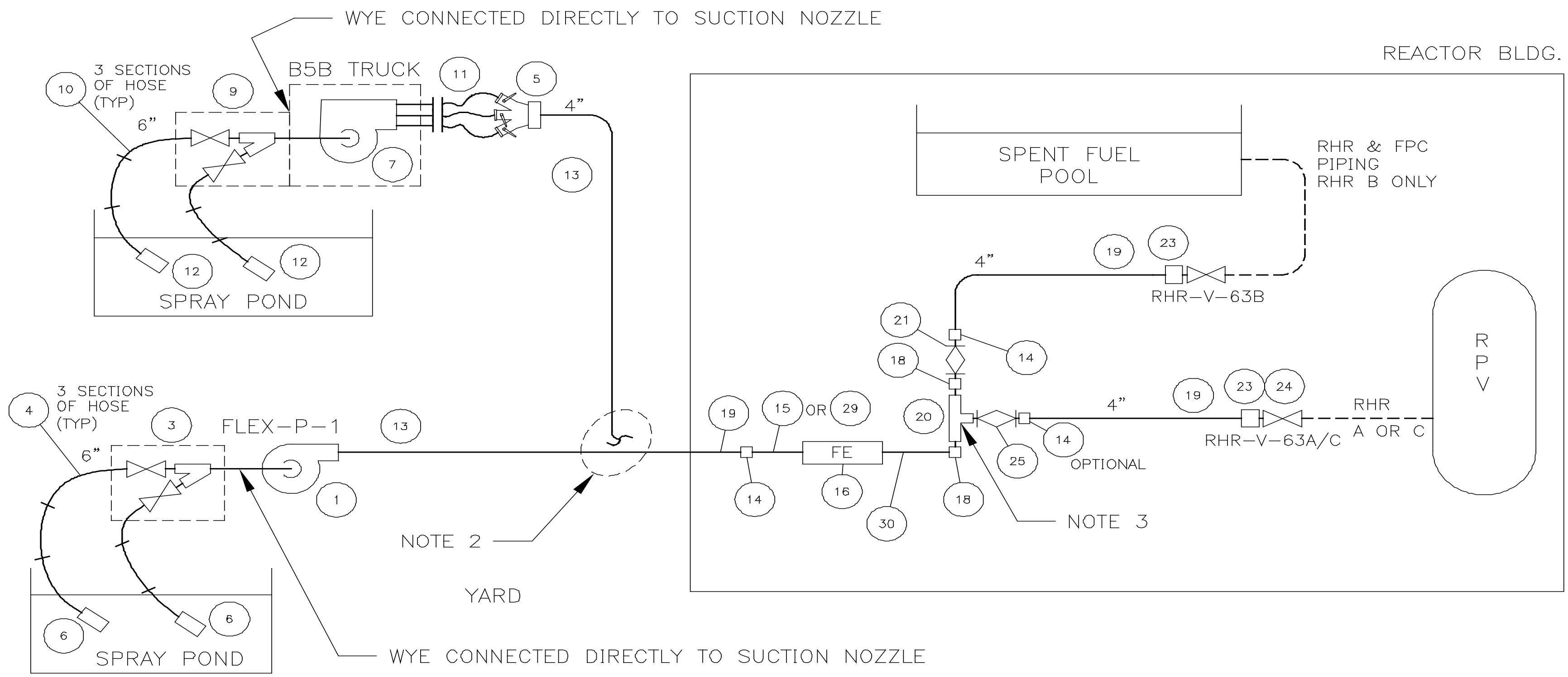



480VAC FLEX
POWER INPUT CONNECTION
E503-6
(NOTE 5)
E-MC-8A
CRITICAL DIV. 2
480V
1200A
E-TR-8A
75KVA XFMR
480-120/240VAC
1Ø, 3W, 60HZ
1G
(NOTE 7, E504-1)
E-PP-8A
CRITICAL POWER PANEL
120/240VAC 1Ø 3W
RPS 2 RM, ELEV 467
EWD-46E-317
4R
100A
70A
40A
40A
BP8A-10
E-CO-3
BATTERY CHARGER
AC INPUT: 120V, 1Ø
DC OUTPUT: 24V
RPS 2 RM, ELEV 467
1260-00,1
E-BO-3
24V DC, 12 CELLS
LEAD ACID BATTERY
1260 AMP HRS CAP
AT 8HR DISCH RATE
TO 1.75 VOLTS PER CELL
BATT. RM #2, EL. 467
BP8A-21
BP8A-11
E-DP-S0/2
24 VDC DISTRIBUTION PANEL
RPS 2 RM, EL. 467
(NOTE 4)
SHUNT
NOTE 3
NOTE 2
200
150
100
90
MAIN
SPARE
BD02-9002
E-IR-85
ROOM D113, DG BUILDING
EWD-22E-080 AND EWD-22E-081
BD02-9004
HCV-RIS-RAD/1
ROOM D113, DG BUILDING
EWD-22I-015
BD02-9005
POSITION SWITCHES
HCV-POS-V1 & HCV-POS-V2
TERMINAL BOX E-TB-W201
RPS 2 ROOM, RADWASTE BUILDING
EWD-22E-080
BD02-9006
NOTE 2
HCV-TT-1
TERMINAL BOX E-TB-D1120
ROOM D113, DG BUILDING
EWD-22I-015
NOTE 2
SPACE
NOTES:
1. FOR ELECTRICAL SYMBOL LIST SEE DWG E501-1.
2. VOLTMETER WIRED TO LOAD-SIDE BOX LUGS ON E-DISC-DPS02/6.
3. SHUNT INSTALLED ON POSITIVE CONDUCTOR FOR BP8A-21.
4. THIS PANEL COMES EQUIPPED WITH A 3-POLE LUG ASSEMBLY. THE MIDDLE POLE SHALL BE SPARED IN PLACE. ALL SWITCHES SHALL BE 2-POLE, FUSIBLE, SIZE AS INDICATED.
5. FLEX POWER INPUT IS SHOWN FOR REFERENCE ONLY.
LEGEND:
1 NON SAFETY RELATED.
REFERENCES:
E504-1 VITAL ONE LINE DIAGRAM
EWD-46E-317 ELECTRICAL WIRING DIAG AC ELECTRICAL DISTRIBUTION SYSTEM RADWASTE BUILDING POWER PANEL E-PP-8A
24V D.C.
REV DATE DESCRIPTION DWN CHK APVD
0 6/6/17 NEW DRAWING PER 13094-D.3-172C DRJ
ENERGY NORTHWEST
COLUMBIA GENERATING STATION
SIGNATURE DATE TITLE
APPROVED DR JACOBSEN 6/6/17
CHECKED D. DAHLKE 2/1/17
DRAWN B. STAFFORD 2/15/16
ONE LINE DIAGRAM
HARDENED CONTAINMENT VENT
24VDC SYSTEM
E-DP-S0/2
SCALE NTS
DWG NO. E505-3
REV. 0
TOP TIER

Attachment 4: One Line Diagram of SAWA Flow Paths



"While Figures 1 and 2 show branch flow to the RPV, ME-02-12-06 Rev 5 calculated flows conservatively by assuming branch flow for whichever flow path is active. Therefore, operators may install the tee with branch flow to either receptor."



NOTES:

1. USE THIS CONFIGURATION WHEN UPPER FLOORS OF REACTOR BLDG. ARE NOT ACCESSIBLE.
2. EITHER B5B-P-1 OR FLEX-P-1 CAN BE USED. DO NOT RUN IN PARALLEL.
3. LOCATE TEE ASSEMBLY (ITEM 20) AT REACTOR BUILDING EL. 522'-0."

FIGURE 2
FLEX COMPONENT DIAGRAM
NORMAL OPERATION
REACTOR CORE IN THE RPV
ALTERNATE CONNECTION
USING HARD-PIPING SYSTEMS

KEY:
——— FLEX HOSE
------ PLANT INSTALLED PIPING

SUPPORTS ME-02-12-06

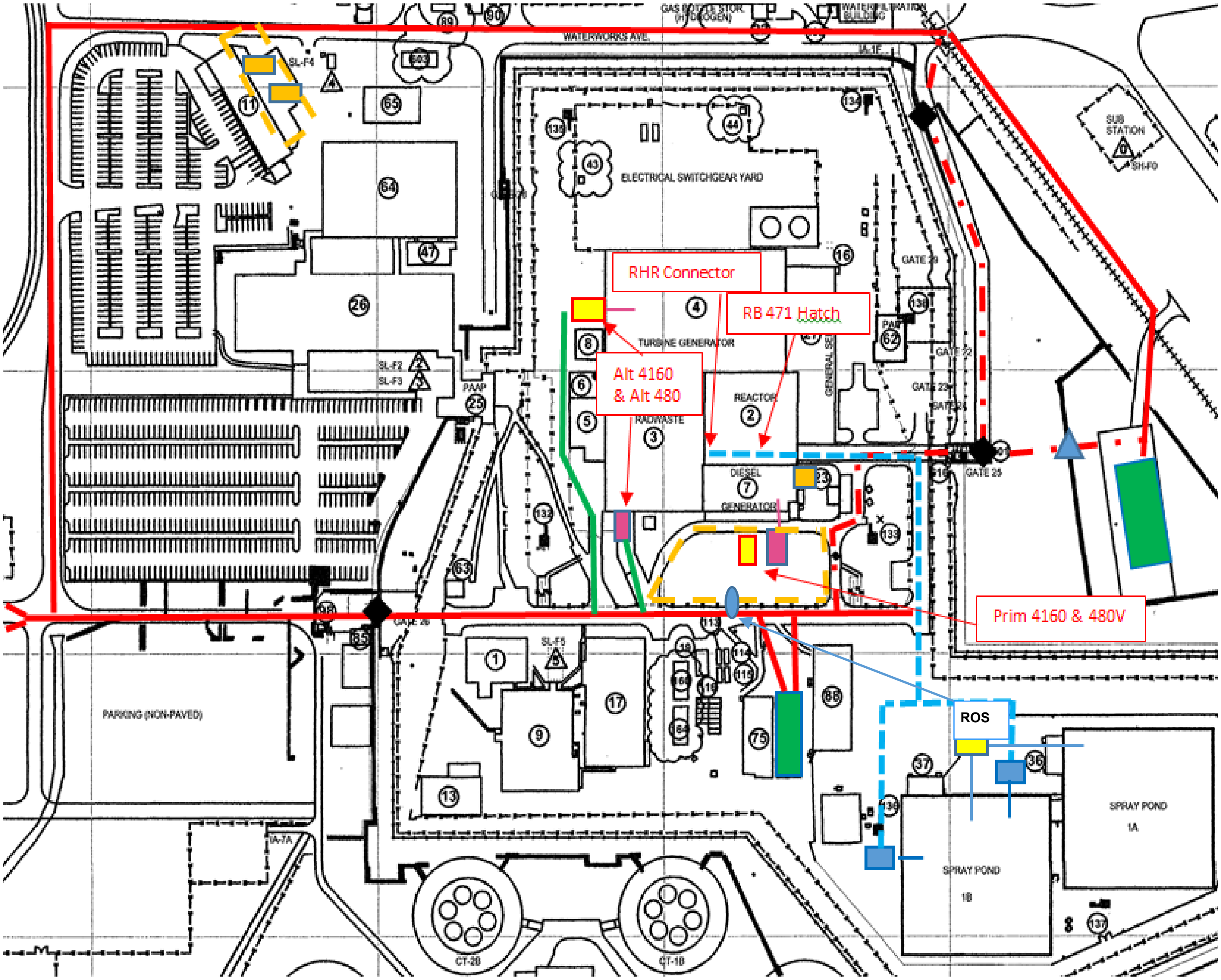
ABN-FSG-002

CADD FILE LOCATION: S:\Major Projects\Fukushima\3.0Mitigation\Equipment\Figures & Tables.DWG

Attachment 5: One Line Diagram of SAWA Electrical Power Supply

N/A for Columbia Station

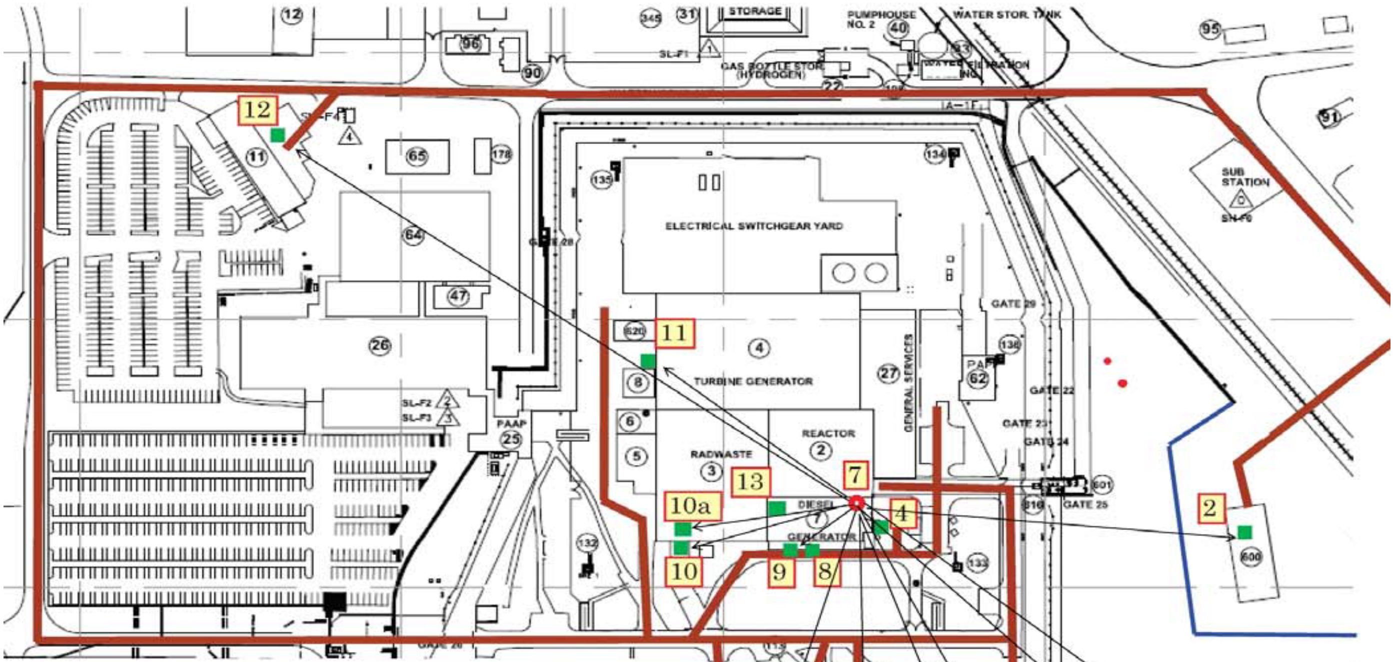
Attachment 6: SAWA equipment Locations and Dose Fields

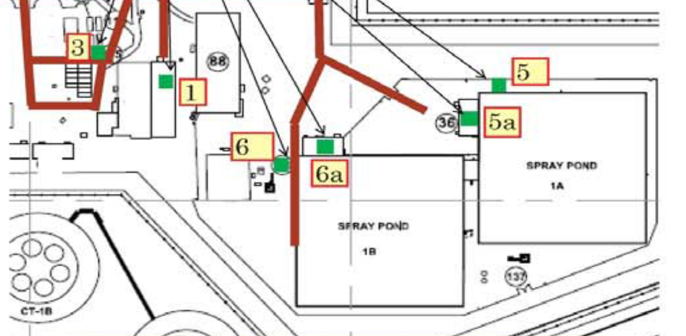


FLEX Buildings
Makeup Water B5B-P-1 or FLEX P-1 (to Loop A – preferred)
FLEX Suction Hose
480V DG 4 or DG5 (to Div1 - preferred)
FLEX Cable
Fuel Dispensing Station
NSRC Pump (to Loop B)
NSRC 4160KV DG to SM-3 (to Div 2)

Security Barrier moved
Security Gate
Access Route
Alternate Route
Refuel- Access to Tanks
Stage Water Hoses – Deployment route
Stage Diesel Generators- Deployment route

DOSE FIELDS





	Specific Locations	x, ft	z, ft
1	B-82 FLEX BLDG Equipment Storage	388	0
2	B-600 FLEX BLDG Equipment Storage	60	-575
3	Gasoline Storage Locker (alternate) ***	347	99
4	Underground Diesel Fuel Storage Tanks	-40	32
5	FLEX/NSRC Pump Spray Pond A	406	-494
5a	Inside SW A Pump House*	406	-494
6	FLEX/NSRC Pump Spray Pond B	531	-170
6a	Inside SW B Pump House*	531	-170
7	HCVS Vent Above DG Bldg	0	0
8	Primary NSRC 4160v Generator Location 1	90	67
8a	Primary NSRC 4160v Generator Location 2**	105	67
8b	Primary NSRC 4160v Generator Location 3**	81	67
9	Primary FLEX 480v Generator Location 1	90	101
9a	Primary FLEX 480v Generator Location 2 **	105	101
9b	Primary FLEX 480v Generator Location 3 **	81	101
10	Alternate FLEX 480v Generator Connection	86	263
10a	Inside RW Building Truck Bay	70	263
11	Alternate NSRC 4160 Generator Connection**	-238	309
12	4000 gal Gasoline Tank **	-610	852
13	DG Room D113	37.5	133
14	General Area	52	401
15	General Area	144	340

* the same location is used for inside and outside the pump house due to their proximity in relation to distance from the source.

** Locations 8a, 8b, 9a, 9b are not shown in the figure. They have been included to show the sensitivity of dose rate with proximity to the DG Building wall. Locations 8 and 9, about 13 ft from the wall, are expected to be optimal. Locations 8a and 9a are about 28 ft from the wall and have higher dose rates. Locations 8b and 9b are about 4 ft from the wall, and dose rates there reflect what could be expected for operators standing near the wall.

Locations 11 and 12 are north of the HCV and are addressed in Appendix G.

***The receptor point labeled as the alternate Gasoline Storage Locker (Point 3) may not be used for that purpose as final coping strategies and refueling plans are developed. Of significance is the dose rate at that location regardless of its final use.

CGS SITE PLAN
1"=200'-0" (24" x 36" PLOTTED SIZE)

Drawing: FSK-353, Rev 44

Access Routes

Barrier change

200' 400' 600'

1" = 200'-0"

Table C-2 Summary of Dose Rates -No Scrubbing or Dilution												
Specific Locations		x, ft	z, ft	Zone	Dose Rate, rem/hr							
					6 hr	8 hr	12 hr	18 hr	24 hr	36 hr	48 hr	72 hr
1	B-82 FLEX BLDG Equipment Storage	388	0	1	11.89	11.65	9.99	8.96	8.10	7.24	6.38	5.58
2	B-600 FLEX BLDG Equipment Storage	60	-575	1	7.40	7.25	6.22	5.58	5.04	4.51	3.97	3.48
3	Gasoline Storage Locker (alternate)	347	99	1	13.02	12.75	10.93	9.81	8.86	7.93	6.99	6.11
4	Underground Diesel Fuel Storage Tanks	-40	32	1	68.92	67.51	57.88	51.90	46.91	41.95	36.99	32.35
5	FLEX/NSRC Pump Spray Pond A	406	-494	1	6.60	6.46	5.54	4.97	4.49	4.02	3.54	3.10
5a	Inside SW A Pump House*	406	-494	6	0.03	0.03	0.021	0.019	0.017	0.015	0.014	0.012
6	FLEX/NSRC Pump Spray Pond B	531	-170	1	7.72	7.56	6.48	5.81	5.25	4.70	4.14	3.62
6a	Inside SW B Pump House*	531	-170	6	0.03	0.03	0.025	0.022	0.020	0.018	0.016	0.014
7	HCVS Vent Above DG Bldg	0	0	NA	NA	NA	NA	NA	NA	NA	NA	Na
8	Primary NSRC 4160v Generator Location 1	90	67	2	12.03	11.78	10.10	9.06	8.19	7.32	6.46	5.65
8a	Primary NSRC 4160v Generator Location 2	105	67	2	31.10	30.46	26.12	23.42	21.17	18.93	16.69	14.60
8b	Primary NSRC 4160v Generator Location 3	81	67	3	4.63	4.54	3.89	3.49	3.15	2.82	2.49	2.18
9	Primary FLEX 480v Generator Location 1	90	101	2	10.83	10.61	9.09	8.15	7.37	6.59	5.81	5.08
9a	Primary FLEX 480v Generator Location 2	105	101	2	27.55	26.99	23.14	20.75	18.75	16.77	14.79	12.93
9b	Primary FLEX 480v Generator Location 3	81	101	3	3.98	3.90	3.34	3.00	2.71	2.42	2.13	1.87
10	Alternate FLEX 480v Generator	86	263	2	5.34	5.23	4.49	4.02	3.64	3.25	2.87	2.51
10a	Inside RW Building Truck Bay	70	263	4b	0.024	0.023	0.020	0.018	0.016	0.015	0.013	0.011
13	DG Room D113	37.5	133	4a	0.019	0.019	0.016	0.014	0.013	0.012	0.010	0.009
14	General Area	52	320	3	1.56	1.53	1.31	1.17	1.06	0.95	0.84	0.73
15	General Area	144	340	1	12.65	12.40	10.63	9.53	8.61	7.70	6.79	5.94
16	RB/DG Bldg Corridor	5	80	4	0.88	0.87	0.74	0.67	0.60	0.54	0.48	0.42

Table H-2 Summary of Dose Rates at Selected Receptor Points - Dilution + Deposition & Concentration Vent = Containment											
Specific Locations		x, ft	z, ft	Zone	Dose Rate, rem/hr - Time is After LOOP - Vent Open @ 6 hrs						
					6 hr	8 hr	12 hr	18 hr	24 hr	36 hr	48 hr
1	B-82 FLEX BLDG Equipment Storage	388	0	1	11.893	2.354	0.260	0.179	0.162	0.145	0.128
2	B-600 FLEX BLDG Equipment Storage	60	-575	1	7.403	1.465	0.162	0.112	0.101	0.090	0.079
3	Gasoline Storage Locker (alternate)	347	99	1	13.020	2.576	0.285	0.196	0.177	0.159	0.140
4	Underground Diesel Fuel Storage Tanks	-40	32	1	68.916	13.637	1.509	1.038	0.938	0.839	0.740
5	FLEX/NSRC Pump Spray Pond A	406	-494	1	6.598	1.306	0.144	0.099	0.090	0.080	0.071
5a	Inside SW A Pump House	406	-494	6	0.025	0.000	0.001	0.000	0.000	0.000	0.000
6	FLEX/NSRC Pump Spray Pond B	531	-170	1	7.715	1.527	0.169	0.116	0.105	0.094	0.083
6a	Inside SW B Pump House	531	-170	6	0.030	0.006	0.001	0.000	0.000	0.000	0.000
7	HCVS Vent Above DG Bldg	0	0	NA	NA	NA	NA	NA	NA	NA	NA
8	Primary NSRC 4160v Generator Location 1	90	67	2	12.027	2.380	0.263	0.181	0.164	0.146	0.129
8a	Primary NSRC 4160v Generator Location 2	105	67	2	31.733	6.282	0.731	0.486	0.438	0.386	0.341
8b	Primary NSRC 4160v Generator Location 3	81	67	3	4.634	0.917	0.101	0.070	0.063	0.056	0.050
9	Primary FLEX 480v Generator Location 1	90	101	2	10.828	2.143	0.237	0.163	0.147	0.132	0.116
9a	Primary FLEX 480v Generator Location 2	105	101	2	0.000	5.452	0.603	0.415	0.375	0.335	0.296
9b	Primary FLEX 480v Generator Location 3	81	101	3	3.977	0.787	0.087	0.060	0.054	0.048	0.043
10	Alternate FLEX 480v Generator	86	263	2	5.342	1.057	0.117	0.080	0.073	0.065	0.057
10a	Inside RW Building Truck Bay	70	263	4b	0.024	0.005	0.001	0.000	0.000	0.000	0.000
13	DG Room D113	37.5	133	4a	0.019	0.004	0.000	0.000	0.000	0.000	0.000
14	General Area	52	320	3	1.559	0.309	0.034	0.023	0.021	0.019	0.017
15	General Area	144	340	1	12.653	2.504	0.277	0.191	0.172	0.154	0.136
16	RB/DG Bldg Corridor	5	80	4	0.884	0.175	0.019	0.013	0.012	0.011	0.010

Attachments 7: Tables

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

Component Name	Equipment ID	Range	Location	Local Event Temp[3] ºF	Local Event Humidity %	Local Radiation Level	Qualification	Qualification Temp[4] F	Qualification Humidity %	Qualification Radiation	Power Supply
Wetwell Vent Instruments and Components											
HCVS Temperature Element	HCV-TE-1	0 to 700	R501	293 Note 3	72	TID = 5.93E+06 rads	QC CVI OMM 1260-00,1 (pdf page 2723) EC Temperature of sat. steam at 45 psig	0 to 700	100	3.00E+08 rads	HCV Battery E-DP-S0/2
HCVS Temperature Transmitter	HCV-TT-1	NA	ROS D113	104.2 Note 2	Note 1	Note 4	QR CVI OMM 1260-00,1 (pdf pages 2605 & 2670 for Rosemount 48) EC NE-02-12-07 Rev 1	-40 to 185	0 to 99	Note 4	HCV Battery E-DP-S0/2
Temperature Indicator	HCV-TI-1	0 to 350ºF	MCR (C414)	116.5 Note 2	Note 1	Note 4	Outside RB QR CVI OMM 1260-00,1 (pdf p. 2854). Built to ANSI 39.1 for humidity limit. EC CVI 1201-00,1 R2	-4 TO 150	95	Note 4	HCV Battery E-DP-S0/2
HCVS Power Regulator	HCV-PWRS-1	NA	C213	122.6 Note 2	Note 1	Note 4	QR CVI OMM 1260-00,1 pdf p. 2849 EC CVI 1201-00,1 R2	-40 to 158	95	Note 4	HCV Battery E-DP-S0/2
HCVS 24 VDC Panel	E-DP-S0/2	NA	C213	122.6 Note 2	Note 1	Note 4	QR CVI OMM 1260-00,1, temp limits on QMP Surge logic TVSS devices (pdf page 2903) EC CVI 1201-00,1 Rev 2 (3 days)	14 to 122	0 to 95	Note 4	HCV Battery

[3] Calculation ME-02-14-04 R2 Appendix N, Expected Condition Range
[4] ME-02-14-04 R2 Appendix N Table, Qualified Range
Note 1: These areas have no significant sources of moisture so relative humidity is not a concern.
Note 2: Areas outside the Reactor Building that are not ventilated do not need to be evaluated for low temperature condition.
Note 3: Ventilation, which can cause low temperatures in the Reactor Building when outside ambient is at its extreme low value of -27F, is preceded by opening of the HCV. The steam flowing in the HCV after opening protects these components from the low temperature.
Note 4: ME-02-17-14 R0, page B-5, the highest dose outside the Reactor Building is less than the mild radiation environment limit (1000 rad) below which evaluations are not needed (Ref 1), the following equipment is expected to remain functional when exposed to severe accident radiological conditions associated with ELAP. HCV-RIS-RAD/1, HCV-TT-1, CMS-TI-5, CMS-PR-3, CMS-LR-3, SPTM-TI-5, CMS-PR-1. This note applies to all electrical/electronic outside the reactor building.
Note 5: ME-02-17-14 R0, Page 4, The TID from ELAP/Severe Accident is less than the DBA LOCA which equipment in the reactor building has been designed.

Component Name	Equipment ID	Range	Location	Local Event Temp[3] ºF	Local Event Humidity %	Local Radiation Level	Qualification	Qualification Temp[4] F	Qualification Humidity %	Qualification Radiation	Power Supply
HCVS Radiation Detector/Element	HCV-RE-1	10E-2 to 10E+4 Rad/hr	R501	293 Note 3	72	TID = 3.16E+06 rads	QR Qualification Summary Report Vendor Doc # 04518900-QSR (p 17) located in CVI OMM 1260-00,1 (pdf p. 1720) EC ME-02-14-04 Rev 2 (471S)	-40 to 350	100	2.00E+08 rads	HCVS Battery E-DP-S0/2
Radiation Monitor	HCV-RIS-RAD/1	NA	ROS D113	104.2 Note 2	Note 1	Note 4	Outside RB QR Qualification Summary Report Vendor Doc # 04518900-QSR (p 16) located in CVI OMM 1260-00,1 (pdf p. 1719) EC NE-02-12-07 Rev 1	40 to 131	0 to 95	Note 4	HCVS Battery E-DP-S0/2
Radiation indicator	HCV-RI-1	0 to 10,000 R	MCR (C414)	116.5 Note 2	Note 1	Note 4	Outside RB QR CVI OMM 1260-00,1 (pdf p. 2854). Built to ANSI 39.1 for humidity limit. EC CVI 1201-00,1 R2	-4 to 150	95	Note 4	HCVS Battery E-DP-S0/2
HCVS Battery Bank	E-B0-3	NA	C215	108.1 Note 2	Note 1	Note 4	QR Procurement Spec 15785 R0 EC CVI 1201-00,1 Rev 2 (3 days)	40 to122	20 to 90	Note 4	E-C0-3
HCVS Battery Charger	E-C0-3	NA	C213	122.6 Note 2	Note 1	Note 4	Outside RB QR CVI OMM 1260-00,1 pdf p 627 EC CVI 1201-00,1 Rev 2 (3 days)	-40 to 158	0 to 100	Note 4	Power Pnl E-PP-8A FLEX DG Back-up
HCVS Battery Voltage	E-VM-DP/SO/2	0V to 10VDC	C213	122.5 Note 2	Note 1	Note 4	QR CVI OMM 1260-00,1: Pdf page 2778 for T&H performance EC CvI 1201-00,1 Rev 2 (3 days)	39 to 140	12 to 95	Note 4	
HCVS Battery Current	E-AM-DP/SO/2	4m to 20 mADC	C213	122.6 Note 2	Note 1	Note 4	QR CVI OMM 1260-00,1: Pdf page 2778 for T&H performance EC CVI 1201-00,1 Rev 2 (3 days)	39 to 140	12 to 95	Note 4	

Component Name	Equipment ID	Range	Location	Local Event Temp[3] ºF	Local Event Humidity %	Local Radiation Level	Qualification	Qualification Temp[4] F	Qualification Humidity %	Qualification Radiation	Power Supply
Drywell Pressure Transmitter	CMS-PT-1 CMS-PT-5 CMS-PT-7	0 to 25 psig 0 to 180 psig -5 to 3 psig	R548 R548 R548	40 to 97 40 to 97 40 to 97	92 92 92	Note 5	QC CVI 707-00,1,2: LCD display (p A35) for temp. QID 156005-01 pdf page 29 for humidity EC ME-02-18-12 Rev 0 (501S) (548S)	40 to 200 40 to 200 40 to 200	0 to100 0 to 100 0 to 100	Note 5	UPS Power E-PP-7AA FLEX DG Back-up
Drywell Pressure Recorder	CMS-PR-1	Pen 1 -5 to +3 psig Pen 2 0 to 25 psig Pen 3 0 to 180 psig	MCR C414	116.5 Note 2	Note 1	Note 4	CVI OMM 659-00,27 CVI 659-00,21 QID 384002-01	0 to 122	20 to 80	Note 4	UPS Power E-PP-7AA FLEX DG Back-up
Wetwell Level Sensor	CMS-LE-6A	1' 11" to 51' 1.4" ft.	C437	90 to 267	100	Note 4	QR CVI 497-00,5 (page 38 for temp). QID 049008 for humidity. EC ME-02-14-04 Rev 2 (Sat T @ 25 psig)	70 to 275	100	Note 4	NA
Wetwell Level Transmitter	CMS-LT-6A	NA	MCR C414	116.5 Note 2	Note 1	Note 4	QR CVI 497-00,5 (page 38 for low temp) Power supply temp range per QID 829213 RW-206. EC CVI 1201-00,1 R2	70 to 122	100	Note 4	UPS Power E-PP-7AA FLEX DG Back-up
Wetwell Level Recorder	CMS-LR-3	Pen 2: 2 ft. to 52 ft. Pen 1: +25 in. to 0 to -25 in	MCR C414	116.5 Note 2	Note 1	Note 4	Outside RB QR CVI 659-00,21 (page 19) & CVI 569-00,30 (Section 12.6). Humidity limits vary based on temp. EC CVI 1201-00,1 R2	0 to 122ºF	20 to 80	Note 4	UPS Power E-PP-7AA FLEX DG Back-up
SAWA Flow Meter	FLEX-FE-7 FLEX-FE-8	50 - 600 gpm	Building 82 Building 600	23 to97	74	Max TID = 0.486 rad	QR FC1000 FlowCom product data sheet dated 2-13-2018 for temp. NEMA 4X housing, which can handle dripping liquids. EC ME-02-18-12 Rev 0 (501N)	-4 to 158	100	Note 4 Applies ME-02-17-14 Section 6.3	Internal Battery

Table 2: Operator Actions Evaluation

Operator Action		Evaluation Time[9]	Validation Time	Location	Thermal conditions	Radiological Conditions	Evaluation
1	Deploy and connect SAWA pump and hoses	<6 hours	Revised Validation Plans No.13 and 14 Plan No.13 is 3 hrs. 22 min. Plan No. 14 adds 20 min. to run hose up to the SFP.	Outside Spray Pond Yard Area Inside Reactor Building	Most work is outside. The reactor building stairwell to the 522' open areas are estimated to be in the upper 90ºF range as shown in ME-02-14-04.	Fuel damage occurs at 1 hour. At that time, dose rate is estimated at 2.6 mrem/hr. The connection of hoses for RPV injection is completed prior to HVC operation.	Acceptable
2	Deploy and connect FLEX DG	<6 hours	Validation Plan No. 9 shows the action starting at 45 min. with a completion time of 2 hours 50 min.	Outside DG Building or Inside Radwaste Truck Bay	Work is outside the reactor building	Completed prior to HVC operation.	Acceptable
3	Open reactor building roof hatch and rail bay doors	<6 hours	Validation Plan No. 12. In a SA event, only sub-tasks a. (open doors) and b. (open roof hatch) are completed for a total of 30 min. sub-tasks c. (remove the RCIC floor pug) and d.(open the 471 hatch) are not required RCIC is not operating and the 471' hatch has been eliminated by adding procedural controls that maintain the hatch open except during special evolutions.	Inside the reactor building	ME-02-14-04 shows that the room and area temperatures remain at or below 104ºF.	Completed prior to HCV operation ME-02-17-12 NE-02-15-04	Acceptable

Operator Action		Evaluation Time[9]	Validation Time	Location	Thermal conditions	Radiological Conditions	Evaluation
4	Line up pneumatic for HCVS operation	<6 hours	Validation Plan No. 7 < 20 min.	Diesel Generator Building	Building habitability not expected to change appreciably during the activity	Completed prior to HVC operation.	Acceptable
5	Begin SAWA at 450 gpm[5]	By 8 hours	The equipment will have been staged. Water addition will begin prior to 8 hours as stipulated by the reference plant analysis.	Spray Pond Reactor Building 522' elevation.	Spray pond habitability is determined by prevailing weather conditions. Habitability during flow adjustment at the 522' estimated to be in the upper 90ºF range as shown in ME-02-14-04.	Completed prior to HCV operation. ME-02-17-12 estimates the dose at the 522' elevation at .009 rem/hr. when the vent is first opened. Once flow is set, operators can move to low dose areas identified in maps contained in procedures.[6]	Acceptable Initial flow of 450 gpm is established prior to venting. Reducing flow to 90 gpm occurred during venting.
6	Begin venting from the suppression pool	≤6 hours	NA	Control Room	Habitability in the control room is maintained by taking actions identified in PPM 5.6.2 Attachment 8.5	NE-02-15-06 Section 6.4.2.5 discusses the control room shielding. ME-02-17-12 estimates 0.6 mrem for a 12 hour shift.	Acceptable

[5] ME-02-14-02 Appendix H and I provide the freeboard availability. It shows that 450 gpm from 8 to 14 hours and 90 gpm from 14 to 168 provides 10.71' of freeboard to the HCV penetration.

[6] Reducing flow to maintain suppression pool level below the HCV will require reentry to the 522' elevation. ME-02-14-02 shows that this reentry can be postponed for as long as 6 hours after commencing injection at 450 gpm without encroaching on the HCV penetration.

Operator Action		Evaluation Time[9]	Validation Time	Location	Thermal conditions	Radiological Conditions	Evaluation
7	Begin refueling of SAWA pump and FLEX DG	≥6 hours Refueling preparations is expected to start shortly after the ERO begins to arrive.	Validation Plan No.10	Outside of buildings	Area habitability is determined by prevailing weather conditions.	Due to the high dose rates, refueling plans were changed to use fuel from the least affected tanks first. SOP-FLEX-EQUIPMENT-REFUEL Maintaining awareness of the dose rates and reducing rates after 8 hours (NE-02-15-06)	Acceptable with dose map or RP technician and applying ALARA principles.
8	Reduce SAWA to 90 gpm	≤1 hour	NA	Reactor building 522'		ME-02-17-12 states that worst case being in the area right after opening the vent for 12 hours would be 17 mrem.	Acceptable

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