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April 23, 2015

Dr. Rajender Auluck
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Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Transmittal of NEI 13-02, *Industry Guidance for Compliance with Order EA-13-109*, Revision 1, April 2014

Project Number: 689

Dear Dr. Auluck:

The Nuclear Energy Institute (NEI),[1] on behalf of the nuclear industry, is pleased to submit to the U.S. Nuclear Regulatory Commission (NRC) NEI 13-02, *Industry Guidance for Compliance with Order EA-13-109*, Revision 1, April 2015. The information contained in this guidance will be used by NRC licensees to implement the requirements of Phase 2 of NRC Order EA-13-109, *Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions*, June 6, 2013. The NRC previously endorsed industry guidance for implementing Phase 1 of EA-13-109 on November 14, 2013 (see JLD-ISG-2013-02). We request that the NRC endorse NEI 13-02, Revision 1.

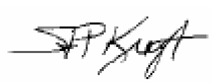
Draft Revision 0E2 of NEI 13-02 was transmitted to NRC on December 10, 2014, requesting review and endorsement. We modified Revision 0E2 based on feedback provided by NRC staff, as documented in our comment letter[2] on the draft Interim Staff Guidance (JLD-ISG-2015-01, March 2015).

[1] The Nuclear Energy Institute (NEI) is the organization responsible for establishing unified industry policy on matters affecting the nuclear energy industry, including the regulatory aspects of generic operational and technical issues. NEI's members include all entities licensed to operate commercial nuclear power plants in the United States, nuclear plant designers, major architect/engineering firms, fuel cycle facilities, nuclear materials licensees, and other organizations and entities involved in the nuclear energy industry.
[2] Letter, Steven P. Kraft (NEI) to Cindy K. Bladey (USNRC), *Nuclear Industry Comments on U.S. Nuclear Regulatory Commission Draft 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,"* 80 *Fed. Reg*. 12649, March 10, 2015; Docket ID: NRC-2015-0048, April 9, 2015.

In conclusion, we reiterate our appreciation for the constructive engagement by the NRC staff in developing the guidance for implementation of Phase 2 of EA-13-109. We look forward to continuing this engagement as the industry and NRC move to the next steps of Order EA-13-109 implementation. NEI also wants to recognize the vital contributions of the Boiling Water Reactor Owners' Group to this effort.

If you have any questions or require additional information, please do not hesitate to contact me.

Sincerely,



Steven P. Kraft

Attachment

c: Mr. William D. Reckley, NRR/JLD/JPSB, NRC

NEI 13-02 [Rev. 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

April 2015

NEI 13-02 [Rev. 1]

Nuclear Energy Institute

INDUSTRY GUIDANCE FOR COMPLIANCE WITH ORDER EA-13-109:

BWR Mark I & II Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions

April 2015

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ACKNOWLEDGEMENTS

This report was prepared by the NEI Filtering Strategies Working Group and under the oversight of the industry Fukushima Response Steering Committee. This document would not have been possible without the engagement of the BWROG and the technical bases and rationale provided by EPRI.

NOTICE

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1. INTRODUCTION

The nuclear energy industry and the NRC share a common challenge of ensuring prevention and mitigation strategies are available to maintain safety in the face of unlikely and extreme events. An approach that focuses on diverse and flexible mitigation capability will provide additional defense-in-depth safety enhancement against a range of extreme events, some of which cannot be forecasted.

The importance of reliable operation of hardened vents during conditions involving loss of active containment heat removal has been reinforced by the lessons learned from the accident at Fukushima Dai-ichi. Hardened vents have been in place in U.S. plants with BWR Mark I containments for many years but design variances exist across the industry with regard to the capability of the vents for a broad spectrum of events. Generally, BWR Mark II containments do not currently have hardened vent paths. The NTTF 90-day report [Ref. 6] indicated hardened vent designs that were AC independent to operate with limited operator actions from the control room are necessary. Therefore, Order EA-12-050 [Ref. 2] required hardened containment venting systems in BWR facilities with Mark I and Mark II containments on the basis that they are needed to provide reasonable assurance of adequate protection of public health and safety.

Subsequently the original Order was rescinded and replaced with a new order to require a severe accident capable containment vent on the basis that it provides a cost-justified substantial safety improvement beyond what is needed to provide reasonable assurance of adequate protection of public health and safety. Order EA-13-109 [Ref. 1] was issued to expand the set of design and quality requirements originally imposed by EA-12-050 to ensure that venting functions are available during postulated severe accident conditions. Because EA-12-050 has been rescinded and its requirements are now reflected in Order EA-13-109, licensees are no longer expected to comply with the requirements of Order EA-12-050, including any applicable time lines for submission of integrated plans, or for completion dates for implementation.

The severe accident Hardened Containment Venting System (HCVS) Order contains historical information and decision making insights in sections I, II and III that provide useful information, but do not contain the legally binding actions which licensees are required to comply with, which are in sections IV and Attachment 2.

1.1 Purpose

The purpose of this guidance is to assist nuclear power reactor licensees with the identification of measures needed to comply with the requirements of Order EA-13-109, “Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions” [Ref. 1]. This guidance provides an acceptable method for satisfying those requirements; however, licensees may propose other methods for satisfying these requirements.

Incorporation of the lessons learned from the March 11, 2011 Fukushima Dai-ichi Accident is a key element in the foundation of requirements and guidance associated with the scope of work required in response to Order EA-13-109, which is prefaced by the following statement:

> *"The events at the Fukushima Dai-ichi nuclear power plant following the March 2011 earthquake and tsunami highlight the possibility that events such as rare natural phenomena could challenge the traditional defense-in-depth protections related to preventing accidents, mitigating accidents to prevent the release of radioactive materials, and taking actions to protect the public should a release occur. At Fukushima Dai-ichi, limitations in time and unpredictable conditions associated with the accident significantly hindered attempts by the operators to prevent core damage and containment failure. In particular, the operators were unable to successfully operate the containment venting system. These problems, with venting the containments under the challenging conditions following the tsunami, contributed to the progression of the accident from inadequate cooling of the core leading to core damage, to compromising containment functions from overpressure and over-temperature conditions, and to the hydrogen explosions that destroyed the reactor buildings (secondary containments) of three of the Fukushima Dai-ichi units. …The events at Fukushima reinforced the importance of reliable operation of hardened containment vents during emergency conditions, particularly for smaller containments such as the Mark I and Mark II designs …"*

To address this event with the rest of the nuclear industry, there are many regulatory and industry recommendations and changes to be considered. Many of these are documented in the following:

- NRC Near Term Task Force 90 Day Report, [Ref. 6]
- NRC SRM/SECY 11-0124 - Recommended Actions to be taken Without Delay From The Near-Term Task Force Report, [Ref. 7]
- NRC – SRM/SECY 11-0137 - Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned, [Ref. 8]

The primary objectives of the industry response scope of work derived from these documents resulted in NEI 12-06, revision 0, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide [Ref. 20], for implementation of NRC Order EA-12-049, Mitigation Strategies for Beyond-Design-Basis External Events (FLEX), [Ref. 4. Many of these cornerstones will be utilized in this guidance document for addressing NRC Order EA-13-109 even though they did not originally extend to venting capabilities under severe accident conditions.

The industry is committed to continuous improvement of nuclear safety. Some applicable continuous improvement work items from lessons learned from the Fukushima Daiichi event are listed below:

a) Confirm or establish effective coping measures to address the vulnerability of onsite and offsite AC power systems to common mode failures resulting from external and internal events, including beyond design basis events.

b) Confirm the external events that formed the basis for plant designs exceed credible hazards based on historical data and current models (floods, high winds, seismic events, etc.) or revise the design bases and change the plants, as necessary to accomplish the revised design bases.

c) Confirm or establish effective primary containment protective strategies that can manage post-accident conditions, including such factors as elevated pressures and hydrogen generation from fuel damage more extensive than original design bases, including use of hardened venting, etc. as appropriate.

d) Confirm or establish effective integrated strategies to provide for system based response for events and/or severe accidents involving multiple reactors at a site (i.e., integrate Emergency Operating Procedures (EOPs), Severe Accident Management Guidelines (SAMGs), Abnormal Operating Instructions (AOIs), Extreme Damage Mitigation Guidelines (EDMGs), etc.).

e) Provide for support during extended emergencies involving infrastructure loss, including fuel supplies, coordination of offsite resources, communications, near site living requirements and transportation, etc.

f) Share and participate with other stakeholders to co-develop responses, improve acceptance and consensus, and minimize development costs.

g) Establish national response centers with multiple sets of site response equipment and long term coping equipment for preventing fuel damage from an Extended Loss of AC Power (ELAP) event.

1.2 HCVS Guiding Principles

Hardened vents have been in place in U.S. plants with BWR Mark I containments for many years but a variance exists with regard to the capability of the vents for a broad spectrum of events. BWR Mark II containments have containment venting capability but they typically are not hardened vent paths. Therefore, hardened containment venting systems in BWR facilities with Mark I and Mark II containments were required by the NRC (Order EA-12-050) on the basis that they are needed to enhance protection of public health and safety.

On June 6, 2013, the US NRC rescinded Order EA-12-050 and issued a new order, EA-13-109, expanding the requirements of the original order to include requirements for the reliable hardened vent to be capable of operation during severe accident conditions. The new order is applicable to all operating BWR licensees with Mark I and Mark II containments issued under Title 10 of the Code of Federal Regulations (10 CFR), Part 50, “Domestic Licensing of Production and Utilization Facilities.”

The original Order EA-12-050 required that all boiling water reactor (BWR) Mark I and Mark II containments have a reliable hardened vent to remove decay heat from the containment and maintain containment pressure within acceptable limits following events that result in the loss of active containment heat removal capability or prolonged station blackout (SBO), i.e., Extended Loss of AC Power (ELAP). The original order did not include requirements relating to severe accident service for the hardened containment venting system (HCVS); rather, the HCVS was only required to be able to support strategies related to the prevention of core damage under a wide range of plant conditions. JLD-ISG-2012-02, "Compliance with Order EA-12-050, Reliable Hardened Containment Vents" [Ref. 5] provided the Interim Staff Guidance (ISG) for implementation of Order EA-12-050.

All licensees subject to Order EA-12-050 provided integrated plans for the design and implementation of reliable hardened containment vents by February 28, 2013. In SRM-SECY-12-0157, "Staff Requirements - SECY-12-0157, "Consideration Of Additional Requirements For Containment Venting Systems For Boiling Water Reactors With Mark I And Mark II Containments" [Ref. 3], the Commissioners directed the staff to revise Order EA-12-050 to require the upgrade or replacement of the reliable hardened vents required by Order EA-12-050, with a containment venting system designed and installed to remain functional during severe accident conditions.

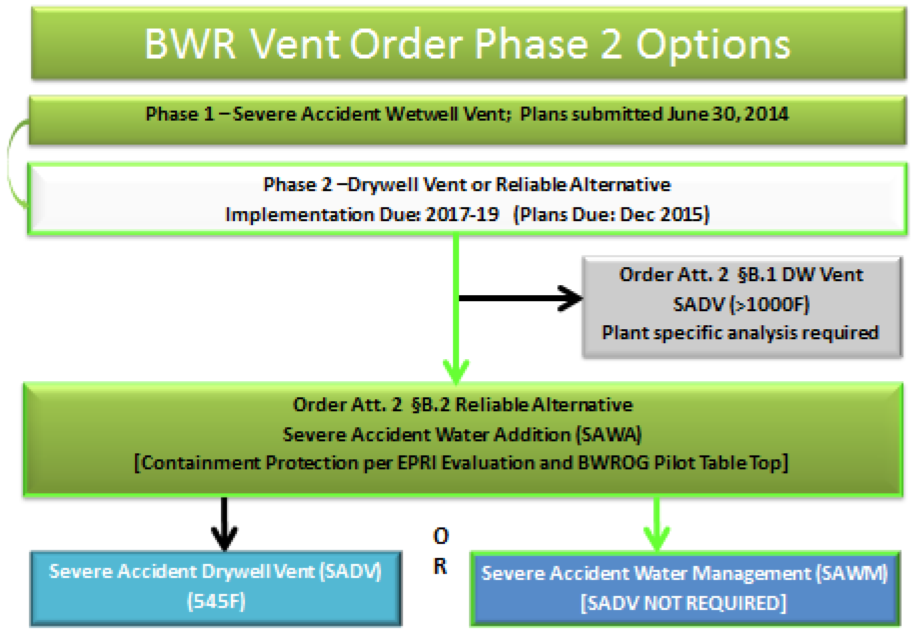
EA-13-109 requires that BWRs with Mark I or Mark II containments ensure that in addition to pre-core damage venting capability, the HCVS also provides a reliable hardened venting capability from the wetwell and drywell under severe accident conditions, including those involving a breach of the reactor vessel by molten core debris. However, EA-13-109 also allows a reliable containment venting strategy that makes it unlikely that a licensee would need to vent from the containment drywell as an acceptable alternate to the drywell vent. The severe accident capable HCVS is intended to keep the originally required function of the HCVS, which is to help prevent severe accidents from occurring, and to add the capability of operating during a severe accident conditions. The wetwell and drywell vent pathways are not required to be in operation at the same time.

The development and implementation of the severe accident capable HCVS consists of two phases. The first phase consists of providing a venting system from the containment wetwell that meets the functional, quality, and programmatic requirements listed in subsequent sections of this guide. The second phase involves either installing a severe accident capable containment drywell venting system or developing 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. The second phase will not be required to be installed concurrently with the first phase.

Analysis and calculations performed in conjunction with participation in the Containment Protection and Release Reduction (CPRR) rulemaking, as documented in Reference 27, has confirmed that water addition in conjunction with venting that can be accomplished under severe accident conditions provides more safety benefit than venting alone, including events involving extensive core damage and reactor vessel breach. The safety benefit comes from the cooling effect of the added water on the containment temperatures. The reduction in containment temperature provides reasonable assurance that the probability of gross containment leakage due to temperature related effects is minimized. Water addition that can be provided to the Reactor Pressure Vessel (RPV) or Drywell under severe accident conditions has been termed Severe Accident Water Addition (SAWA). The analysis also shows that in-vessel retention may occur with RPV injection. The preservation of the wetwell vent path which is accomplished by managing the water addition flow rate to the extent that the wetwell vent line remains available until other means of severe accident coping are available is termed Severe Accident Water Management (SAWM). Severe Accident Coping is defined in Appendix A and SAWM is described in Appendix C.

The analysis performed to support the SAWA/SAWM strategies established timing for specific accident sequences (e.g., RCIC failure at T=0, 1 hour to core damage, 8 hours to establish SAWA flow) that conform to the reference plant in Reference 27. Licensees should ensure procedures and designs consider the early deployment of portable equipment to facilitate expedited water addition and to repower needed equipment and instrumentation such that no unnecessary delays in deployment are introduced into accident response. This expectation is to encourage licensees to take reasonable actions to minimize SAWA equipment deployment times, but does not imply that licensees are required to modify existing or construct additional structures for SAWA equipment storage, or to choose alternate SAWA connections points from those otherwise complying with Orders EA-12-049 and EA-13-109.

The order provides two (2) compliance methods (B.1 and B.2) for phase 2 , The first method is described in B.1 of attachment 2 of the order and it requires a drywell vent supported by plant specific analysis (e.g., high temperature). Those licensees that desire to pursue this option will work directly with the NRC for acceptable guidance. For the other method of compliance (B.2) there are two (2) options that both include Severe Accident Water Addition as a required element for implementing Phase 2 strategies of the Order, as shown in the following figure.



These options are informed by the results of the Containment Protection and Release Reduction rulemaking analysis in Reference 27, which demonstrate a safety benefit from water addition in conjunction with venting over response without water addition. SAWA is required to meet Phase 2 option B.2 of the Order, whether the 545°F Severe Accident capable Drywell Vent (SADV) or alternate venting strategy (SAWM) option is chosen. SAWA in the context of this guidance provides the benefit of satisfying the SADV design temperature of 545°F described in Section 2 and prevention of failure of drywell head seals and other penetrations from gross leakage. The key elements of SAWA need to be defined to ensure the intent of B.2 is met (SAWA guidance is contained in Appendix I). SAWA functional requirements will be defined with Order EA-13-109 Section A as a logical starting point, with those functional requirements defined in Sections 4, 5 and 6 of this guidance.

Option 1 – Utilization of the wetwell vent as long as available with SAWA to either the RPV or Drywell and then transition to a SADV meeting all the requirements of Section A of Order EA-13-109. Use of SAWA and SADV should be maintained until alternate reliable decay heat removal and pressure control is established. (Guidance for SADV is contained in Section 2.) This option must include both SAWA and the 545°F SADV.

Option 2 – Utilization of the wetwell vent with SAWA to either the RPV or Drywell with control of the water addition using SAWM as part of the Order implementation meeting the requirements of B.2 (B.2.1, B.2.2 and B.2.3) of Order EA-13-109. Capability to vent directly from the wetwell is to be preserved until alternate reliable decay heat removal and pressure control is established (Severe Accident Coping). This strategy does not require the installation of a severe accident capable drywell vent (Guidance for SAWM is contained in Appendix C). The table below summarizes the scope of the elements used to implement a successful containment venting strategy needed to meet Section B.2 requirements of Phase 2 of the Order. Use of SAWA and SAWM should be maintained until alternate reliable containment heat removal and pressure control are established. SAWA must be implemented by a licensee in order to credit SAWM as the alternate venting strategy.

Severe Accident Water Addition (SAWA) • Water addition path – RPV or Drywell • Utilization (Motive force, Instrumentation) • Severe accident deployment considerations (Temperature, Radiation)
Severe Accident Water Management (SAWM) • Requires implementation of SAWA • Requires use of the Phase 1 wetwell vent • Designed to preserve wetwell vent path for a period of Sustained Operation, as defined in this guidance,
Severe Accident Drywell Vent (SADV) • Requires implementation of SAWA • Design Temperature 545°F after second Primary Containment Isolation Valve • Utilization (Motive force, Instrumentation) • Severe accident deployment considerations (Temperature, Radiation)

SAWA supports both the 545°F SADV and SAWM options for Phase 2. As such it should be subject to consideration of Order EA-13-109 Section A requirements, which serves as a logical starting point for defining functional requirements for SAWA. However, given that SAWA is primarily the use of portable equipment that also supports FLEX strategies, not all of the Order Section A functional requirements apply. Sections 4, 5 and 6 of this guidance will address those aspects of Order Section A functional, quality and programmatic requirements that apply to SAWA. Additional functional requirements for SAWA are contained in Appendix I.

SAWA with SAWM is an alternative venting strategy under Order Section B.2. It will primarily consist of the use of the Phase 1 wetwell vent and SAWA hardware to implement a water management strategy that will preserve the wetwell vent path until alternate reliable containment heat removal can be established. Appendix C contains the SAWM strategy that will meet the requirements of EA-13-109 Section B.2.

1.3 Procedure Interface

This section is intended to provide information on the accident management features of the suite of procedures needed to respond to symptoms present in a Beyond Design Basis Event (BDBE). Inclusion of this information does not intend to provide any express or implied endorsement of Emergency Procedure Guidelines/Severe Accident Guidelines (EPG/SAG) or other details presented in this section. If any conflicts arise between the discussion in this section and the criteria stated in Order EA-13-109, then the criteria in the Order takes precedence over the direction in EPGs/SAGs.

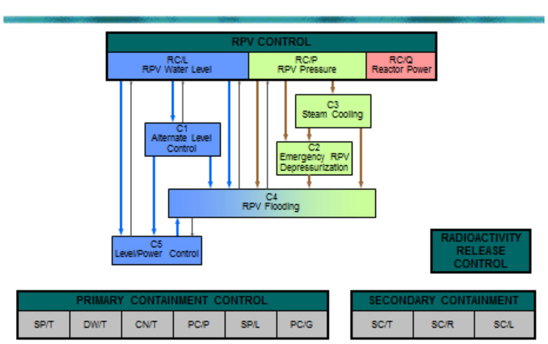
Command and Control for accident response is governed by the suite of Emergency Preparedness guidelines and procedures. Containment heat removal and pressure control functions are, and have always been, manually initiated at BWR facilities. Therefore, the use of procedures to direct the use of installed systems has existed well before the development of either order. The HCVS is also initiated manually and therefore requires procedural direction to initiate venting for containment heat removal and containment pressure control.

Use of the HCVS is governed by the plant specific Emergency Operating Procedures (EOPs), severe accident management guidelines (SAMGs), and Emergency Preparedness procedures. The EOPs provide direction, based on symptomatic containment conditions, to initiate use of installed vent paths from containment to assure adequate core cooling has been maintained for prevention of fuel damage. The SAMGs provide direction for use of hardened vents for the purpose of containment pressure control after adequate core cooling has been lost.

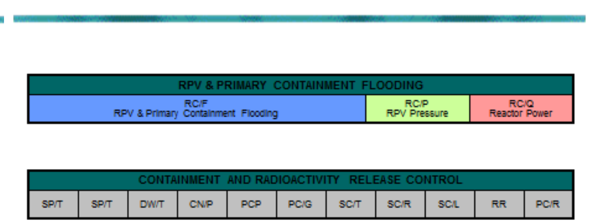
HCVS reliability does not only depend upon the design of the HCVS, but also the procedural guidance directing use based on containment parameters. The importance of reliable operation of hardened vents during conditions involving loss of containment heat removal capability is well established and this understanding has been reinforced by the lessons learned from the accident at Fukushima Dai-ichi. Understanding the procedural interface and direction in determining HCVS design criteria is essential.

The plant specific procedures are based upon the Boiling-Water Reactor Owners Group BWROG generic Emergency Procedure Guidelines/Severe Accident Guidelines (EPGs/SAGs), whose organizational structure is diagramed below:

EPG Structure

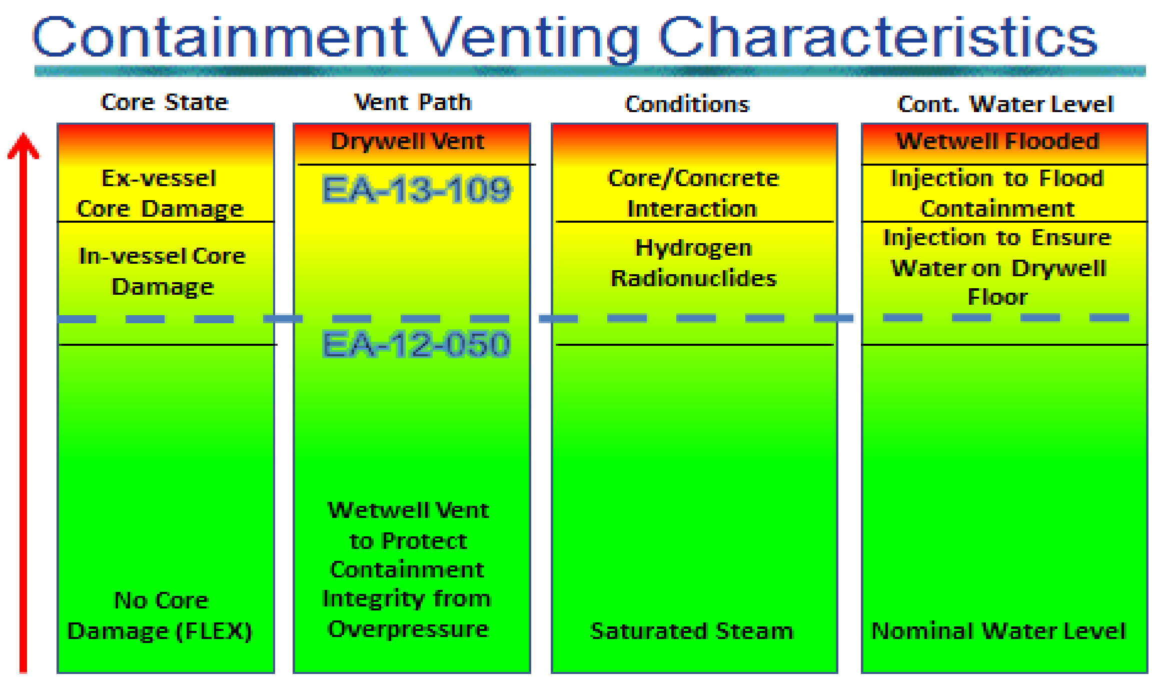


SAG Structure



Utilities currently have implemented Revision 2 of the EPG/SAGs, but Revision 3 has been published and includes the lessons learned from Fukushima Dai-ichi.

The BWROG standard emergency procedure guidelines and severe accident guides (EPG/SAGs) (Revision 2 and 3) both provide direction for BWR Mark I and II plants to leave EPG/SAGs flowcharts (into recovery actions) at any point where adequate containment heat removal methods are in effect as on the following illustration of containment venting characteristics (i.e., they are not predisposed to have to use drywell venting.)



Revision 3 of the EPG/SAGs enhanced the flow of information from revision 2 using lessons learned from the Fukushima event. The information presented is representative of the structure in Revision 3.

From the plant specific EOPs developed from the EPGs, use of a hardened vent is directed:

- Before primary containment pressure reaches the primary containment overpressure limit defined by the Primary Containment Pressure Limit (PCPL),
- If lower containment pressure is necessary to provide RPV injection; if suppression pool approaches saturation conditions and can no longer effectively condense steam discharged from RCIC; or
- To limit total offsite dose by venting steam prior to experiencing fuel damage.

From the plant specific SAMGS developed from the SAGs, use of a hardened vent is directed:

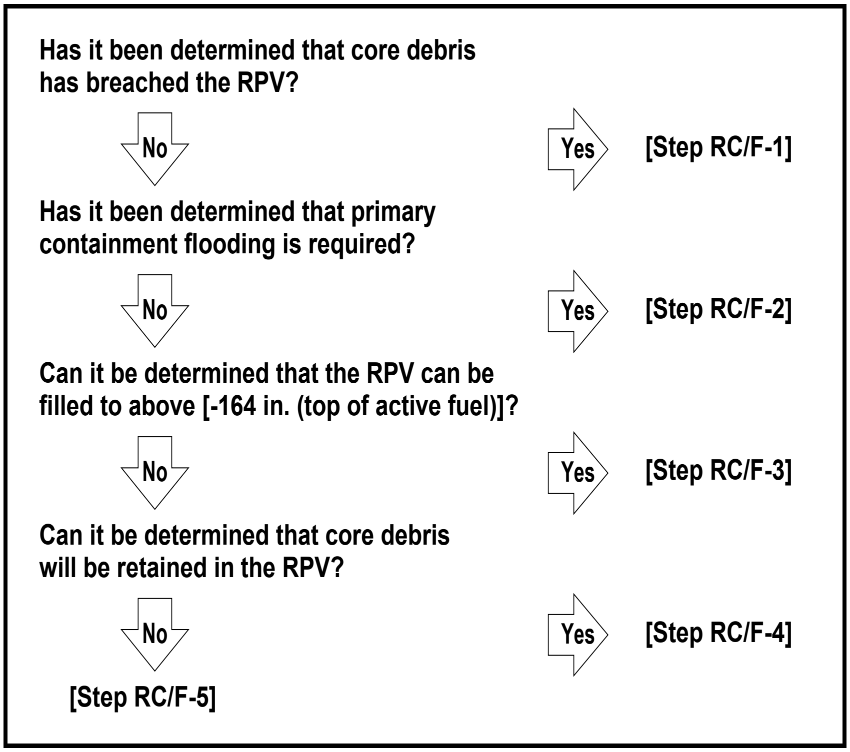
- Before primary containment pressure reaches the primary containment overpressure condition defined by (PCPL);
- To facilitate RPV injection or containment injection; or
- To remove combustible gases from primary and secondary containment.

Containment venting per the procedures and guidelines should be coordinated with evacuation procedures and timed to take advantage of favorable meteorological conditions. It should be coordinated to take advantage of suppression pool scrubbing as much as possible.

For venting using EOPs the wetwell vent is expected to be used to protect containment and will be venting mostly saturated steam, while Primary Containment Water level and pressure will be maintained to preserve the Pressure Suppression Capability of the Containment. This could include venting to protect steam driven systems being used to provide adequate core cooling or to limit the total offsite dose if it is expected that fuel damage may occur.

Once fuel damage occurs as assumed in Order EA-13-109 and transfer to plant specific SAMGs is made, containment venting will depend on other plant conditions. Only two steps in plant specific SAMGs require containment flooding, steps RC/F-1 and RC/F-2. The remaining steps seek to maintain Pressure Suppression Capability (which means suppression pool water is maintained in an extended range but not flooding containment prior to RPV breach). Containment venting could be used to restore Pressure Suppression Capability by lowering containment pressure. The SAMGs discuss containment venting but do not mandate Drywell venting for all conditions.

The following graphic shows the SAMG decision block and briefly describes the conditions each step implements:



RC/F-1 RPV breached. Submerge debris and flood containment.

RC/F-2 Pressure Suppression Capability not maintained or Primary system break. Cool debris and flood containment.

RC/F-3 Re-flood RPV above TAF. Maintain Pressure Suppression Capability.

RC/F-4 Debris expected to remain in RPV. Cool debris and maintain Pressure Suppression Capability.

RC/F-5 Debris may melt through RPV. Containment may fail. Maximize RPV injection. Maintain Pressure Suppression Capability.

To summarize, containment venting is addressed in plant specific EOPs for prevention of core damage. After core damage cannot be prevented, plant specific SAMGs address mitigation of core damage. The basis for these actions is documented in the BWROG EPG/SAG Rev. 3 Appendix B, Technical Basis, and the Technical Support Guidelines, Rev. 0. Hardened containment vent designs should include a review of any pending procedure changes that could influence the design, such as the EPG/SAG Revision 3 directions for use of containment vents. A more detailed discussion of containment venting post core damage and how it relates to Order EA-13-109 follows.

Use of a drywell vent after the 7 day Sustained Operation period or after establishing an alternate method of reliable containment heat removal, that does not require a reliable severe accident capable drywell venting system, is governed by the SAGs and not subject to Order EA-13-109 requirements.

The water addition (SAWA) and water management (SAWM) provisions in the SAGs will be evaluated for changes consistent with the Phase 2 guidance and EPRI Technical Report 3002003301 (Reference 27).

1.4 Overview

This industry guidance has been developed to provide an integrated set of considerations for the design and implementation of a severe accident capable hardened containment venting system (HCVS). This guidance is organized in the following manner:

Section 2:	Description of the boundary conditions to be applied to the design of HCVS including the applicable severe accident conditions, the design boundary conditions and operational assumptions, and the role of mitigation strategy capabilities implemented under EA-12-049 “Order Modifying Licenses with Regard to Requirements For Mitigation Strategies For Beyond-Design-Basis External Events,” [Ref. 4].
Section 3:	Drywell vent design per B.1 of the Order.
Section 4:	Guidance on the design considerations for the HCVS including vent path design, vent operation and monitoring, support systems for sustained operations, protection from flammable gas ignition, other design requirements such as environmental qualification, seismic and external hazard design and quality requirements.
Section 5:	Guidance on meeting the programmatic requirements associated with the order.
Section 6:	Guidance on the operational considerations for the HCVS including procedural guidance and training related to the operator actions required for use of the HCVS and the testing and inspection of the HCVS and associated components. Operational consideration for the HCVS including environmental considerations, procedures, allowed out of service time, and testing.
Section 7:	Template for Overall Integrated Plan Submittal and six month status updates
Section 8:	References
Appendices:	Appendices are provided to elaborate on specific aspects of the guidance including:

- Glossary of key terms and cross-reference roadmap of order requirements,
- Phase 2 containment venting strategy that makes it unlikely that a Severe Accident drywell vent is needed and Water addition to the RPV/DW during severe accidents,
- Generic letter 89-16 and FLEX interfaces,
- Methods for defining plant-specific severe accident operator doses and source terms and design approaches to address control of flammable gases,
- OIP Templates and Frequently Asked Questions from OIP development.

Licensees may propose other methods for satisfying the requirements of Order EA-13-109. The NRC staff can review such methods and determine their acceptability on a case-by-case basis.

2. HCVS BOUNDARY CONDITIONS FOR VENT DESIGN AND OPERATION (DRYWELL CONDITIONS ASSUMING SAWA)

Boiling-Water Reactors (BWRs) with Mark I and Mark II containments shall have a reliable, severe accident capable hardened containment venting system (HCVS). The HCVS includes a severe accident capable wetwell venting system, and may also, depending on the approach taken for Phase 2 of Order EA-13-109, include a severe accident capable drywell venting system. The implementation of the order can be in two phases, but the interaction of the phases needs to be coordinated since the containment conditions that exist at the initiation of venting from the wetwell and drywell may be different. Boundary conditions used in design of HCVS shared components, instrumentation and piping is included in this Section and in Section 4.1.

Under Phase 1 of Order EA-13-109, Licensees with BWR Mark I and Mark II containments shall design and install a HCVS, using a vent path from the wetwell to remove decay heat, vent the containment atmosphere (including steam, hydrogen, carbon monoxide, non-condensable gases, aerosols, and fission products), and control containment pressure within acceptable limits. The HCVS shall be designed for those accident conditions (before and after core damage) 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 (AC) power (ELAP). The HCVS shall meet the requirements of Sections 4, 5, and 6 of this document.

Under Phase 2 of Order EA-13-109, Licensees with BWR Mark I and Mark II containments shall either, (1) design and install a HCVS, using a vent path from the containment drywell, that meet the requirements in Sections 2 or 3 and 4 through 6 or, (2) develop and implement a reliable containment pressure control and cooling strategy using the guidance provided in Appendix C of this document that demonstrates it is unlikely that a licensee would need to vent from the containment drywell before alternate reliable containment heat removal and pressure control is reestablished to meet the requirements in Section B.2 of the Order.

The requirements of Order EA-12-050 addressed the use of the HCVS for both prevention of core damage and protection of the containment from overpressure failure during a Beyond Design Basis Event (BDBE) that do not progress to core damage and severe accident conditions. Unlike conditions resulting from postulated plant events, severe accidents, by their very nature, are an effectively unbounded class of events. Although reactors licensed under 10CFR52 have certain regulatory requirements related to severe accident capabilities, the extension of regulatory requirements to design features required for severe accident conditions is unique for existing reactors licensed under Part 50. This unique aspect of Order EA-13-109 calls for very clear definition of the boundary conditions to be applied to the design and operational considerations required to implement the HCVS. The purpose of this section is to clearly outline these boundary conditions and the key terms used in relation to the conditions associated with a severe accident capable vent.

Two key functional aspects of the HCVS involve the prevention of containment over-pressurization for events that do not result in core damage and for events where severe accident conditions exist.

A key guiding principle regarding the design of the HCVS is defining conditions that are consistent with the capability of the containment to withstand severe accidents. This document will define the design parameters of the HCVS equipment, including that of a drywell vent, with the understanding that the HCVS design parameters should provide margin to meet the EA-13-109 order language of "The design is not required to exceed the current capability of the limiting containment components".

2.1. HCVS Use for Design Basis

Use of the HCVS during design basis accident or other events (DBE) is not assumed nor required.

2.2. HCVS Use for Beyond Design Basis Events (BDBE) and Beyond Design Basis External Events (BDBEEs)

A spectrum of Beyond Design Basis Events (BDBE) or Beyond Design Basis External Events (BDBEE) may be postulated; however, in the context of the HCVS, the design and operation in response to such events is not intended to be constrained to a specific set of scenarios or timelines. Rather, the considerations for the HCVS are defined to provide a broad functional capability for the prevention of containment over-pressurization prior to core damage and mitigation of containment over-pressure conditions that may exist after core damage.

2.2.1. BDBE are events that involve assumptions and failures that exceed those associated with DBEs but may not be considered severe accidents.

2.2.2. Certain beyond design basis events such as an extended loss of AC power (ELAP) can result in the loss of active containment heat removal capability.

2.2.2.1. Plant actions to address an ELAP are contained in the plant's response to NRC Order EA-12-049, commonly referred to as FLEX. An ELAP itself may not lead to a severe accident since the purpose of FLEX mitigating strategies is to prevent core damage. However, if ELAP is not mitigated a severe accident with core damage and vessel breach may evolve.

2.2.3. The primary design objective of the HCVS is to provide sufficient venting capacity to prevent a long-term overpressure failure of the containment by restoration and maintenance of containment pressure below the primary containment design pressure and the primary containment pressure limit (PCPL).

2.2.4. The HCVS venting pressure for a BDBE may be driven by conditions created during BDBEs, such as to lower pressure to use a low pressure portable pump or to control containment conditions to allow continued use of installed equipment such as installed steam-driven equipment that discharges to the Suppression Pool/Torus during loss of containment cooling and may be using the suppression pool as a water source and thus also the cooling medium for pump components.

2.3. HCVS Use during Applicable Severe Accident Conditions

The primary severe accident use of the HCVS is to protect the containment from over-pressure failure caused by the increase in containment pressure from steam, non-condensable gases, and elevated containment temperature following severe core damage. For the purposes of this order, the severe accident is caused by loss of active containment heat removal capability or failure to mitigate an ELAP. The conditions include both scenarios in which all core debris is cooled in-vessel (similar to the accident at TMI-2) and scenarios in which core debris breaches the reactor coolant boundary and relocates into containment, with some of the core debris remaining within the reactor vessel. Increased temperature resulting from severe accidents may impact the pressure retention capability of containment penetration seals, particularly the drywell head gasket. The performance of the HCVS in response to a severe accident is intended to minimize, as far as reasonably practicable, uncontrolled releases of radionuclides and combustible gases to the environment external to the containment by preventing containment over-pressure failure.

The HCVS would also be used as an element of the Plant procedures to maintain the Pressure Suppression Pressure function of the containment prior to RPV breach by controlling suppression pool/torus pressure and level. Additionally, venting of non-condensable gases from containment can reduce the challenge to containment integrity from stratified gas temperature effects on the drywell head gasket.

2.3.1. Realistic assumptions (i.e. not bounding) may be used to determine the initial conditions for design of the HCVS, e.g., Suppression Pool initial temperature, DW initial temperature, use of heat sinks in analysis models. These initial condition assumptions are consistent with the starting point for order EA-12-049, in response to an ELAP. (HCVS-FAQ-06, generic assumption 049-14)

2.4. Vent Design Boundary Conditions

The potential scope of possible severe accident conditions is essentially unbounded. In some scenarios, severe accident containment conditions can compromise containment integrity for reasons other than over-pressurization, (e.g., drywell shell melt-through in Mark Is, extremely high temperature effects on drywell head seal leakage or other postulated containment failure modes). The unbounded nature of severe accident conditions calls for a more reasonable design philosophy; the HCVS capability should exceed the current capability of the limiting containment components or meet the conditions under which it is required to operate. Four primary parameters are defined for use in defining the HCVS component capability; Pressure, Temperature, Radiation and Hydrogen/CO Concentration.

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

2.4.1. Depending on the HCVS design, the HCVS may have three distinct portions.

2.4.1.1. a portion that only supports wetwell venting,

2.4.1.2. a portion that only supports drywell venting, and

2.4.1.3. a portion that is shared by both.

2.4.1.3.1. The temperature boundary conditions for the drywell vent are impacted by other conditions that may exist at the time the vent is needed. Reference 27 demonstrates that water addition during severe accident conditions provides a safety benefit by reducing containment temperatures. The temperature boundary conditions with water addition are described in this section.

2.4.2. The use of the HCVS is provided in Industry Guidance and adopted on a plant-specific basis through the use of flowcharts and procedures.

2.4.2.1. In the plant procedures, the highest pressure used for venting to control (restore and maintain) pressure is based on the plant-specific Primary Containment Pressure Limit (PCPL).

2.4.2.1.1. When designated herein, the most bounding PCPL for design of components is the limit based on the pressure capability of containment.

2.4.2.1.2. PCPL is selected as the boundary condition for the design pressure of the HCVS components, instrumentation and piping. It is expected that the capability of HCVS components and piping will be greater than the design boundary conditions.

2.4.3. During a severe accident, temperature of gases in the wetwell and drywell will differ but this is expected based on the physical configuration of the plant.

2.4.3.1. The suppression pool/wetwell of a BWR Mark I/II containment can be considered to be in a saturated condition.

2.4.3.2. The plant-specific PCPL determination provides a temperature range for the suppression pool of 70ºF to 350ºF.

2.4.3.3. Therefore, the design temperature for the wetwell vent portions of the HCVS are recommended to be based on the 350ºF upper bound of the EPG/SAG bases document which is above the saturation temperature corresponding to typical PCPL values.

2.4.4. For the drywell vent path, the plant-specific PCPL is within a drywell temperature range of 100ºF - 545ºF.

2.4.4.1. The PCPL and 545ºF, is recommended as the design pressure and temperature for the drywell vent system and any common and shared portions of the vent line if Severe Accident Water Addition as described in Appendix I is also implemented as part of Phase 2 of the Order. For portions of the vent line past the second primary containment isolation valve (PCIV) an auditable analysis may justify lower values. (This guidance is providing design pressure and temperature for the drywell vent system to address the possibility that the wetwell vent system associated with Phase I may share piping and components with the drywell vent portion associated with Phase 2.)

2.4.4.1.1. The postulated boundary of severe accident conditions could exceed the recommended design envelope of the drywell vent as evidenced by the Fukushima events and supported by various studies prior to Fukushima. In that event, the HCVS should have the capability to continue to perform its function at more extreme conditions. Inherent margins above design of the components, such as higher plastic failure temperatures provide assurance of this capability (reference Figure 2-1.)

2.4.4.1.2. The HCVS capability at extreme conditions should consider all potential aspects of vent usage and operation under severe accident conditions, including but not limited to drywell flood up and protection of drywell head seal from over-pressure and associated over-temperature induced gross leakage; which is accomplished by maintaining containment pressure below the lower of containment design pressure or PCPL.

Notes:

- The Switzerland Regulator imposed a vent design pressure of 150% of containment design pressure or 66% of failure pressure via HSK-AN-2026.
    - A European BWR uses 150°C (302°F) as the design temperature for its vent system.
- Not all BWR Containment, Drywell Sprays and Suppression Pools are sized and/or configured similarly depending on NSSS provider and construction timeline.
- These vent design parameters are associated with a particular configuration and severe accident mitigation strategy that is intended to protect the containment pressure retaining capability.

2.4.4.2. As pictorialized in Figure 2-1, which illustrates the representative margin of the containment based on the design envelope, extending the DW HCVS vent design values to PCPL and 545°F (from point 1 to point 2 on the diagram) provides an assurance that margin is maintained in the DW head region by selecting this design point for the DW vent.

Selection of this design point (PCPL and 545°F) should provide margin to avoid gross drywell head seal leakage (as illustrated by comparing point 2 to point 4 on the diagram).

The basis of Figure 2-1 is a compilation of various test and engineering evaluations that are publically available on the integrity of containment, e.g., SOARCA, NUREG/CR-2442, NUREG/CR-5334, NUREG/CR-3234, NUREG/CR-4064, DE-ACO4-76DP00789 [Ref. 9, 11 – 15].

The HCVS operational procedures should provide direction such that containment pressures are controlled. This capability of pressure control should be shown to provide containment pressure and associated temperature margin below the ultimate failure prediction for gross drywell head seal leakage.

2.4.4.2.1. The green, blue and light blue highlighted regions of the diagram show the dominant items contributing to loss of containment for that range of temperatures and pressures based on the containment design bases grey box.

2.4.4.2.2. The red area of the diagram shows the region where there is high likelihood that significant containment compromise will occur based on the containment design values (point 1).

2.4.4.2.3. The failure predictions for gross drywell head seal leakage from over-pressure/over-temperature, individually or in combination, shall be based on Figure 2-1 compilation basis and any other available data and research on the subject matter.

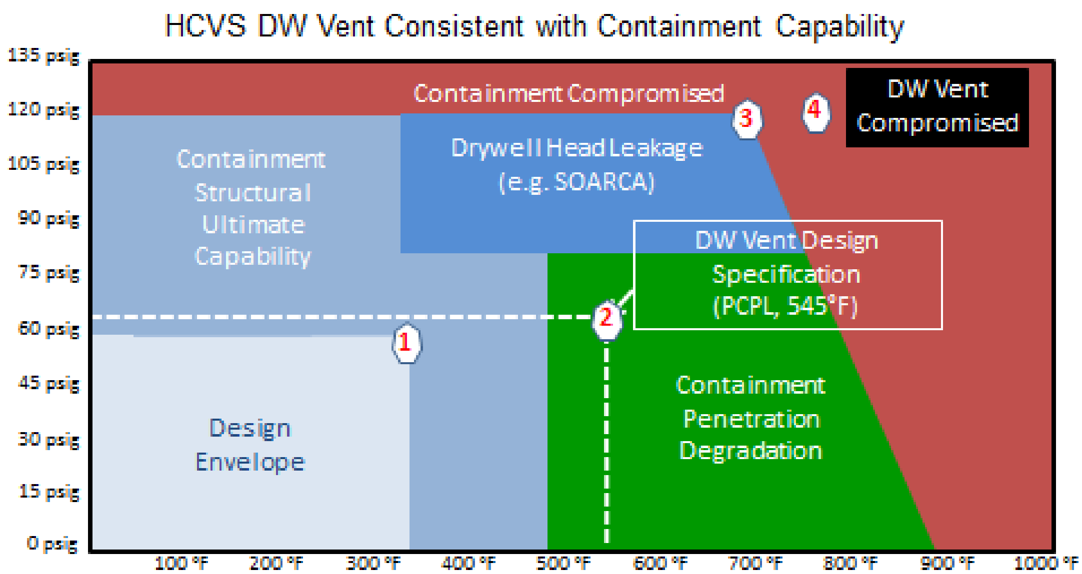


Figure 2-1

2.4.4.3. The selection of the DW HCVS vent design values to PCPL and 545°F (with SAWA) does not imply that the containment vent should be operated at this value since elevated temperatures and pressures increase the probability of DW head gasket compromise, which should be avoided.

2.4.4.4 A severe accident capable drywell vent meeting the requirements of Section B.1 of Order EA-13-109 with SAWA to either the RPV or Drywell as part of the Order implementation justifies a temperature design boundary condition of 545°F.

2.4.4.4.1 The recommended design temperature boundary condition for this option is 545°F. As shown in Figure 2-2, the maximum containment structure temperatures remain at or below 545°F in 100% of all frequency weighted end states with water addition evaluated in conjunction with CPRR rulemaking analysis (Reference 27). Figure 2-3 shows that there is little difference in temperature benefit if the water addition occurs directly to the RPV or to the drywell.

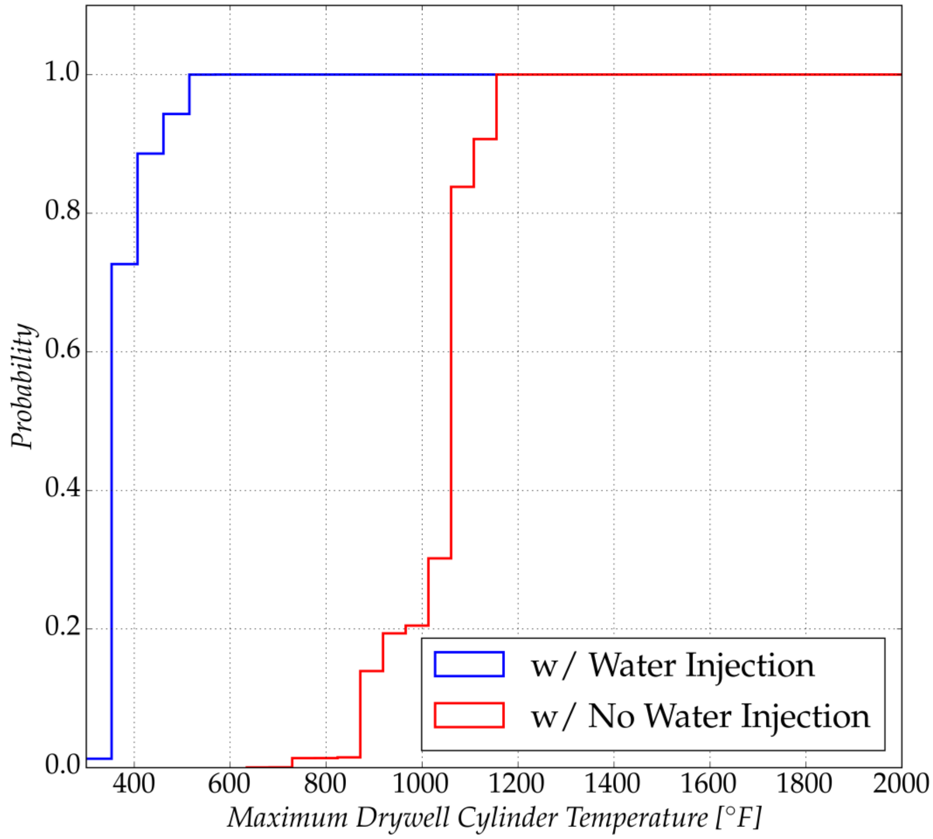


Figure 2-2 Probability that the Maximum Drywell Gas Temperature is below the indicated value under Various Severe Accident Sequences, Water Addition vs. No Water Addition (Reference 27)

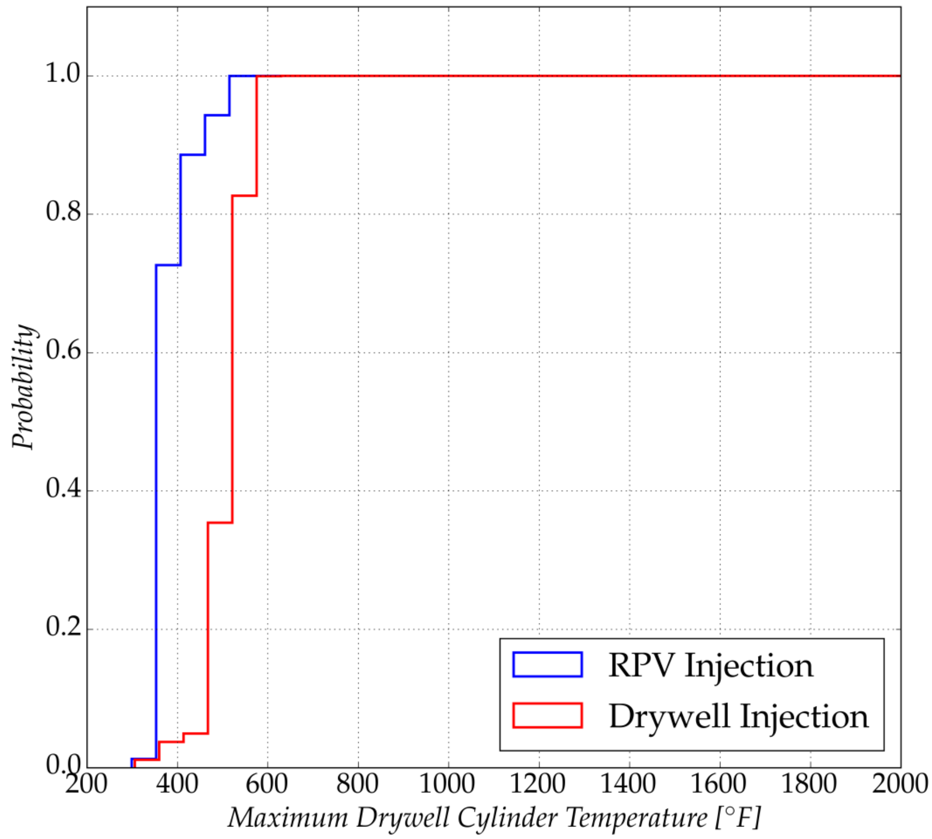


Figure 2-3 Probability that the Maximum Drywell Gas Temperature is below the indicated value under Various Severe Accident Sequences, water addition to RPV vs. water addition to Drywell (Reference 27)

2.4.4.4.2 Maintaining the containment below PCPL and 545°F provides reasonable assurance that the potential for gross leakage from the drywell head seal is minimized. This is shown in Figure 2-1 and further supported in Section 2.4.4.5.

2.4.4.4.3 Licensees choosing this option must also implement SAWA as described in Appendix I.

2.4.4.5 Additional supporting information for a drywell vent design temperature boundary condition of 545°F as described in Section 2.4.4.4.

2.4.4.5.1 Analysis has been performed by the NRC using MELCOR and EPRI using MAAP. The MAAP analysis produced the results shown in Figures 2-2 and 2-3.

2.4.4.5.2 MELCOR analysis shows that with water addition and containment venting, the maximum upper drywell gas temperatures for most of the dominant sequences would range from 400°F to 600°F, except for short durations when the temperature in the drywell pedestal region/elevation has a significant spike.

2.4.4.5.3 Sandia National Laboratories performed testing of compression seals and gaskets commonly used for DW head seals for the NRC in the early 1990s. Materials tested include EPDM, Silicone Rubber and Neoprene. Temperatures at which significant leakage could occur range from 460°F to 670°F. The pressures applied during the test are significantly higher (143 to 160 psig) than typical PCPL values (45 to 105 psig). The test pressures are more than twice the containment design pressure. (NUREG/CR-4944, SAND87-7118 R1, Containment Penetration Elastomer Seal Leak Rate Tests (Reference 15)). The study was performed on smaller diameter flange seals (14 and 18 inch standard piping flanges machined for double elastomeric seals). However, this is a material property study and provides some insight as to the limits of DW head seal performance

2.4.4.5.4 The use of the containment vent to maintain Containment pressure below PCPL will maintain continuity of the metal-to-metal contact between drywell head flanges so that only minor leakage is expected if some seal degradation occurs due to the elevated temperature and radiation. This is based on NUREG/CR 7110, Volume 1, Peach Bottom Integrated Analysis, Section 4.6, Containment Failure Model (Reference 26), description of Containment over-pressure failure mechanism for the drywell head seal flange.

2.4.5. The order drives two options regarding design of the HCVS for flammable mixtures; ensure that the flammability limits of gases passing through the system are not reached or to design for detonation.

2.4.5.1. Designing for detonation is addressed in Appendix H.

2.4.5.2. The exclusion of oxygen is an acceptable method to ensure that flammability limits are not reached.

2.4.5.3. Hydrogen and other combustible gases are a product of the core damage process as a result of chemical reactions involving zirconium and steam (or steel and steam) and Molten Corium Concrete Interaction (MCCI).

2.4.5.3.1. Depending on the scenario, vent operating cycles and the timing of vent use, the volume fraction of hydrogen can vary widely.

2.4.5.3.2. Based on information discussed in Appendix H, consideration of a hydrogen concentration range of 40 - 4% is recommended (see NUREG C/R-2475/NUREG C/R-6524, GE SIL 643) [Ref. 17, 18 and 19].

2.4.5.3.3. Hydrogen is flammable at above 4% in many references.

2.4.5.3.4. Purging is an acceptable method for keeping the flammable concentration below 4%

2.4.6. The recommended boundary conditions for the severe accident capable vent are summarized in Table 2-1 below:

Severe Accident Capable Vent Design Parameter Boundary Conditions

<table>
<tr><th>Boundary Parameter</th><th>Wetwell Vent Path</th><th>Drywell Vent/ Shared Paths[1]</th></tr>
<tr><td>Containment Design Pressure</td><td colspan="2">For Sizing Design use the <u>Lesser</u> of Design Pressure or PCPL
For Pressure Rating use the <u>Higher</u> of Design Pressure or PCPL</td></tr>
<tr><td>Containment Design Temperature</td><td>350 ºF</td><td>545ºF with SAWA</td></tr>
<tr><td colspan="3">[1]The 545°F design temperature for shared paths only applies when a drywell vent designed to 545°F is installed as part of Phase 2 of the Order.</td></tr>
</table>

Table 2-1

2.4.6.1. Selection of values that are more conservative than the above recommended values is acceptable (i.e., higher design pressures and temperatures).

2.4.6.2. Less restrictive bases than the above recommended values require a plant-specific technical justification.

2.4.7. The piping, valves, and the valve actuators should be designed to withstand the dynamic loading resulting from the actuation of the system, including piping reaction loads from valve opening, resultant loads from SRV operation, potential for water hammer from accumulation of steam condensation, and hydrogen detonation, if applicable, during multiple venting cycles.

2.5. Vent Operation Assumptions

The vent must be capable of operation during an extended loss of AC power (ELAP) and under conditions that may exist during a severe accident.

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

2.5.1. Severe accident conditions within the containment require consideration of accessibility and stay time issues using the methodologies in Appendix F and G. Sections 4.2.5 and 4.2.6 provide the requirements for design.

2.5.2. The 24 hour dedicated and permanently installed equipment requirement does not apply to non-HCVS equipment (e.g., SAWA pumps, valves and instrumentation) needed to support strategies implemented for B.2 of the Order for a Containment venting strategy using SAWA and/or SAWM. Refer to Appendix I for additional requirements for SAWA. (HCVS-FAQ-02: While the above components need not be dedicated, they need to be available to support HCVS function when containment venting using the HCVS system is required.)

3. DRY WELL VENT TEMPERATURE BOUNDARY CONDITIONS WITHOUT SAWA

3.1. Drywell Vent Design Boundary Conditions without SAWA.

3.2 If SAWA is not provided during severe accident conditions, Reference 27 shows that containment temperatures with ex-vessel core debris will likely exceed the 545°F temperature boundary condition identified in Section 2 by a large margin (Figure 2-2). The requirements for this method of compliance are defined in part B.1 of the Order.

3.2.1 If this option is selected, the Licensee will need to submit plant specific analysis relative to the design temperature boundary condition for NRC approval.

3.2.2 Licensees selecting this option for Phase 2 compliance should consider that the CPRR rulemaking may impose additional requirements similar to SAWA on a time table consistent with the rulemaking schedule.

4. DESIGN CONSIDERATIONS

The purpose of the reliable HCVS is to enhance the capability of BWRs with Mark I and II containments to preserve containment capability in a wide spectrum of possible beyond design basis accident conditions including the presence of ex-vessel core debris, controlling containment pressure within acceptable limits by venting the containment atmosphere including steam, hydrogen, non-condensable gases, aerosols, and fission products. As described in Section 2, the HCVS will be designed for those accident conditions for which containment venting is relied upon to prevent containment failure; including accident sequences that result in the loss of active containment heat removal capability or extended loss of AC power (ELAP). This section describes the design considerations applicable to the design and implementation of a plant-specific HCVS.

This Section addresses design considerations of the HCVS for both wetwell and drywell vent. The applicability of these design considerations to SAWA are indicated in this section. Additional SAWA design considerations are contained in Appendix I

4.1. Vent Design Criteria

4.1.1. Vent Thermal Design and Capacity

The primary design objective of the HCVS is to provide sufficient venting capacity to prevent a long-term overpressure failure of the containment by keeping the containment pressure below the lower value of either PCPL or containment design pressure, and maintaining Pressure Suppression Capability such that the safety relief valves (SRVs) can be opened and closed as required by plant conditions. Operational functionality of these valves will ensure the capability to depressurize the RPV to permit injection of low head injection systems and to maintain the containment pressure boundary.

Order Reference: 1.2.10 – The HCVS shall be designed consistent with containment pressures and temperatures during severe accident conditions as well as dynamic loading resulting from system actuation. The design is not required to exceed the current capability of the limiting containment components.

Order Reference: 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 analyses), and be able to maintain containment pressure below the primary containment design pressure and the primary containment pressure limit (PCPL).

4.1.1.1. Key issues to be addressed in the Vent Thermal Design and Capacity requirements are:

4.1.1.1.1. Consideration of containment venting to support mitigation strategies for BDBEE including ELAP conditions.

4.1.1.1.2. Ability of the vent system to operate under the expected pressures and temperatures of the containment.

4.1.1.1.2.1. The key consideration would be design temperature of the drywell vent components and instrumentation.

4.1.1.1.3. Sizing considerations for the wetwell and drywell vent.

4.1.1.1.3.1. A wet well vent sized under conditions of constant heat input at a rate equal to 1 percent of rated thermal power and containment pressure equal to the lesser of the PCPL or containment design pressure, the exhaust-flow through the wetwell vent would be sufficient to prevent the containment pressure from increasing.

4.1.1.1.3.2. The suppression pool/torus suppression capacity is typically sufficient to absorb the decay heat generated during at least the first three hours following the shutdown of the reactor with the suppression pool as the source of cooling. The decay heat is typically less than 1 percent of rated thermal power following this three hour period and continues to decrease to well under 1 percent thereafter.

4.1.1.1.3.2.1 Licensees shall have an auditable engineering basis for the decay heat absorbing capacity of their suppression pools, venting pressure and associated decay heat value.

4.1.1.1.3.2.2. Licensees may justify use of decay heat rates of less than 1 percent for purposes of vent sizing capability if analyses demonstrate that containment pressure can be maintained below the lower of design pressure or PCPL (Wetwell or drywell).

4.1.1.1.3.3. In cases where plants were granted, have applied, or plan to apply for power uprates, the decay heat value selected should correspond to the uprated thermal power.

4.1.1.1.3.4. The basis for the venting capacity should give appropriate consideration of where venting is being performed from (i.e., wetwell or drywell) and the difference in pressure between the drywell and the suppression chamber.

4.1.1.1.3.5. Vent sizing for multi-unit sites must take into consideration simultaneous venting from all the units, and ensure that venting on one unit does not negatively impact the ability to vent on the other units. This includes ensuring any shared portions of the vent can pass the cumulative flow requirements

4.1.1.2. Key issues to be addressed in the SAWA Thermal Design and Capacity requirements are consistent with Section 4.1.1.1 except that the maximum capacity requirement for SAWA is 500 GPM including those plants that may have (or plan to) implemented Extended Power Uprate.

4.1.1.2.1 Sites may use SAWA capacity at 500 GPM based on the generic analysis per reference 27.

4.1.1.2.2 Sites may use a SAWA capacity equivalent to the site specific RCIC design flow rate if less than 500 GPM (e.g., some sites have a RCIC design flow rate of 400 or 450 GPM).

4.1.1.2.3 SAWA capacity less than specified in 4.1.1.2.1 or 4.1.1.2.2 should be supported by plant specific design (i.e., SAWA flow rate determined by scaling, a ratio of the plant thermal power rating over the reference plant power level multiplied by 500 GPM).

4.1.1.2.2 The selection for SAWA capacity should be described in the Phase 2 OIP.

4.1.2. Multipurpose Penetration Use

Order Reference: 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.

Order Reference: 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. These items include piping, piping supports, containment isolation valves, containment isolation valve actuators and containment isolation valve position indication components.

4.1.2.1. Key issues to be addressed regarding HCVS multipurpose penetration and containment isolation barriers use are:

4.1.2.1.1. Exception to GDC 56, 10 CFR 50.12 submittal.

4.1.2.1.1.1. Each HCVS containment penetration must have two in-series PCIVs as required by GDC 56.

4.1.2.1.1.1.1. Although GDC 56 stipulates that one valve should be inside containment and the other outside containment, both PCIVs on each HCVS containment penetration may be installed outside containment and as close as reasonably possible to the penetration.

4.1.2.1.1.1.2. Locating a power operated valve inside containment that must open and remain operable following a beyond design basis severe accident decreases the reliability of any valve and operator (including motive air and DC instrumentation and controls) located inside the containment.

4.1.2.1.2. The rational for locating the PCIVs as close as reasonably possible to the containment penetration is to comply with the applicable GDCs.

4.1.2.1.2.1. It limits the amount of the HCVS flow path that is part of the containment penetration boundary.

4.1.2.1.2.2. Minimizing the amount of new containment penetration piping limits the risks to containment integrity. Any piping that is part of the containment penetration boundary must be designed to the appropriate criteria (typically, protected from pipe whip, jet impingement, missiles, and be designed to ASME Section III class 2 with the added requirement for low stresses during design basis operation of the plant to preclude having to postulate pipe break or pipe cracks).

4.1.2.1.2.2.1. New piping and valves should be evaluated for both Design Basis events and Beyond Design Basis Events as separate evaluations.

4.1.2.1.2.2.2. Boundary conditions and loads associated with the Beyond Design Basis event do not have to be included or considered in Design Basis Calculations.

4.1.2.1.2.2.3. Qualification for piping/valves associated with the BDBE may include both different loading combinations and allowed stresses.

4.1.2.1.2.3. Locating the PCIVs close to the containment penetration restricts the possibility for practical local-manual operation; Section 4.2 discusses design features that will increase remote-manual operation.

4.1.2.1.3. GDC 56 stipulates that the valves must be either locked-closed or have automatic closure.

4.1.2.1.3.1. The intent of automatic isolation is to ensure that penetrations that may be open to the containment atmosphere during normal operation (e.g., nitrogen inerting, nitrogen purging) are closed when containment integrity is required.

4.1.2.1.3.2. Automatic isolation of the HCVS valves on a containment isolation signal is possible, but it would be redundant since these valves are required to be closed during all anticipated modes of operation that could require containment isolation. (Except during the period required for operation when the containment isolation signals are to be defeated to allow HCVS operation)

4.1.2.1.3.3. Also, automatic isolation would unnecessarily complicate valve opening if HCVS is required.

4.1.2.1.3.4. To support not providing locked-closed valves or automatic isolation, an option is new PCIVs that are normally-closed valves that have a fail-closed mode (i.e., AOVs).

4.1.2.1.3.5. These valves shall have remote-manual operation, but with a key-lock on the control switch to prevent inadvertent opening.

4.1.2.1.4. As required by GDC 54, these penetrations "shall be designed with a capability to test periodically the operability of the isolation valves and associated apparatus and to determine if valve leakage is within acceptable limits." (HCVS-FAQ-05)

4.1.2.1.4.1. The periodic PCIV testing frequency is dictated by the unit's Technical Specifications.

4.1.2.1.4.2. Periodic rupture diaphragm testing frequency shall be based on manufacturer recommendations, if the rupture diaphragm is used as a relied upon penetration barrier

4.1.2.1.4.3. However, testing at any time may be required if a valve or rupture diaphragm reliability issue arises.

4.1.2.1.4.4. Therefore, the HCVS flow path can be credited for being closed and remaining closed during all design basis transients and accidents.

4.1.2.2 Key issues to be addressed regarding SAWA multipurpose penetration and containment isolation barriers use are consistent with Section 4.1.2.1.

4.1.2.2.1 SAWA exceptions to Section 4.1.2.1 guidance including the basis for the exception should be described in the Phase 2 OIP

4.1.3. Routing Considerations

Order Reference: 1.1.4 – The HCVS controls and indications shall be accessible and functional under a range of plant conditions, including a severe accident environment, extended loss of AC power, and inadequate containment cooling.

4.1.3.1. Key issues to be addressed regarding routing considerations are listed in Appendices F & G on source term and dose considerations and Section 4.2 for operator "residence time". These routing considerations are applicable to both the HCVS vent path and SAWA flow path.

4.1.4. Multi-Unit Interfaces

System cross-connections or shared Unit vent exhaust flow paths present a potential for steam, hydrogen, and airborne radioactivity leakage to other areas of the plant and to adjacent units at multi-unit sites if the units are equipped with common vent piping. At Fukushima, an explosion occurred in Unit 4, which was in a maintenance outage at the time of the event. Although the facts have not been fully established, a likely cause of the explosion in Unit 4 is that hydrogen leaked from Unit 3 to Unit 4 through a common venting system. (HCVS-FAQ-05)

Order Reference: 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."

4.1.4.1. HCVS design should provide design features to minimize the cross flow of vented fluids and migration to other areas within the plant or to adjacent units at multi-unit sites.

4.1.4.1.1. A design that is free of physical and control interfaces with other systems eliminates the potential for any cross-flow is one way to satisfy this requirement.

4.1.4.1.2. Examples of acceptable means for minimizing cross flow are the use of valves, "leak-tight" dampers, and check valves.

4.1.4.1.3. Pressurizing with inert gas between system boundary valves could also be used (provided sufficient gas exists to support this during the required sustained operation period).

4.1.4.1.4. Other means are acceptable with a site specific justification based on the component parameters.

4.1.4.1.5. Any HCVS flow path interface should be designed to remain closed or automatically close upon the initiation of the HCVS and remain closed for as long as the HCVS is in operation.

4.1.4.1.5.1. If Operator actions are required for confirming/changing state of interfacing valves, then validation of the action using normal plant validation methods should be included in the HCVS plant procedures.

4.1.4.1.6. The environmental conditions (e.g. pressure, temperature) at the flow path interface locations during venting operations should be evaluated to ensure that the interface will remain sufficiently leak-tight.

4.1.4.1.7. If power is required for the interfacing valves to move to isolation position, it should be from power sources meeting the same standards and qualifications as the vent valves.

4.1.4.1.8. Leak tightness of any such barriers should be periodically verified by testing as described in Section 6 of this document (HCVS-FAQ-05).

4.1.4.2 SAWA design differs from the HCVS design in that SAWA provides water flow into the containment and is not intended for the containment fluids to reverse flow from containment. Therefore, unintended cross flow and migration to other areas within the plant can be prevented with backflow prevention. The means of backflow prevention should be described in the Phase 2 OIP.

4.1.4.3 SAWA design should consider other possible flow paths and diversions that may exist under the conditions of use (ELAP, Severe Accident conditions in containment).

4.1.4.3.1 Licensees should evaluate the SAWA flow path for possible diversions from the intended flow path (e.g., intersystem connections, pump minimum flow lines, relief valves and recirculation paths.

4.1.4.3.2 Licensees should evaluate the SAWA flow path controls for potential logic conditions that may prevent the flow path from being lined up under the expected conditions of use.

4.1.4.3.3 From the evaluations performed for Section 4.1.4.3.1 and 4.1.4.3.2, licensees should develop plant specific guidance to ensure that the SAWA flow path can be lined up with the required flow rate to the intended location (RPV or drywell).

4.1.4.3.4 Licensees should include a discussion of the evaluations performed for Sections 4.1.4.3.1 and 4.1.4.3.2, and a functional level discussion of the plant specific guidance developed per Section 4.1.4.3.3 in the Phase 2 OIP.

4.1.5. Release Point

The HCVS release to outside atmosphere should be at an elevation higher than adjacent plant structures. (Refer to Section 5 for discussion of qualification details) (HCVS-FAQ-04)

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

4.1.5.1. Release through existing plant meteorological stack(s) is acceptable.

4.1.5.2. If the release from HCVS is through a stack different than the plant meteorological stack, the elevation of the stack should meet the following criteria:

4.1.5.2.1. Be higher than the nearest power block building or structure.

4.1.5.2.2. The release point should be situated away from ventilation system intake and exhaust openings or other openings that may be used as natural circulation ventilation intake flow paths during a BDBEE (e.g., to prevent recirculation of the releases back into the buildings.)

4.1.5.2.3. The release stack or structure exposed to outside should be designed or protected to withstand missiles that could be generated by the external events that screen in for the plant site using the guidance in NEI 12-06 as endorsed by JLD-ISG-12-01 [Ref. 21] (See Section 5 for details). (HCVS-FAQ-04)

4.1.5.3. Order requirements for release point are not applicable to SAWA.

4.1.6. Leakage Criteria

The HCVS design should address the reduction of Hydrogen Gas flammability in the vent pipe through the use of steam suppression (Reference Appendix H and reference NUREG C/R-2475/NUREG C/R-6524, GE SIL 643 [Ref 17, 18 and 19],) inerting/purging or the exclusion of oxygen. (HCVS-WP-03, HCVS-FAQ-05)

Order Reference: 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.

Order Reference: 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.

4.1.6.1. Design for Leakage during HCVS Operation:

4.1.6.1.1. HCVS line inerting

4.1.6.1.1.1. The HCVS up to the second containment isolation valve should be either inerted/purged or be "steam inerted" such that any combustible gases within the containment or vent pipe remain below the combustible gas flammability limit (See NUREG/CR-2475).

4.1.6.1.1.2. The HCVS pipe beyond the final isolation valve used to initiate/cease venting should be designed for deflagration/detonation due to potential for oxygen intrusion resulting from steam condensation following HCVS vent closure or have the capability of being purged prior to the vent drawing in oxygen.

4.1.6.1.2. HCVS line oxygen exclusion

4.1.6.1.2.1. The exclusion of oxygen as an acceptable alternative to either inerting with steam or inert gas or making the piping detonation/deflagration proof. An example of this approach is maintaining the line pressure above atmosphere to the last discharge isolation valve.

4.1.6.1.2.2. The HCVS pipe beyond the isolation valves should be able to tolerate a detonation/deflagration or have a purge system that would either keep oxygen out of the system or reduce hydrogen concentration below flammability limits following vent cycles.

4.1.6.2 Design for Leakage in interfacing piping to HCVS:

4.1.6.2.1 The HCVS pipe beyond the interfacing piping isolation valve should meet the provisions of Section 4.1.4.1.

4.1.6.3 The backflow prevention guidance provided in Section 4.1.4.2 addresses the design for leakage considerations for SAWA.

4.1.7. Protection from Flammable Gas Ignition

Protection from flammable gas ignition should utilize principles found in NUREG/CR-2475. Additional information is provided in Appendix H of this document. The evaluation of gas ignition is to document the capability of the HCVS piping to maintain integrity should deflagration or detonations occur. Deformation of the pipe is acceptable given the integrity and continued functional capability of the vent system is shown to be maintained. (HCVS-WP-03)

Order Reference: 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.

Note: Use Appendix H and HCVS-WP-03 for guidance on design of HCVS piping system for combustible gas deflagration or detonation loads.

4.1.7.1. Design for Deflagration and/or Detonation

Most plants have a UFSAR evaluation of the Offgas flow path for detonation potential that evaluates piping for this issue. This method can be similarly used to evaluate the HCVS design. Methods of designing the HCVS piping/components/instrumentation against flammable gas detonation/deflagration are discussed in Appendix H. Susceptible portions of the piping should be determined based on where oxygen can be drawn into the piping/interfacing piping.

4.1.7.2. Purge systems to reduce gas concentrations below flammability limits.

Use of a purge system in sections of pipe susceptible to air intrusion from intermittent HCVS operation can also be used to minimize detonation/deflagration potential.

4.1.7.3. Design Systems to Prevent Detonation/Deflagration

Design of the HVCS may include features that prevent air/oxygen backflow into the discharge piping. Use of design features in sections of pipe susceptible to air intrusion from intermittent HCVS operation can also be used to minimize detonation/deflagration potential. See Appendix H for further information relative to this approach.

4.1.7.4. Combination of loads

The design of the HCVS may require that it withstand the dynamic loading resulting from hydrogen deflagration and detonation. For design purposes, the HCVS is not required to consider assumed simultaneous loads that would not be present or occur during the venting of hydrogen.

4.1.7.5 The backflow prevention guidance provided in Section 4.1.4.2 addresses the design for deflagration and/or detonation design considerations for SAWA.

4.1.8. Combined Drywell/Wetwell Vent pipe Design considerations

4.1.8.1. Depending on the HCVS design, the HCVS may have three distinct portions or flow paths;

4.1.8.1.1. A portion that only supports wetwell venting,

4.1.8.1.2. A portion that only supports drywell venting, and

4.1.8.1.3. A portion that is shared by both.

4.1.8.2. The drywell generally has the most limiting boundary conditions, so the drywell boundary condition parameters described in Sections 2.4.4 are recommended for the shared portions of the HCVS, unless lower values are justified.

4.1.8.3. Examples of reasons for lower temperature values include heat loss through piping and dead-legged piping (for example, WW vent piping when DW vent is being used)

4.1.8.4 SAWA will not share portions of the system with the HCVS wetwell and/or drywell system, i.e., they are independent flow paths to (SAWA) or from (HCVS) the containment.

4.1.9. Fault/Failure Evaluations

The table below provides an example of a Failure Evaluation that will be included in the Overall Integrated Plan. The table details the HCVS system interactions with design and operation for potential failures and alternate actions. It should not be construed from inclusion of this table in this guide, that the HCVS should be designed as a single failure proof system due to the low probability of a Severe Accident BDBEE. However, licensees should give consideration for low cost measures to provide enhanced reliability of the vent system.

SAMPLE: Failure Evaluation Table

Functional Failure Mode	Failure Cause	Alternate Action*	Failure with Alternate Action Impact on Containment Venting?
Fail to Vent (Open) on Demand	Valves fail to open/close due to loss of normal AC power	Switch power supply to inverter backed AC power	No
	Valves fail to open/close due to loss of one train of inverter backed AC power	Align power supply to alternate inverter	No
	Valves fail to open/close due to complete loss of DC batteries (long term)	Recharge batteries with FLEX provided generators considering severe accident conditions	No
	Valves fail to open/close due to loss of normal pneumatic air supply	No action needed, valves are provided with accumulator tanks which are sufficient for up to 5 actuations in a 24 hour period	No
	Valves fail to open/close due to loss of alternate pneumatic air supply (long term)	Recharge accumulator tanks with N_2 bottles and/or portable air compressors. Replace bottles as needed.	No
	Valve fails to open/close due to mechanical binding	Heroic Action needed	Yes

4.2 Vent Operation and Monitoring

The importance of reliable operation of hardened vents during conditions involving loss of containment heat removal capability is well established and this understanding has been reinforced by the lessons learned from the accident at Fukushima Dai-ichi. This sub-section describes the design considerations relative to the HCVS operation and monitoring.

By nature, some BDBEEs create a need to initially operate the vent manually (either locally or from remote stations) and the design concepts espoused in this document protect that operational capability. Due to the multiple functions provided by the vent path, a single set of passive features (e.g., Rupture Diaphragms) cannot achieve all of the operational functions, therefore operator actions are required. The challenges found in operating the vents at Fukushima have been addressed by this guidance as have the required actions to complete multiple functions (e.g. FLEX heat removal venting, intermittent venting in severe accidents and post severe accident venting for combustible gas control). Based on this, the design elements proposed by this guidance (as listed below) do not require specific new requirements to minimize operator actions to address the ability to operate vents as required for ELAP and severe accident conditions.

This Section addresses operation and monitoring of the HCVS for both wetwell and drywell vent. The applicability of these operation and monitoring considerations to SAWA are specifically stated in each element of this section. Unless otherwise specifically stated, then the operation and monitoring considerations in this section do not apply to SAWA. Additional SAWA operation and monitoring considerations are contained in Appendix I.

4.2.1 Protection from Inadvertent Actuation

The design of the HCVS should incorporate features, such as control panel key-locked switches, locking systems, rupture diaphragms, or administrative controls to prevent the inadvertent opening of the vent.

a. The system should be designed to preclude inadvertent actuation of the HCVS due to any single active failure.

b. The design should consider general guidelines such as single point vulnerability and spurious operations of any plant installed equipment associated with HCVS.

c. Use of Administrative controls on energizing the HCVS controls can also be a part of the acceptable plan to minimize impact on Current Licensing Basis (CLB) controls.

Order Reference: 1.2.7 - The HCVS shall include means to prevent inadvertent actuation.

4.2.1.1 One or more of the following criteria are acceptable approaches for inadvertent actuation features of the HCVS.

4.2.1.1.1 Rupture diaphragm in the HCVS flow path

4.2.1.1.2 Key lock for HCVS valve switches

4.2.1.1.3 Administrative Controls for energizing HCVS components/controls

4.2.1.1.4 Interface with Technical Specification Components (such as current primary containment isolation valve (PCIV) controls).

4.2.1.2 Meeting design features and the above criteria will show compliance with separation of controls from negative impact on CLB equipment and methods to demonstrate reasonable prevention of inadvertent actuation of the system.

4.2.1.3 Prevention of inadvertent actuation, while important for all plants, is essential for plants relying on containment accident pressure (CAP) to provide adequate net positive suction head to the emergency core cooling system (ECCS) pumps. Plants that rely on CAP should have an evaluation that specifically addresses the design considerations for minimizing inadvertent actuation interaction. This evaluation may include a combination of design features and administrative controls.

4.2.1.4 Protection from inadvertent actuation is applicable to SAWA. The means for preventing inadvertent actuation described in Section 4.2.1.1 is primarily the use of manual valves for connecting this portable system. Since SAWA will not be capable of removing inventory from the containment since a back flow device is required in section 4.1.4.2, Section 4.2.1.3 is not applicable to SAWA. If a Licensee is using a means other than manual valves for connecting the portable SAWA components, that means and the protection from inadvertent actuation of the SAWA system should be described in the Phase 2 OIP.

4.2.2 Required HCVS Controls Primary Control and Monitoring Location

The preferred location for remote operation and control of the HCVS is from the main control room. However, alternate locations to the control room are also acceptable. (HCVS-FAQ-01, HCVS-FAQ-08 and HCVS-FAQ-09)

Order Reference: 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.

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

4.2.2.1 The control location should take into consideration the following:

4.2.2.1.1 The ability to open/close the valves multiple times during the event, i.e., sustained operations.

4.2.2.1.1.1 Licensees should determine the number of open/close cycles necessary during the first 24 hours of operation and provide supporting basis consistent with the plant-specific containment venting strategy.

4.2.2.1.1.2 Sustained operational requirements may continue beyond the capacity of the installed HCVS system motive force (air/nitrogen) make-up, power supply changes or both, i.e., beyond the first 24 hours.

4.2.2.1.1.3 Sustained operations provisions should continue until 7 days or a shorter period of time if an alternative method of containment heat removal is put in place by using installed or portable equipment (e.g., a means of shutdown cooling aligned directly to the RPV, drywell or suppression pool.) The alternate method of containment heat removal should not rely on the HCVS (i.e., the HCVS isolation valves should be able to remain closed such that releases and cross unit or system interface leakages are no longer a concern.)

4.2.2.1.1.4 During Sustained Operation, the containment barrier is initially manually controlled by the plant staff/ERO during containment heat removal operations (either by containment venting or alternative measures) to prevent further fuel damage. This manual containment heat removal allows RPV injection by use of RCIC or external water supplies (reduced containment pressure may be required.)

4.2.2.1.2 The temperature and radiological conditions that operating personnel may encounter both in transit and locally at the controls. (HCVS-FAQ-07, HCVS-FAQ-09, HCVS-WP-02)

4.2.2.1.2.1 This should include the impacts on initial release of post severe accident source term and impacts of vent piping related heat up in areas with little or no ventilation on the controls/controlling station. Alternatives may be used, such as providing features to facilitate manual operation of valves from remote locations or relocating/reorienting containment vent valves.

4.2.2.1.3 Availability of permanently installed HCVS equipment, including any connections required to supplement the HCVS operation during an ELAP (e.g., electric power, N_2/air) should be consistent with the staff's guidance in JLD-ISG-2012-01 for Order EA-12-049 with consideration of severe accident conditions.

4.2.2.1.4 The controls/control location design should preclude the need for operators to move temporary ladders or operate from atop scaffolding to access the HCVS valves or remote operating locations.

4.2.2.1.5 HCVS valve position indication should be available at the primary controlling location.

4.2.2.1.6 HCVS valve position indicators should be capable of operating under the temperature/radiation conditions existing at the valve locations.

4.2.2.1.7 HCVS valve position indicators and indications should be powered from sources that will be available during the appropriate mission time of the HCVS system. The mission time may vary by component but the cumulative mission time for credited components and instrumentation performing a required installed plant HCVS equipment function should be no less than the first 24 hours post event.

4.2.2.1.8 HCVS system should include indications of effluent temperature. Permanently installed gauges that are at, or nearby, the HCVS control panel is an acceptable method to address this item.

4.2.2.1.9 The HCVS system should include indications for the Containment Pressure and Wetwell level for determination of vent operation. These indications may be either at the primary controlling location (order criteria 1.2.4) for the HCVS or at another location with communication to the HCVS controlling location. Use of existing control room indications is adequate and these instruments do not need to be powered by the HCVS battery system.

4.2.2.1.10 Considerations for alternative approaches for system status instrumentation must provide sufficient information and justification for alternative approaches and be submitted to the NRC for approval.

4.2.2.2 The following criteria are acceptable approaches for HCVS Primary Controls and Monitoring location:

4.2.2.2.1 Requirement for sustained operation of the HCVS

4.2.2.2.2 Requirements for assessment of temperature and radiological condition

4.2.2.2.3 Reasonable protection of required equipment

4.2.2.2.4 Required design criteria for indications

4.2.2.3 Meeting design features and the above criteria will show compliance with Primary Controls and Monitoring location requirements (including instrumentation).

4.2.2.4 The SAWA system will consist of both portable and permanently installed equipment.

4.2.2.4.1 The following criteria are applicable to installed portions of the system, with consideration of the radiological and thermal conditions that may exist during severe accident conditions (HCVS-WP-02)

4.2.2.4.1.1 Verification of a functioning SAWA flow path can be obtained from local or remote valve position indication in the main Control Room, remote operating station or some other severe accident evaluated location for remote operated valves. An acceptable alternative approach is using a combination of indication of pump flow and changing containment pressure and/or suppression pool level for validation of an open SAWA flow path.

4.2.2.4.1.2 An ability to provide motive force to any power or pneumatically operated valve from the water addition point to the RPV or containment before SAWA is needed to support use of the SADV or SAWM.

4.2.2.4.1.3 The 7 day Sustained Operation requirement applies to SAWA installed systems, but not the 24 hour motive force requirements of Order element 1.2.6.

4.2.2.4.1.3.1 In lieu of Order element 1.2.6, the motive force needed to establish the SAWA flow path is expected to be achieved in the same manner to meet NEI 12-06 guidance (compliance with Order EA-12-049) except that it needs to be established prior to 8 hours as indicated in Appendix I.

4.2.2.4.1.4 SAWA components that need to be accessed to establish the SAWA flow path should be accessible without the need for ladders or scaffolds.

4.2.2.4.2 The following criteria are applicable to portable portions of the system with consideration of the radiological and thermal conditions that may exist during severe accident conditions (HCVS-WP-02).

4.2.2.4.2.1 A means to monitor the SAWA pump flow will be provided

4.2.2.4.2.2 The 7 day Sustained Operation requirement applies to SAWA portable systems, but not the 24 hour motive force requirements of Order element 1.2.6.

4.2.2.4.2.2.1 In lieu of Order element 1.2.6, the motive force needed to establish the SAWA flow path is expected to be established in the same manner to meet NEI 12-06 guidance (compliance with Order EA-12-049) except that it needs to be established prior to 8 hours as indicated in Appendix I.

4.2.3 Alternate Remote Operation {Alternate/Local Valve Control Location}

During an ELAP, manual operation/action from alternate control locations may become necessary to operate the HCVS. As demonstrated during the Fukushima event, the valves lost motive force including electric power and pneumatic air supply to the valve operators, and control power to solenoid valves. (HCVS-FAQ-01, HCVS-FAQ-03, HCVS-FAQ-08 and HCVS-FAQ-09)

a. If direct access and local operation of the valves is not feasible due to temperature or radiological hazards, licensees should include design features to facilitate remote manual operation of the HCVS valves. This could include means such as reach rods, chain links, hand wheels, alternative control locations, and portable equipment to provide motive force as needed (e.g., air/N_2 bottles, diesel powered compressors, and DC batteries). (HCVS-FAQ-07, HCVS-FAQ-09, HCVS-WP-02)

   Note, throughout this section portable equipment will not be relied upon until 24 hours after event initiation.

Order Reference: 1.2.5 - The HCVS shall, in addition to the requirements of 1.2.4, 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.

4.2.3.1 The HCVS design should consider the following elements to facilitate remote manual operation:

4.2.3.1.1 An assessment of temperature and radiological conditions that operating personnel may encounter both in transit and locally at the local or alternate control location. (HCVS-FAQ-07, HCVS-FAQ-09, HCVS-WP-02)

4.2.3.1.1.1 Include radiological conditions associated with post severe accident source terms and impacts of vent piping related heat up in areas with little or no ventilation on the local or alternate control location.

4.2.3.1.1.2 Alternatives such as providing features to facilitate manual operation of valves from remote locations or relocating/reorienting the valves may be used.

4.2.3.1.1.3 Consider that local-manual access to PCIVs for an ELAP event may not be feasible due to high temperature or radiation levels in the Reactor Building since they will be located near a containment penetration.

4.2.3.1.1.4 The connections between the valves and portable equipment should be designed for quick deployment.

4.2.3.1.1.5 If a portable motive force (e.g., air or N_2 bottles, DC power supplies) is used in the design strategy, licensees should provide reasonable protection of that equipment consistent with the staff's guidance in JLD-ISG-2012-01 for Order EA-12-049 considering severe accident conditions.

4.2.3.1.1.6 The Local Controls/Alternate Valve Control Location design should preclude the need for operators to move temporary ladders or operate from atop scaffolding to access the HCVS valves or remote operating locations.

4.2.3.2 Alternate remote operation is not applicable to SAWA.

4.2.3.3 The following criteria are acceptable approaches for HCVS Local Controls/Alternate Valve Control Location:

4.2.3.3.1 Supply an alternate method of HCVS valve operation

4.2.3.3.2 Assessment of temperature and radiological conditions

4.2.3.3.3 Reasonable protection of required equipment

4.2.3.3.4 Required design criteria for indications

4.2.3.3.5 Criteria for manual opening of HCVS and Interfacing AOVs

4.2.3.3.6 Criteria for operation of HCVS and Interfacing MOVs

4.2.3.3.7 Criteria 4.2.3.3.2 through 4.2.3.3.4 are also applicable to SAWA.

4.2.3.4 Meeting design features and the above criteria will show compliance with local controls/alternate control location requirements (including instrumentation).

4.2.4 Vent Monitoring

Plant operators must be able to readily monitor the radiological conditions that exist during venting operations of the HCVS at all times. (HCVS-FAQ-08 and HCVS-FAQ-09)

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

4.2.4.1 The HCVS design should provide a means to allow plant operators to readily determine, or have knowledge of, the following system parameters:

4.2.4.1.1 HCVS vent valves position (open and closed).

4.2.4.1.2 HCVS vent pipe radiation levels. The range of the instrument should be consistent with the dose rates anticipated during severe accident venting. The use of a multi-range instrument that will span the expected dose rates is acceptable.

4.2.4.1.2.1 The effluent discharge radiation monitor is required to provide additional knowledge of HCVS operation not as a required change for Emergency Preparedness off-site dose functions.

4.2.4.1.3 Other important information includes the status of supporting systems, such as availability of electrical power and pneumatic supply pressure.

4.2.4.1.3.1 Monitoring by means of permanently installed gauges or meters that are at, or nearby, the HCVS control panel or in the Control Room with communication to the HCVS control panel is acceptable.

4.2.4.1.4 The HCVS system should include indications for the Containment Pressure and Wetwell level for determination of vent operation. These indications may be either at the local controls/alternate control location for the HCVS systems or at another location with communication to the Primary Controls location or local controls/alternate control location.

4.2.4.1.5 Alternative approaches for system status instrumentation may be considered with appropriate justification provided for alternative approaches.

4.2.4.2 The means to monitor system status should support Sustained Operations during an ELAP, and be designed to operate under environmental conditions that would be expected following a loss of containment heat removal capability and an ELAP. “Sustained operations” beyond the first 24 hours may include the use of portable equipment to provide an alternate source of motive force to components used to monitor HCVS status. (HCVS-FAQ-06, generic assumption 049-11)

Note: Additional instrumentation required to comply with Order EA-12-049 as discussed in NEI 12-06 may be useful in support of HCVS operation, but is not required for HCVS functionality.

4.2.4.3 Instrument reliability should be demonstrated via an appropriate combination of design, analyses, operating experience, and/or testing of HCVS components for the conditions described in Section 2 of this guide.

4.2.4.3.1 Selection of HCVS components should consider ease and simplicity of design so that maintenance and calibration during system operation is not necessary. This design consideration should avoid the need for explosion proof or intrinsically safe instruments.

4.2.4.4 Sections 4.2.4.1.1, 4.2.4.1.3, 4.2.4.1.4, 4.2.1.4.5, 4.2.4.2 and 4.2.4.3 of the vent monitoring guidance in this section are applicable to SAWA with the modifications described below.

4.2.4.4.1 Section 4.2.4.1.1 applicability to SAWA is verification of a functioning SAWA flow path from indication of local or remote valve position indications in the main Control Room, remote operating station or some other severe accident evaluated location for remote operated valves. An acceptable alternative approach is to use a combination of pump flow and changing containment pressure and/or suppression pool level for validation of an open SAWA flow path.

4.2.4.4.2 Section 4.2.4.1.3 indications may be local since there is not a SAWA control panel. Communication between the local SAWA components and/or controls and the MCR or Remote Operating Station should be used for this section.

4.2.4.4.3 Section 4.2.4.1.4 is a support function for SAWA and SAWM.

4.2.4.4.4 Section 4.2.4.2 is applicable for SAWA except that portable equipment may be used to provide SAWA indications for the entire 7 day Sustained Operation period.

4.2.4.5 The following criteria are acceptable approaches for HCVS monitoring:

4.2.4.5.1 Requirements to monitor HCVS vent pipe conditions including radiological releases, vent pipe pressure and temperature.

4.2.4.5.2 Sustained operation of HCVS vent pipe condition instrumentation and other required indications during an ELAP condition (limiting analysis).

4.2.4.5.3 Requirements for assessment of radiological, temperature and pressure conditions in the area of HCVS monitoring instruments.

4.2.4.6 Meeting design features and the above criteria will show compliance with HCVS monitoring.

4.2.5 Operational Hazards

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

Order Reference: 1.1.3 - The HCVS shall also be designed to account for radiological conditions that would impede personnel actions needed for event response.

4.2.5.1 HCVS and SAWA controls should be located in areas where sustained operation is possible accounting for expected temperatures and radiological conditions in the HCVS vent pipe and attached components without extreme heat stress or radiological over exposure to the operators. (HCVS-FAQ-07, HCVS-FAQ-09, HCVS-WP-02)

4.2.5.1.1 Operation must be possible without placing the operators in dose fields above those allowed by the ERO guidance to conduct local equipment operation. The use of shielding and other radiological dose control actions may provide acceptable radiation levels for operator access

4.2.5.1.2 Operating locations (Primary and Alternate for HCVS) must account for the expected lack of ventilation that is encountered during an ELAP event.

4.2.5.1.3 Operating locations should not place the operators in areas above the maximum safe entry points in the applicable plant safety manual/guidance.

4.2.5.1.4 Controls should be located in areas where sustained operation is possible accounting for radiological conditions in the HCVS vent pipe and attached components (instrumentation) within allowed doses per the ERO guidance to the operators for non-heroic actions. These conditions should include estimation of the impact during an ELAP event and following core damage required vent operations.

4.2.5.1.5 The HCVS vent pipe routing and shielding must be considered for other actions required of the plant staff/ERO during the event should venting be required during severe accident conditions. Guidance for the allowable dose fields/dose during required actions with the source term in the HCVS vent pipe would be the limits prescribed in the ERO guidance. (HCVS-WP-02)

Note: Any deviation from the above can be considered provided justification is submitted.

4.2.5.2 The following criteria are acceptable approaches for HCVS operational hazards at local controls/primary and alternate control locations and SAWA control location(s):

4.2.5.2.1 Temperature conditions at the HCVS proposed operating stations and SAWA control location(s) meet plant safety manual/guidance or justification is provided to the Staff.

4.2.5.2.2 Radiological conditions at the HCVS proposed operating stations and SAWA control location(s) meets ERO allowable dose guidance or justification is provided.

4.2.5.2.3 Other plant actions required by the plant staff/ERO should account for the expected radiological conditions caused by HCVS vent pipe routing with severe accident source term release through the HCVS vent pipe. The expected limits imposed on the dose/dose field from the ERO guidance should be used for these actions.

4.2.5.3 Meeting design features and the above criteria will show compliance with HCVS operational hazards at Primary Controls and Local/Alternate Valve Control Locations and SAWA control locations.

4.2.6 Designed to minimize Operator Actions

HCVS and SAWA systems should be designed to maximize the probability of successful operator action to operate vents when required and to line up the SAWA flow path.

Order Reference: 1.1.1 - The HCVS shall be designed to minimize the reliance on operator actions.

4.2.6.1 Design features consistent with this approach include:

4.2.6.1.1 Environmental considerations

4.2.6.1.1.1 Heat stress impact on ability to vent and line up the SAWA flow path

4.2.6.1.1.2 Radiological condition impact on ability to vent and line up the SAWA flow path. (HCVS-FAQ-07, HCVS-WP-02, HCVS-FAQ-09)

4.2.6.1.2 Sustained operational capability (HCVS-FAQ-02)

4.2.6.1.2.1 Independent 24 hour electrical and pneumatic supplies. (HCVS-WP-01)

4.2.6.1.2.2 The system will be capable of multiple valve cycles during the first 24 hour period without the need to recharge pneumatic or electrical power supplies. (HCVS-WP-02)

4.2.6.1.2.3 SAWA Sustained operational capability of the SAWA flow path is limited to no greater than the first 7 day period until ERO actions govern. Neither section 4.2.6.1.2.1 nor 4.2.6.1.2.2 applies to SAWA.

4.2.6.1.3 Ease of vent valve operation

4.2.6.1.3.1 Readily accessible under all operational conditions (e.g., accessible location without need for ladders or scaffolds)

4.2.6.1.3.2 Operation achievable at a localized location.

4.2.6.1.3.3 Operation does not require the use of jumpers or lifted leads to defeat valve interlocks.

4.2.6.1.3.4 System comprised of installed equipment. No need for system or component disassembly/reassembly.

4.2.6.1.3.5 Section 4.2.6.1.3.1 and 4.2.6.1.3.2 are applicable to SAWA except that the SAWA system will be a combination of installed and portable equipment.

4.2.6.1.3.5.1 The portable equipment connection will utilize engineered connection points such that SAWA functionality can be readily accomplished under the expected accident conditions present at that location at the time of connection, such as elevated humidity, temperature and radiation.

4.2.6.2 The following criteria are acceptable approaches for HCVS and SAWA to minimize operator actions that could prevent vent operations or establish a SAWA flow path when required:

4.2.6.2.1 Compliance with other sections of this guidance as listed above.

4.2.6.3 Meeting design features and the above criteria will show compliance with HCVS and SAWA to minimize operator actions that could prevent vent and SAWA operations when required.

5. PROGRAMMATIC CONTROLS

5.1. Environmental Conditions

The HVCS and SAWA systems are required to be capable of functioning during severe accidents in which the containment function is otherwise not compromised by the severe accident conditions. The HCVS and SAWA equipment is designed to provide reasonable assurance of operation in the severe accident environment for which it is intended to function and over the time span for which it is needed. However, the environmental requirements of 10CFR50.49 are design basis regulatory requirements and as such are not applicable under severe accident conditions.

Order Reference: 1.2.10 – The HCVS shall be designed consistent with containment pressures and temperatures during severe accident conditions as well as dynamic loading resulting from system actuation. The design is not required to exceed the current capability of the limiting containment components.

5.1.1. The resultant design conditions for the HCVS and SAWA equipment to provide reasonable protection to assure functionality may be different for the wetwell vent and/or the drywell vent, thus the following environmental conditions should be considered in the design of the system:

5.1.1.1. The limiting wetwell conditions are assumed to be 350°F and design pressure or PCPL as defined in Table 2-1 in Section 2 based on the saturation temperature at the drywell failure pressure.

5.1.1.2. The drywell conditions are assumed to be 545°F and design pressure or PCPL as defined in Table 2-1 in Section 2 corresponding to the temperature and pressure at which the drywell head may exhibit some leakage. Although some range of temperatures above this may be encountered due to stratification in areas of the drywell, the HCVS equipment should be designed using a temperature of 545°F consistent with the boundary conditions as detailed in Section 2 of this document.

5.1.1.3. Drywell radiological conditions should be consistent with the conditions assumed in the plant's current licensing basis (CLB) for a major accident. (i.e., the most severe design basis accident during or following which the equipment is required to remain functional, including the radiation resulting from recirculating fluids for equipment located near the recirculating lines and including dose-rate effects.)

5.1.1.3.1. Such accidents have generally been assumed to result in substantial meltdown of the core with subsequent release of appreciable quantities of fission products (e.g., Technical Information

Document (TID) 14844, “Calculation of Distance Factors for Power and Test Reactor Sites (March 1962),” or NUREG-1465, “Accident Source Terms for Light-Water Nuclear Power Plants” consistent with the current design basis of the plant.) Refer to Appendix G for further details.

5.1.1.3.2. With the exception of the HCVS design boundary conditions specified in Section 2, Table 2-1, the evaluation of HCVS and SAWA functionality should consider the potential conditions resulting from accidental events, whether postulated, hypothesized or otherwise identified, which do not exceed the conditions resulting from any credible accident as identified in the plant’s CLB.

5.1.1.4. If the drywell vent and wetwell vent are interconnected, interaction between the two vent flow paths should be considered although only one flow path is required to be operated at any one time.

5.1.1.5. Environmental effects of the areas traversed by the HCVS and SAWA systems should be considered in both standby and operating conditions.

5.1.1.6. Tornado and wind loading and missile impacts are required to be considered for portions of the HCVS and SAWA systems. (HCVS-FAQ-04)

5.1.1.6.1. Current design of the structure is acceptable regarding wind and missile protection for portions of the HCVS enclosed within a seismic category 1 (or equivalent) building/enclosure or through the plants existing elevated release point (e.g., meteorological stack). The release point is not applicable to SAWA.

5.1.1.6.2. Reasonable protection evaluations per the guidance in NEI 12-06 as endorsed by JLD-ISG-12-01 for Order EA-12-049 should be performed for portions of the HCVS and SAWA not covered in 5.1.1.6.1 above.

5.1.1.7. The HCVS and SAWA systems should be designed to provide reasonable assurance of operation for up to 7 days consistent with the Sustained Operation definition.

5.1.2. The SAWA addition point may be subject to the expected severe accident environmental conditions. The operating locations of the SAWA equipment are also subject to expected environmental conditions as described in EA-12-049/NEI-12-06 conditions. Appendix

I provides additional details and requirements for SAWA environmental conditions.

5.1.2.1. Operation of components in locations subject to severe accident conditions is acceptable provided these actions are evaluated and determined reasonable to accomplish without heroic action (HCVS-WP-02, Appendix F and Appendix G). Examples of actions that may be determined acceptable include:

- Connection of hoses with quick disconnect fittings
- Positioning electrical disconnect switches
- Positioning quick acting manual valves (e.g., quarter turn ball valves)

5.1.2.2. The acceptability of operator actions in areas subject to severe accident conditions will be determined by the expected dose rates, temperatures and length of time needed to perform the action. Consideration should be given to the radiological, temperature and humidity conditions that may exist at the time the action is needed and the possibility that subsequent action may be needed (e.g., actions to monitor or replenish pneumatic, electrical power or fuel supplies). Subsequent equipment failures would be addressed by ERO actions and are not assumed within the Sustained Operation time frame.

5.2. Seismic and External Hazard Conditions

Order Reference: 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. These items include piping, piping supports, containment isolation valves, containment isolation valve actuators and containment isolation valve position indication components.

Order Reference: 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.

5.2.1. HCVS and SAWA components including instrumentation should be designed, as a minimum, to meet the seismic design requirements of the plant.

5.2.2. HCVS and SAWA components including instrumentation that are not required to be seismically designed by the design basis of the plant should be designed for reliable and rugged performance that is capable of ensuring HCVS functionality following a seismic event.

(Reference ISG-JLD-2012-01 and ISG-JLD-2012-03 [Ref. 22] for seismic details.)

5.2.3. HCVS and SAWA components including instrumentation external to a seismic category 1 (or equivalent) building or enclosure should be designed to meet the external hazards that screen in for the plant as defined in guidance NEI 12-06 as endorsed by JLD-ISG-12-01 for Order EA-12-049.

5.2.4. Equipment used to support SAWA is comprised of a permanent connection point and mitigation strategies equipment. In addition to the guidance above, the following guidance applies:

5.2.4.1. The connection point should be designed consistent with the design basis of the plant for the system it is connected to (e.g., Residual Heat Removal), up to the first valve that isolates the plant system from the SAWA connected piping.

5.2.4.2. The SAWA piping system beyond the first valve that isolates the plant system from the SAWA piping should be designed for reliable and rugged performance that is capable of ensuring SAWA functionality following a seismic event.

5.2.4.3. Portable equipment supporting both a FLEX function and a SAWA function should meet the seismic requirements of both Orders EA-12-049 and EA-13-109.

5.2.4.4. Portable equipment supporting a SAWA function only should be designed for reliable and rugged performance that is capable of ensuring SAWA functionality following a seismic event.

5.3. Quality Requirements

Order Reference: 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. These items include piping, piping supports, containment isolation valves, containment isolation valve actuators and containment isolation valve position indication components.

Order Reference: 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.

5.3.1. HCVS components including instrumentation should, as minimum, meet the quality design requirements of the plant, ensuring HCVS functionality.

5.3.1.1. The HCVS up to and including the second isolation valve is designed to the same quality requirements of the connected system up to the first isolation valve.

5.3.1.2. HCVS elements that are not covered by 5.3.1.1 should be reliable and rugged to ensure HCVS functionality following a seismic event.

5.3.1.3. Additionally, HCVS equipment installed to meet the requirements of Order EA-13-109 must be implemented so that it does not degrade the existing safety-related systems.

5.3.2. SAWA components including instrumentation should, as minimum, meet the quality design requirements of the plant, ensuring SAWA functionality.

5.3.2.1. The connection point is designed to the same quality requirements of the connected system up to the first isolation valve.

5.3.2.2. The SAWA piping system beyond the first valve that isolates the plant system from the SAWA piping should meet the quality requirements of Order EA-13-109.

5.3.2.3. Portable equipment supporting both a FLEX function and a SAWA function should meet the limiting quality requirements of Order EA-12-049 and EA-13-109.

5.3.2.4. Portable equipment supporting a SAWA function only should meet the quality requirements of Order EA-13-109.

5.3.2.5. Additionally, SAWA non-safety, permanently installed equipment and piping systems must be installed to meet the requirements of Order EA-13-109 and must be installed so that they do not degrade any existing safety-related systems.

5.3.3. Design quality requirements and supporting analysis documentation should be auditable, consistent with generally accepted engineering principles and practices, and controlled within the configuration document control system

5.4. Maintenance Requirements

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

5.4.1. HCVS and SAWA equipment should be initially tested or other reasonable means used to verify performance conforms to the design and operational requirements.

5.4.2. Validation of source manufacturer quality is not required.

5.4.3. The HCVS and SAWA maintenance program should ensure that the HCVS and SAWA equipment reliability is being achieved in a manner similar to that required for FLEX equipment. Standard industry templates (e.g., EPRI) and associated bases may be developed to define specific maintenance and testing.

5.4.3.1. Periodic testing and frequency should be determined based on equipment type and expected use (further details are provided in Section 6 of this document).

5.4.3.2. Testing should be done to verify design requirements and/or basis. The basis should be documented and deviations from vendor recommendations and applicable standards should be justified.

5.4.3.3. Preventive maintenance should be determined based on equipment type and expected use. The basis should be documented and deviations from vendor recommendations and applicable standards should be justified.

5.4.3.4. Existing work control processes may be used to control maintenance and testing.

5.4.4. HCVS and SAWA permanently installed equipment should be maintained in a manner that is consistent with assuring that it performs its function when required.

5.4.4.1. HCVS and SAWA permanently installed equipment should be subject to maintenance and testing guidance provided to verify proper function.

5.4.5. HCVS and SAWA non-installed equipment should be maintained in a manner that is consistent with assuring that it does not degrade over long periods of storage and that it is accessible for periodic maintenance and testing.

5.4.6. HCVS and SAWA non-installed equipment should be stored in a manner consistent with the requirements imposed by EA-12-049/NEI-12-06. If the storage location is located within 100 feet of the HCVS vent pipe, the storage location should be evaluated for accessibility under severe accident conditions. (HCVS-WP-02, HCVS-FAQ-04 and HCVS-FAQ-09)

6. OPERATIONAL CONSIDERATIONS

6.1. Operator Actions

During the extended loss of AC power condition at the Fukushima Dai-ichi units, operators faced many challenges while attempting to restore adequate core cooling in addition to complications associated with controlling containment pressure via the containment venting system. The difficulties faced by the operators related to operation of the containment venting system included the location of their vent valves, ambient temperatures and radiological conditions, loss of all alternating current electrical power, loss of motive force to open the vent valves, and exhausting DC battery power. The use of a hardened containment vent provides an important method of containment heat removal which can become necessary for an ELAP/loss of Ultimate Heat Sink (UHS) event. Indirectly, an elevated containment pressure may prevent the injection from a low head water supply to the RPV. Operator actions are a vital part of normal and off-normal plant activities and are expected to play an important role in mitigation of beyond design basis external events. It is fully recognized that operator actions will be needed to implement the EA-13-109 severe accident capable HCVS; however, the licensees should consider design features for the system that will minimize the need and reliance on operator actions to the extent possible during a variety of plant conditions, as further discussed in this guidance. Actions should be simple and easily accomplished with direct feedback to indicate when the action is successfully accomplished.

The HCVS should be designed to be operated from a control panel located in the main control room or a remote but readily accessible location. The HCVS should be designed to be fully functional and self-sufficient with permanently installed equipment in the plant, without the need for portable equipment or connecting thereto, until such time that on-site or off-site personnel and portable equipment become available. At least one method of operation of the HCVS should be capable of operating with permanently installed equipment for at least 24 hours during the extended loss of AC power. The system should be designed to function in this mode with permanently installed equipment providing electrical power (e.g., DC power batteries or electrical or pneumatic operation) valve motive force (e.g., N_2/air cylinders). The HCVS operation in this mode depends on a variety of conditions, such as the cause for the extended loss of AC power (e.g., seismic event, flood, tornado, high winds), severity of the event, and time required for additional help to reach the plant, move portable equipment into place, and make connections to the HCVS. The HCVS system should be designed to function in this mode for a minimum duration of 24 hours with no operator actions required or credited to replenish electrical power and pneumatic supplies. Operator action is expected to perform system alignment and monitoring functions from either the primary (1.2.4) or alternate (1.2.5) locations as needed for event mitigation. To ensure continued operation of the HCVS beyond 24 hours, licensees may credit manual actions, such as moving portable equipment to supplement electrical power and valve motive power sources.

For the period of sustained operation beyond the initial 24 hours after event initiation, the licensee should consider the number and complexity of actions and the cumulative demand on personnel resources that are needed to maintain hardened vent functionality as a result of design limitations. The use of supplemental portable power or pneumatic sources may be acceptable if the supplemental power or pneumatic source is readily available, could be quickly and easily moved into place, and installed through the use of pre-engineered quick disconnects, and the necessary human actions were identified along with the time needed to complete those actions. Conversely, supplemental power sources that require a qualified electrician or mechanic to temporarily wire into the panel or connect to a piping system would not be considered acceptable because its installation requires a series of complex, time-consuming actions in order to achieve a successful outcome.

SAWA will require operator actions. Connection of SAWA portable equipment will be subject to the requirements applicable to NEI 12-06 equipment with the additional requirement that it may be connected under severe accident conditions. The time frame for connection of SAWA equipment is based on loss of permanent plant injection systems. SAWA system connections and operator actions should be achievable without heroic action (HCVS-FAQ-09) when performed under the severe accident conditions defined by Order EA-13-109 (both for deployment and continuing operations).

Note that Order Element 1.2.6 requires that the HCVS be able to operate for 24 hours without the use of portable equipment. This Order Element does not apply to SAWA portable equipment since it is not necessary to support the installed HCVS function. Instrumentation needed to support SAWA or SAWM is normally powered by Safety Related power sources that are expected to be repowered by FLEX portable equipment and procedures such that functionality is continuously maintained. The difference between FLEX and SAWA/SAWM is that the capability must be demonstrated to power the instruments under severe accident conditions. Additional details concerning SAWA and SAWM instrumentation are contained in Sections 4, 5 and Appendices C and I.

6.1.1. Feasibility and Accessibility

During an extended loss of AC power, the drywell, wetwell (torus or suppression pool), and nearby areas in the plant where HCVS and select SAWA components including instrumentation are expected to be located will likely experience elevated temperatures due to inadequate containment cooling combined with loss of normal and emergency building ventilation systems. In addition, installed normal and emergency lighting in the plant may not be available. Licensees should take into consideration plant conditions expected to be experienced during applicable beyond design basis external events when locating valves, instrument air supplies, and other components including instrumentation that will be required to safely operate the HCVS and SAWA systems. Components required for manual operation should be placed in areas that are readily accessible to plant operators, and not require additional actions, such as the installation of ladders or temporary scaffolding, to operate the system. (HCVS-WP-01, HCVS-FAQ-02)

6.1.1.1. The design strategy should evaluate potential plant conditions and use acquired knowledge of these areas to provide input to system operating procedures, training, the choice of protective clothing, required tools and equipment, and portable lighting. The evaluation should include considerations such as, how temperatures would elevate due to extended loss of AC power conditions and the lighting that would be available following beyond design basis external events. Use of handheld or portable lighting is acceptable.

6.1.1.2. The design of the HCVS and SAWA systems should account for radiological conditions resulting from the beyond design basis external event including dominant severe accident impacts. During the Fukushima event, personnel actions to manually operate the containment vent valves were impeded due to the location of the valves in the torus (suppression pool) rooms. The HCVS should be designed to be placed in operation by operator actions at a control panel, located in the main control room or in a suitable alternate location (Requirements 1.2.4 and 1.2.5). The design of the severe accident capable HCVS and SAWA systems will take into account the radiological conditions that may be encountered during system operation. The use of shielding and locating components having significant source term away from system control stations where the system will be operated are the primary means available to control operational dose. Additional means of minimizing potential radiological dose to the operators may include, but are not limited to: (HCVS-FAQ-07, HCVS-FAQ-09, HCVS-WP-02)

6.1.1.2.1. Simplification of operator actions needed to initiate, control and isolate the system including replenishment of electrical power and pneumatics during the sustained operational period.

6.1.1.2.2. Use of rupture diaphragms are an acceptable component to address inadvertent actuation and leakage, but require operator action to initiate venting at lower pressures than the rupture diaphragm setting. Thus the ability to open the vent path by reasonable operator actions must be addressed if rupture diaphragms are installed in the HCVS (not applicable to SAWA).

6.1.1.2.3. Minimizing the time operators need to spend at the vent controls or HCVS or SAWA monitoring locations during system operation under severe accident conditions.

6.1.1.2.4. Minimizing the number of operators needed to operate and maintain the systems functional under severe accident conditions.

6.1.1.2.5. Rotate operators through the various venting and SAWA actions to minimize the dose received by any one operator.

6.1.1.3. In response to Generic Letter (GL) 89-16, a number of facilities with Mark I containments installed vent valves in the torus (suppression pool) room, near the drywell, or both. Licensees may continue to use these venting locations or select new locations, provided that the requirements of this guidance document are satisfied.

6.1.1.4. The HCVS and SAWA improve the chances of mitigating a core damage accident by removing heat from containment and lowering containment pressure. Radiological and thermal impacts to the plant from the HCVS within the plant and at the location of the external release could impact the event response from on-site operators and off-site help arriving at the plant. An adequate strategy to minimize radiological consequences that could impede personnel actions should include the following: (HCVS-FAQ-07, HCVS-FAQ-09, HCVS-WP-02)

6.1.1.4.1. Provide permanent radiation shielding where necessary to connect and operate HCVS and SAWA equipment and to facilitate personnel access to valve controls that allow manual operation of the valves at a remote manual location. Other alternatives to facilitate personnel access besides radiation shielding can be utilized, such as:

6.1.1.4.1.1. Provide features to facilitate manual operation of valves or SAWA equipment from remote locations, as discussed further in this guidance.

6.1.1.4.1.2. Locate the vent valves or SAWA equipment in areas that are significantly less challenging to operator access/actions.

6.1.1.5. In accordance with Requirement 1.2.10 and 1.2.11, the HCVS and SAWA should be designed for pressures that are consistent with the higher of the primary containment design pressure and the primary containment pressure limit (PCPL), for specification purposes, as well as including dynamic loading resulting from system actuation and, for the HCVS, hydrogen deflagration and detonation if the gases passing through the system cannot be maintained below flammability limits. The capacity for venting should be based on the lower pressure value because the flow characteristics are more limiting at the lower pressure. In addition, the HCVS and SAWA systems should minimize leakage. As such, ventilation duct work (i.e., sheet metal) should not be utilized in the design of the HCVS. Licensees should perform appropriate testing, such as hydrostatic or pneumatic testing, to establish the leak-tightness of the HCVS. HCVS system actuation should consider the dynamics of the driving force for the venting such as the pressure fluctuations from SRV actuations, etc.

6.1.1.6. The HCVS release to outside atmosphere should be at an elevation higher than adjacent power block plant structures. Release through existing plant metrological stacks is considered acceptable, provided the guidance under Requirements 1.2.3 and 1.2.11 are satisfied. If the release from HCVS is through a vent stack different than the plant metrological stack, the elevation of the stack should be higher than the nearest power block building or structure. The routing should be such that radiological conditions resulting from operation of the HCVS would allow event response by the on-site operators and off-site help arriving at the plant without requiring heroic actions. (HCVS-FAQ-04)

6.1.1.7. The required Operator actions to operate the HCVS and SAWA under the design conditions required by Order items 1.1.2 and 1.1.3 at the plant specified operating locations need to be evaluated. (HCVS-WP-02)

6.1.1.7.1. The operations should be feasible for the control locations for conducting the operations under the beyond design basis external event conditions. These expected conditions can be obtained from available generic or plant-specific accident analysis.

6.1.1.7.2. The timing of the operations should be taken into consideration (e.g., operation of the equipment during the worst source term release is not required if the operating location could be accessed prior to the release and after the release for control of radiological dose) for this accessibility/feasibility evaluation. (HCVS-FAQ-07, HCVS-FAQ-09, HCVS-WP-02)

6.1.1.7.3. Guidance is supplied in Appendix D, F, E and G of this guide for this evaluation. Elements of the evaluations can utilize NUREG 1921/1852 [Ref. 23 and 24] guidance and/or procedural controls.

6.1.1.7.4 Operator actions needed to supply motive force to SAWA components, including instrumentation, within the first 24 hours from start of the ELAP event will be validated using the process and documentation requirements developed by NEI for validating FLEX strategies (Reference 37).

6.1.1.7.4.1 Time Sensitive Actions (TSAs) for the purpose of SAWA are those actions needed to transport, connect and start portable equipment needed to provide SAWA flow or provide power to SAWA components in the flow path between the connection point and the RPV or drywell. Actions needed to establish power to SAWA instrumentation should also be included as TSAs.

6.1.1.7.4.2 Equipment monitoring and routine maintenance functions, including motive force replenishment, do not need to be included as TSA provided that a plan for replenishing electric/pneumatic power supplies is established that is implementable under severe accident conditions and with the staffing available.

6.1.1.7.4.3 Level A validation will be used for all TSAs within the first 24 hours of the ELAP event, however, additional staffing may be considered available beyond six hours consistent with NEI 12-01.

6.1.1.8. Environmental conditions and effects on operators need to be considered during event response and Sustained Operation timelines.

6.1.2. Procedural Guidance

6.1.2.1. Procedures to operate, test, and maintain the severe accident capable HCVS and SAWA systems during ELAP conditions should include the following elements:

6.1.2.1.1. System operation including system startup, shutdown and off-normal conditions.

6.1.2.1.2. System standby status verification.

6.1.2.1.3. System out of service controls.

6.1.2.1.4. Location of system components and equipment lineups (may be part of other plant system procedures).

6.1.2.1.5. Instrumentation available that supports HCVS and SAWA operation.

6.1.2.1.6. Directions for Sustained Operation using portable equipment and supplies, which supports HCVS and SAWA operation.

6.1.2.1.7. Storage location of portable equipment.

6.1.2.1.8. Equipment testing and maintenance.

6.1.2.1.9. CAP is credited by some (typically earlier) plants to meet RG 1.1 in a LOCA. Specifically CAP in a LOCA is credited to ensure that the ECCS pumps have adequate NPSH. LOCA is a DBE. If applicable, the nexus between containment accident pressure (CAP) and the ECCS and containment heat removal pump net positive suction head during a design basis LOCA (DBLOCA) and how an inadvertent opening of the vent valve could have an adverse impact on the operation of those pumps. For an ELAP event a LOCA is not considered and ECCS pumps are not available. The HCVS design should ensure that inadvertent opening of the vent path in a DBE is not credible. The procedures should also address the precautions that should be taken to assure adequate net positive suction head before restarting those pumps upon restoration of onsite or offsite power during an ELAP event. This item is not applicable to SAWA.

6.1.2.2. HCVS and SAWA procedures should be developed and implemented in the same manner as other plant procedures.

6.1.2.3. HCVS and SAWA procedures for operation need to be validated for operator usability/accessibility; and, for HCVS, should address the following functional operations:

6.1.2.3.1. With power on normal power sources. [no ELAP]

6.1.2.3.2. With backup power and from local manual location/alternate remote location during conditions of ELAP/loss of UHS with no core damage for containment heat removal AND containment pressure control (PCPL). [FLEX]

6.1.2.3.3. With backup power and from local manual location/alternate remote location during conditions of ELAP/loss of UHS with core damage and vessel breach for containment heat removal AND containment pressure control (PCPL). [Severe Accident Capable Vent]

6.1.2.4. Coordination with guidance and procedures

The Licensee should verify that the procedures for HCVS and SAWA operation are coordinated with other procedures. The following relationships should be evaluated to address this coordination:

6.1.2.4.1. Coordinate EOPs and SAGs with hardened containment vent operation on normal power sources (no ELAP)

6.1.2.4.2. Coordinate Abnormal Operating Procedures (AOPs), EOPs, SAGs and FLEX Support Guidelines (FSGs) with hardened containment vent operation on normal and backup power and from primary and alternate locations during conditions of ELAP/loss of UHS with no core damage. System use is for containment heat removal AND containment pressure control

6.1.2.4.3. Coordinate SAGs with HCVS operation on normal and backup power and from primary and alternate locations during conditions of ELAP/loss of UHS with core damage and vessel breach. System use is for containment heat removal AND containment pressure control (PCPL) with potential for combustible gases.

6.1.2.4.4. Coordinate administrative controls for FLEX, HCVS and SAWA equipment allowed outage times and compensatory actions.

6.1.2.5. Demonstration with other Post Fukushima measures

The Licensee should demonstrate use in drills, tabletops, or exercises for HCVS and SAWA operation as follows:

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

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

6.1.2.5.3. HCVS operation on backup power and from primary or alternate location during conditions of ELAP/loss of UHS with core damage. System use is for containment heat removal AND containment pressure control with potential for combustible gases (Demonstration may be in conjunction with SAG change).

6.1.3. Training

HCVS training should include use of the vent for both mitigating strategies (FLEX) and conditions where core damage is assumed. Only for the conditions where core damage is assumed and other methods of core cooling are unavailable is SAWA a required element of HCVS training scenarios.

6.1.3.1. All personnel expected to operate the HVCS and SAWA should receive initial and continuing training in the use of plant procedures developed for system operations when either normal or backup power is available and during ELAP/loss of UHS conditions consistent with the specific elements of the plant's training program.

6.1.3.2. The training should be refreshed on a periodic basis consistent with the procedure control process at the plant site or when procedural related changes occur to the HCVS.

6.1.3.3. Training should also ensure that specific guidance and procedures that direct HCVS and SAWA operation is referenced and used in formulation of the training (e.g., EOPs, FSGs, SAGs,).

6.1.3.4. When determining the required HCVS and SAWA training a “task analysis” or similar site acceptable process should be used.

6.1.3.5. Training for use of any FLEX equipment in a support role will be governed by the actions developed for compliance with order EA-12-049.

6.1.3.6. The use of a Systematic Approach to Training (SAT) based training program to determine required training and frequency may be used to demonstrate compliance with the training requirements of Order EA-13-109 in lieu of the specific elements defined in 6.1.3.1 through 6.1.3.4.

6.2. Testing and Inspection of HCVS and SAWA. (HCVS-FAQ-05)

6.2.1. The HCVS and SAWA installed equipment design should provide a means (e.g., drain valves, pressure and temperature gauge connections) to periodically test system components including instrumentation, including exercising (opening and closing) the vent valve(s). Testing per EA-12-049 provides compliance with this element for SAWA portable components.

6.2.2. Primary and secondary containment required leakage testing is covered under existing design basis testing programs. (HCVS-FAQ-06, generic assumption 049-13)

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

6.2.3.1. The testing method can either individually leak test interfacing valves or test the overall leakage of the HCVS volume by conventional leak rate testing methods.

6.2.3.2. The test volume should envelope the HCVS between the outer primary containment isolation barrier and the last isolation point from the plant buildings, including the volume up to the interfacing valves.

6.2.3.3. The test pressure should be based on the HCVS design pressure. Methods for testing system boundary leakage should be consistent with the licensee’s design basis for these tests (e.g., permissible leakage rates for the interfacing valves should be within the requirements of American Society of Mechanical Engineers Operation and Maintenance of Nuclear Power Plants Code (ASME OM) – 2009, Subsection ISTC – 3630 (e) (2) [Ref. 25], or later edition of the ASME OM Code.) (HCVS-FAQ-05)

6.2.3.4. When testing the HCVS volume, allowed leakage should not exceed the sum of the interfacing valve leakages as determined by the licensee's test program (e.g., ASME OM Code).

6.2.3.5. For HCVS designs that contain interfacing valves between the HCVS and an isolated system, i.e. systems that do not vent to atmosphere. An assessment of the impact of cumulative leakage past interfacing valves into an isolated system should be performed. The results of the assessment should be used in establishing the leakage limits for interfacing valves between the HCVS and the isolated system(s).

6.2.3.5.1 When interfacing components including instrumentation are found to be degraded such that the HCVS function cannot be assured, then an entry into the plants Corrective Action Program shall be made to address the cause(s) of the non-functionality of the HCVS and prevent recurrence.

6.2.4. Licensees should implement the following operation, testing and inspection requirements for the HCVS and SAWA to ensure reliable operation of the systems. If the valves listed in the following table are portions of safety related systems other than HCVS, then the operation, testing and inspection requirements of that system may be adequate for compliance with order EA-13-109 requirements.

Testing and Inspection Requirements

Description	Frequency
Cycle the HCVS and installed SAWA valves[1] and the interfacing system boundary valves not used to maintain containment integrity during Mode 1, 2 and 3. For HCVS valves, this test may be performed concurrently with the control logic test described below.	Once per every[2] operating cycle
Cycle the HCVS 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

[1] Not required for HCVS and SAWA check valves.
[2] After two consecutive successful performances, the test frequency may be reduced to a maximum of once per every other operating cycle.
[3] Not required if integrity of check function (open and closed) is demonstrated by other plant testing requirements.
[4] After two consecutive successful performances, the test frequency may be reduced by one operating cycle to a maximum of once per every fourth operating cycle.

Description	Frequency
Leak test the HCVS (as described in Section 6.2.2 and 6.2.3).	(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 buildings.
Validate the HCVS operating procedures by conducting an open/close test of the HCVS control function from its control location and ensuring that all HCVS vent path and interfacing system boundary valves[5] move to their proper (intended) positions.	Once per every other operating cycle

6.3. Allowed out of service time for HCVS and SAWA

6.3.1. The unavailability of equipment and applicable connection that directly performs an HCVS or SAWA function should be managed such that HCVS and SAWA functionality is maximized. The primary control and monitoring elements (1.2.4) and alternate valve control elements (1.2.5) of HCVS operation and the control and monitoring elements of SAWA as defined in Appendix I will normally be functional in Modes 1, 2 and 3. However, neither HCVS nor SAWA is a single failure proof system, and as such the primary and alternate methods of HCVS operation or the methods of SAWA operation do not imply system redundancy.

6.3.1.1. If the primary control and monitoring elements <u>or</u> alternate valve control elements of HCVS render operation of the HCVS non-functional, those elements may be out of service for periods of up to 90 consecutive days without any compensatory actions.

6.3.1.2. If the primary control and monitoring elements <u>and</u> alternate valve control elements of HCVS render operation of the HCVS non-functional or non-functional elements of SAWA render SAWA non-functional, those elements may be out of service for periods of up to 30 consecutive days without any compensatory actions.

[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.

6.3.1.3. If the allowed out of service times described in 6.3.1.1 and/or 6.3.1.2 above are exceeded, then through the plant corrective action program determine:

6.3.1.3.1. The cause(s) of the non-functionality,

6.3.1.3.2. The actions to be taken and the schedule for restoring the system to functional status and prevent recurrence,

6.3.1.3.3. Initiate action to implement appropriate compensatory actions, and

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

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

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

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

6.3.5. 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.

7. REPORTING REQUIREMENTS

Licensees shall promptly start implementation of the requirements in Attachment 2 to Order EA-13-109, *Order Modifying Licenses with regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions*, upon NRC issuance of the associated final interim staff guidance (ISG) for each Phase (reference section IV.B of Order EA-13-109). In accordance with NRC Order EA-13-109 the following reporting requirements are established.

7.1. Submittal Guidance

7.1.1. All Licensees shall notify the Commission if they are unable to comply with any of the Phase 1 requirements or if any of the Phase 1 (wetwell vent) requirements would adversely affect the safe and secure operation of the facility within twenty (20) days of the issuance date of the final ISG for Phase 1, The notification shall provide the Licensee's justification for seeking relief from or variation of any specific requirement. Reference EA-13-109 C.1 & 2.

7.1.2. All Licensees shall notify the Commission if they are unable to comply with any of the Phase 2 requirements or if any of the Phase 2 (drywell vent) requirements would adversely affect the safe and secure operation of the facility within twenty (20) days of the issuance date of the final ISG for Phase 2, The notification shall provide the Licensee's justification for seeking relief from or variation of any specific requirement. Reference EA-13-109 C.3 & 4.

7.1.3. All Licensees shall, by June 30, 2014, submit to the Commission for review an Overall Integrated Plan (OIP) including a description of how compliance with the Phase 1 (wetwell vent) requirements will be achieved. Reference EA-13-109 D.1.

7.1.4. All Licensees shall, by December 31, 2015, submit to the Commission for review an updated OIP including a description of how compliance with the Phase 2 (drywell vent) requirements will be achieved. Reference EA-13-109 D.2.

7.1.5. All Licensees shall provide status reports at six (6)-month intervals following submittal of the Phase 1 (wetwell vent) OIP which delineates progress made in implementing the requirements of Order EA-13-109. Reference EA-13-109 D.3.

7.1.5.1. The issuance of the revision to the OIP which includes Phase 2 scope from 7.1.4 can substitute for the six (6)-month status report due on December 31, 2015.

7.1.5.2. The six (6)-month status reports beginning in 2016 shall include both Phase 1 and 2 scope.

7.1.5.3. Once Phase 1 scope is complete the six (6)-month status reports will only update Phase 2 items and leave the Phase

1 items as historical until compliance with both Phase 1 and 2 scope is complete.

7.1.6. All Licensees shall report to the Commission when full compliance with the requirements for Phase 1 and Phase 2 are achieved. Reference EA-13-109 D.4.

7.2. Overall Integrated Plan Template (Appendix K for Phase 1)

The Overall Integrated Plan should include a complete description of the HCVS strategies, including important operational characteristics. The level of detail generally considered adequate is consistent to the level of detail contained in the Licensee's Final Safety Analysis Report (FSAR).

7.2.1. The OIP should provide the following information:

7.2.1.1. Extent to which this guidance, NEI 13-02, is being followed including a description of any alternatives to the guidance

7.2.1.2. A milestone schedule of planned actions

7.2.1.3. Description of the strategies and guidance to be developed to meet the requirements contained in Attachment 2 of the Order

7.2.1.4. Operational characteristics contained in this document, NEI 13-02 are being met.

7.2.1.5. Description of how the design features contained in section 4 of this guide are being met for the appropriate phase

7.2.1.6. Description of major installed and portable components used in the strategies, the applicable reasonable protection for the portable equipment, and the applicable maintenance requirements for the HCVS equipment.

7.2.1.7. Description of major system components including instrumentation, including applicable quality requirements

7.2.1.8. Description of the steps for the development of the necessary procedures, guidance, and training for the HCVS strategies including modifications to meet the requirements contained in this document, NEI 13-02.

7.2.1.9. Conceptual sketches, as necessary to indicate equipment which is installed or equipment hookups necessary for the strategies.

7.2.1.9.1. A preliminary or draft piping and instrumentation diagram (P&ID) or a similar diagram that shows system components including instrumentation and interfaces with plant systems and structures is acceptable piping and instrumentation diagrams should be included in the OIP, while as-built

P&IDs will be available upon completion of plant modifications

7.2.1.9.2. A preliminary or draft electrical/air motive force functional connection sketch should be included in the OIP.

7.2.1.10. Description of how the portable HCVS equipment will be available to be operable during BDBEE and Severe Accident events as defined in this document, NEI 13-02.

7.2.2. Phase 1, wetwell vent OIP shall be submitted by June 30, 2014 that should include a description of how compliance with the “Phase 1” requirements described in Attachment 2 of the Order will be achieved within the required schedule.

7.2.2.1. The Phase 1 OIP should include the items delineated in section 7.2.1 as well as the following items:

7.2.2.1.1. A description of how the design objectives contained in section 2 of this guide, NEI 13-02 are met

7.2.2.1.2. When applicable to a specific Licensee, include details on how this issue will be addressed for all situations when CAP credit is required

7.2.2.2. An industry template is provided that defines the essential information for this submittal (Appendix K).

7.2.3. By December 31, 2015, a revision of the Phase 1 OIP including a description of the approach to the Phase 2 requirements described in Attachment 2 of the Order will be achieved within the required schedule shall be submitted.

7.2.3.1. The Phase 2 OIP revision should address the items delineated in section 7.2.1 as it relates to Phase 2 as well as the following items:

7.2.3.1.1. A description of how the design objectives contained in section 2, Appendix C and/or I (as applicable) of this guide, NEI 13-02 are met.

7.2.3.1.2. When applicable to a specific Licensee, include details on how this issue will be addressed for all situations when CAP credit is required

7.2.3.2. An industry template will be provided that defines the essential information for this submittal (revision).

7.3. Six (6)-Month Updates

7.3.1. The 6-month status submittal should delineate progress made in implementing the requirements of the Order and include the following information

7.3.1.1. An update of the milestone schedule from the OIP

7.3.1.2. A brief summary of the milestones from the OIP completed in the preceding six-month period

7.3.1.3. Changes to the compliance method as stated in the OIP or OIP revision

7.3.1.3.1. Revisions to the OIP detailed implementation details that follow the criteria of NEI 13-02 and comply with the Order requirements need not be submitted to the NRC, but should be documented for inspection after compliance is obtained.

7.3.1.4. Changes to the compliance schedule as required by the Order or revised in other NRC communication on this topic

7.3.1.5. Provide update of any open items from the OIP, Requests for Additional Information or Interim Staff Evaluation.

7.3.2. The 6-month status submittal should not be a revised OIP except for the December 31, 2015 update which could be replaced with the Phase 2 OIP revision submittal.

7.3.3. An industry template is provided that defines the essential information for the 6-month status submittal (Appendix L).

8. REFERENCES

1. USNRC, Order EA-13-109, “Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions,” June 6, 2013 (ADAMS Accession No. ML13143A321).
2. USNRC, Order EA-12-050, “Order Modifying Licenses with Regard to Reliable Hardened Containment Vents,” March 9, 2012 (ADAMS Accession No. ML12054A694).
3. USNRC, SRM SECY-12-0157, “Staff Requirements - SECY-12-0157, ”Consideration Of Additional Requirements For Containment Venting Systems For Boiling Water Reactors With Mark I And Mark II Containments”, March 19, 2013 (ADAMS Accession No. ML13078A017).
4. USNRC, Order EA-12-049, “Order Modifying Licenses with Regard to Requirements For Mitigation Strategies For Beyond-Design-Basis External Events,” March 12, 2012 (ADAMS Accession No. ML12054A735).
5. USNRC, JLD-ISG-2012-02, Revision 0, “Compliance with Order EA-12-050, Reliable Hardened Containment Vents”, Interim Staff Guidance, September 29, 2012 (ADAMS Accession No. ML 12229A475).
6. USNRC – SECY-11-0093, “Near Term Task Force 90 Day Report”, (ADAMS Accession No. ML111861807).
7. USNRC – SRM SECY-11-0124, “Recommended Actions to be taken Without Delay From The Near-Term Task Force Report”, (ADAMS Accession No. ML112911571).
8. USNRC – SRM SECY-11-0137, “Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned”, (ADAMS Accession No. ML113490055).
9. NUREG-1935, State-of-the-Art-Reactor Consequence Analysis (SOARCA) Report (ADAMS Accession No. ML12332A057/ML12332A058)
10. "Mark I Containment Severe Accident Analysis." Prepared for the Mark I Owners Group, Chicago, IL: Chicago Bridge & Iron, NA-CON, April 1987
11. NUREG/CR-2442 U.S. Nuclear Regulatory Commission, Division of Technical Information & Document Control, “Reliability Analysis of Steel Containment Strength”, Grieman, L.G. et al., June 1982.
12. NUREG/CR-5334, “Severe Accident Testing of Electrical Penetration Assemblies”, Clauss, D.B., November 1989
13. NUREG/CR-3234; SAND83-0538, “The Potential for Containment Leak Paths Through Electrical Penetration Assemblies Under Severe Accident Conditions”, Wayne Sebrell, dated July 1983.
14. NUREG/CR-4064, "Structural Response of Large Penetrations and Closures for Containment Vessels Subjected to Loadings Beyond Design Basis," R.F. Kulak et al., February, 1985

15. NUREG/CR-4944, “Containment Penetration Elastomer Seal Leak Rate Tests”, Bridges T.L., July 1987.

16. DE-ACO4-76DP00789, "Performance of Seals and Gaskets Under Severe Accident Conditions," Koenig L., Sandia National Laboratory, pp. 174-180.

17. NUREG/CR-2475, Hydrogen Combustion Characteristics Related to Reactor Accidents (ADAMS Ascension No. ML071700446).

18. NUREG/CR-6524, The Effect of Lateral Venting on Deflagration-to-Detonation Transition in Hydrogen-Air-Steam Mixtures at Various Initial Temperatures (ADAMS Ascension No. ML071650492).

19. General Electric Nuclear Energy Services Information Letter, GE SIL 643, Potential for Radiolytic Gas Detonation, dated June 14, 2002.

20. NEI 12-06 Rev 0, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide (ADAMS Ascension No. 12221A205).

21. USNRC, JLD-ISG-2012-01, Revision 0, “Compliance with Order EA-12-049, Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events”, Interim Staff Guidance, August 29, 2012 (ADAMS Accession No. ML 12229A174).

22. USNRC, JLD-ISG-2012-03, Revision 0, “Compliance with Order EA-12-051, Reliable Spent Fuel Pool Instrumentation”, Interim Staff Guidance, August 29, 2012 (ADAMS Accession No. ML 12221A339).

23. NUREG-1921, EPRI/NRC-RES Fire Human Reliability Analysis Guidelines (ADAMS Ascension No. ML093350494).

24. NUREG-1852, Demonstrating the Feasibility and Reliability of Operator Manual Actions in Response to Fire (ADAMS Ascension No. ML073020676).

25. ASME OM-2009, Operation and Maintenance of Nuclear Power Plants.

26. NUREG/CR-7110, Vol. 1, State-of-the-Art Reactor Consequence Analyses Project, Peach Bottom Integrated Analysis (ADAMS Ascension No. ML120260675).

27. EPRI Technical Report 3002003301, Technical Basis for Severe-Accident Mitigating Strategies.

28. NUREG-2122, Glossary of Risk-Related Terms in Support of Risk-Informed Decision Making (ADAMS Ascension No. ML13311A353).

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30. HCVS-WP-02, Sequences for HCVS Design and Method for Determining Radiological Dose from HCVS Piping .

31. HCVS-WP-03, “Hydrogen/Carbon Monoxide Control Measures.”

32. OECD/MCCI-2005-TR06, OECD MCCI Project Final Report, Feb 28, 2006, M.T. Farmer *et al*. (http://www.ipd.anl.gov/anlpubs/2011/05/69911.pdf).

33. EPRI-1025295, Severe Accident Guidance Technical Basis Report, 2012.

34. EPRI-101869, Severe Accident Guidance Technical Basis Report, 1993.

35. NEI letter from Steven P. Kraft, Senior Technical Advisor of NEI to Jack R. Davis, Director of Japan Lessons-Learned Directorate, Compliance with Phase 2 of NRC Order to Modify the Licenses of Boiling Water Reactors (BWRs) with Mark I and II Containments with Regard to Reliable Hardened Containment Vents Capable of Operation Under Sever Accident Conditions (EA-13-109), dated September 10, 2014 (ADAMS Ascension No. ML14259A186).

36. NRC letter from William M. Dean, Director of the Office of Nuclear Reactor Regulation to Mr. Anthony R. Pietrangelo, Senior Vice President and Chief Nuclear Officer of NEI, response to NEI path forward letter (Reference 35), dated December 10, 2014 (ADAMS Ascension No. ML14343A818).

37. NEI letter from Nicholas X. Pappas, Senior Project Manager of NEI to Industry Administrative Points of Contact, Validation Document for FLEX Strategies, dated July 18, 2014 (expected to become part of NEI 12-06 Rev. 1).

APPENDIX A – GLOSSARY OF TERMS

This glossary provides definitions of key terms used in this guidance document and an acronym listing. The definitions provided in this Appendix are intended for use within the context of this document for implementing Order EA-13-109 requirements and should not be applied to other documents where these are similar terms are used.

A.1 Definitions:

These definitions have been made consistent with other external definitions, to the degree possible, but the definitions herein represent the expressed intent of the terms as used in this guidance.

Active Function: A function that requires mechanical motion or a change of state (e.g., the closing of a valve or relay contacts or the change in state of a transistor

Beyond Design Basis Requirements: Provide reasonable confidence in a flexible operational capability for responding to an unbounded class of event conditions

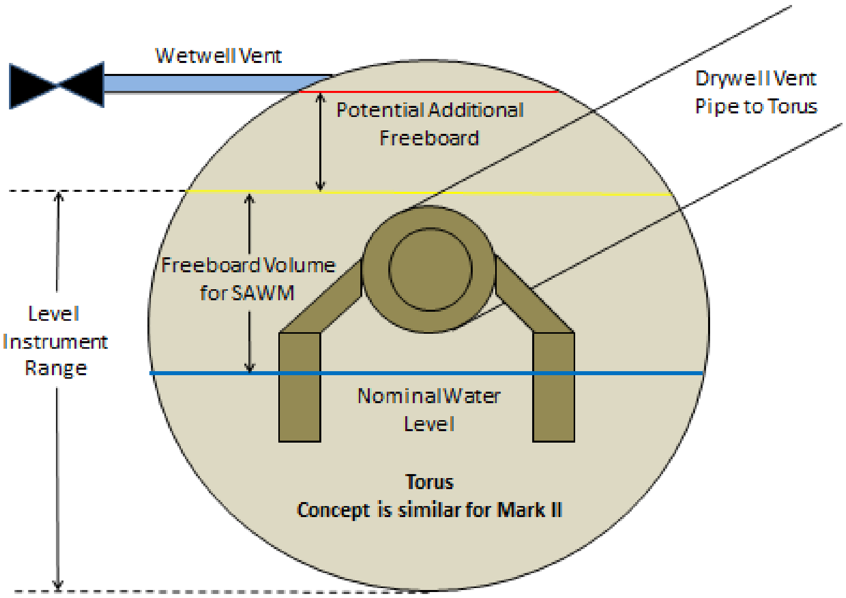
Containment: For the purpose of this guidance, the principal enclosure that acts as a leak-tight barrier, to prevent the release of radioactive material from the structure, system, and component (SSC) containing the radioactive material under DBE conditions.

Current Design Basis Requirements: Provide a high level of assurance of design capability to address a defined set of event conditions

Elevated Release: Release of steam outside the reactor building and other critical buildings necessary for safe shutdown

Explosion Proof: As it relates to instrumentation, means that the housing has been engineered and constructed to contain a flash or explosion. Such housings are usually made of cast aluminum or stainless steel and are of sufficient mass and strength to safely contain an explosion should flammable gases or vapors penetrate the housing and the internal electronics or wiring cause an ignition. The design must prevent any surface temperature of the gases or vapors covered by its Group rating (e.g., Group B: atmospheres containing hydrogen or gases or vapors of equivalent hazard). If the sensing element is a high-temperature device, it may be protected by a flame arrestor to prevent the propagation of high temperature gases to the ambient atmosphere. This classification may apply to installed instruments that have power requirements that are too high to be considered Intrinsically Safe.

Freeboard: Freeboard volume is defined as volume available for water addition that will not result in the loss of the wetwell vent path. This volume may be limited by the wetwell level instrument range or the elevation of the wetwell vent line.



Hardened Containment Vent System (HCVS): A group of physically interconnected components including instrumentation that together perform the specified design function as defined by Order EA-13-109 and this guide.

Hardened Pathway:

- Release of steam, hydrogen or radionuclides at an elevation above the reactor building roof.
- A vent pathway designed to withstand pressures consistent with existing containment design and avoid steam impacts within the Reactor Building.
- A vent pathway designed to withstand PCPL pressures and avoid hydrogen or radionuclide releases or re-entrainment within unacceptable locations such as the Reactor Building or Control Building.
- New venting capability should not change the design basis. The vent capability should be seismically and flooding informed, analogous to risk-informed. The containment function must be protected.

HCVS Stable State: A plant condition, following an EA-13-109 initiating event, in which containment conditions are controllable at or near desired values. This definition is based on the definition of safe stable state defined in NUREG-2122, Glossary of Risk-Related Terms in Support of Risk-Informed Decision making (Reference 28). HCVS Stable State is defined based on the following parameters:

- Drywell Pressure below PCPL and stable or on a predictable trend. Containment pressure is expected to rise and fall with operation of the Wetwell vent.
- Torus (Wetwell) Level below the level required to preserve the Wetwell vent path.
- For the purposes of this Order, stable means that the parameter will remain under control and near its desired value until reliable alternate containment heat removal and pressure control is established.

Intrinsically Safe: An instrument electrical circuit and its wiring will not cause any sparking or arcing and cannot store sufficient energy to ignite a flammable gas or vapor, and cannot produce a surface temperature high enough to cause ignition. Such a design is not Explosion Proof, nor does it need to be. For permanent installations, the instrument may be installed to include “Intrinsically Safe barriers” that are located outside the hazardous location and limit the amount of energy available to the device located in the hazardous area.

Mission Time: The operational or available time a component is required to perform its function. This time may vary by component but the cumulative mission time for credited components including instrumentation performing a required installed plant HCVS equipment function should be no less than the first 24 hours post event. Multiple pieces of equipment may be used to obtain the required time duration, such as two (2) half (1/2) size accumulators to obtain the required 24 hours of installed capacity. When determining HCVS component level mission times, HCVS functionality should be considered and maintained in accordance with the Sustained Operation definition. This also applies to SAWA components supporting the severe accident capable drywell vent or the SAWM alternate venting strategy.

Passive Function: A function that is not an active function (e.g., the pressure-retaining function of a valve, a structural element, pipe support, cable, etc. that is not required to change position in order to perform its design function).

Performance Based: Performance objectives for the design of hardened vents to ensure reliable operation and ease of use (both opening and closing) during a prolonged SBO, ELAP

Primary Containment Pressure Limit (PCPL): The lesser of:

- The pressure capability of the primary containment
- The maximum primary containment pressure at which vent valves sized to reject all decay heat from the containment can be opened and closed
- The maximum primary containment pressure at which SRVs can be opened and will remain open
- The maximum primary containment pressure at which RPV vent valves can be opened and closed

The PCPL is a function of primary containment water level and primary containment temperature.

Public: For the purpose of this guidance, all individuals outside a geographic boundary within which public access is controlled and activities are governed by the operator of a reactor nuclear facility.

Redundant Equipment or System: Equipment or system that duplicates the essential function of another piece of equipment or system to the extent that either may perform the required function regardless of the state of operation or failure of the other.

Regulatory Requirement: For the purpose of this guidance, a requirement stemming directly, or indirectly, from a regulation established by a regulatory agency (e.g., the Code of Federal Regulations (CFR), or an Order or an NRC license condition).

Reliable: Capable of performing its required function in the desired manner under all the relevant conditions and on the occasions or during the time intervals when it is required so to perform. [Source: A.E. Green and A.J. Bourne, Reliability Technology, Wiley-Interscience, 1972.] The vent can be used when needed by procedures, and be usable across a spectrum of events to include both prevention and mitigation of severe core damage

Seismically Reliable and Rugged Performance: A term used to describe the design of components including instrumentation beyond the second containment isolation barrier to ensure that the HCVS is able to remain functional following a design basis seismic event. While the design and construction must meet the plant's design basis earthquake seismic requirements, licensees may use commercial grade components and materials beyond the second containment isolation barrier. Thus, licensees are not required to qualify piping, supports and other related components in accordance with NRC requirements for safety related structures, systems, and components, including Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants," for this portion of the system.

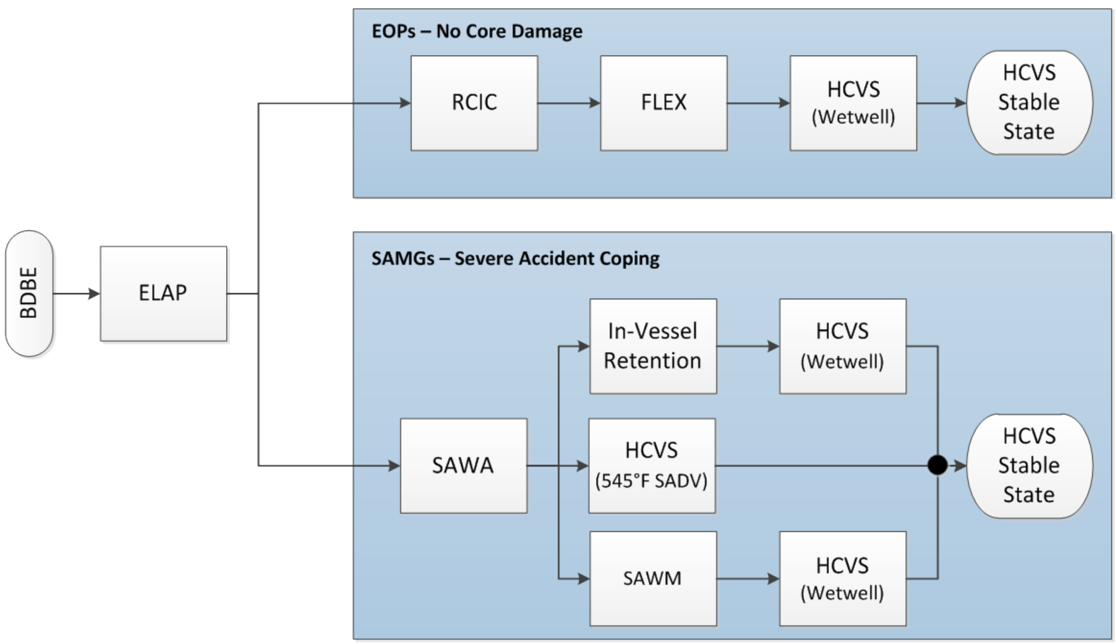
Severe Accident: An accident that involves extensive core damage and fission product release into the reactor vessel and containment with potential release to the environment. Severe accidents include both scenarios in which all core debris is cooled in-vessel (similar to the accident at TMI-2) and scenarios in which core debris breaches the reactor coolant boundary and relocates into containment, with some of the core debris remaining within the reactor vessel.

Severe Accident Coping: Actions that place containment in a HCVS Stable State. Following a Severe Accident, there may be multiple phases of Severe Accident Coping as it relates to Order EA-13-109 including:

- Phase i: Containment pressure control using the HCVS vent. This phase of Severe Accident Coping is limited to controlling containment pressure such that containment capability is maintained.
- Phase ii: Containment pressure control using the HCVS vent and SAWA. This phase of Severe Accident Coping establishes containment protection by maintaining containment pressure and containment temperature such

that containment failure modes due to the effect of molten core debris ex-vessel are minimized (e.g., gross drywell head seal leakage).

- Phase iii: Containment pressure control using the wetwell HCVS, SAWA and SAWM. This phase of Severe Accident Coping preserves the wetwell vent path by seeking to optimize the water addition flow rate (SAWA) with the mass loss rate vented from the wetwell. This phase should result in a HCVS Stable State. This method of Severe Accident Coping is appropriate until a means of reliable Alternate Decay Heat Removal and pressure control is established.
- Note: Severe Accident Coping ends when containment pressure control using alternate containment heat removal is established. To achieve this objective, the alternate containment heat removal method must have sufficient capacity to remove all of the heat input to the containment so that containment pressure can be managed below PCPL without the use of the containment vent.



Severe Accident Water Addition (SAWA): The ability to provide water to the reactor pressure vessel or drywell under Severe Accident conditions. SAWA is predominately hardware related and consists of a water addition path, motive force, instrumentation and control as defined in this guide.

Severe Accident Water Management (SAWM): A strategy to manage SAWA in such a way that the use of the HCVS wetwell vent is preserved as defined in this guide. SAWM is predominately related to procedures and training.

Single Failure: A random failure (e.g., single component failure or operator error) and its consequential effects, in addition to an initiating occurrence, which result in the loss of capability of a component to perform its intended function. Fluid and electrical systems are considered to be designed against an assumed single failure if neither (1) a single failure of any active component (assuming passive components function properly) nor (2) a single failure of any passive component (assuming active components function properly) results in a loss of capability of the system to perform its safety function(s).

Sustained Operation: The ability to operate the HCVS for 7 days or a shorter time if an alternative method of containment heat removal is put in place by using installed or portable equipment (e.g., a means of shutdown cooling aligned directly to the RPV, drywell or a means of suppression pool cooling). Use of the Hardened Containment vent should not be the credited means of containment heat removal after alternate containment heat removal is placed in service, but may be credited while SAWA/SAWM are in service along with the hardened Wetwell vent for long-term accident coping. Note that SAWA/SAWM with the hardened Wetwell vent may be able to maintain a HCVS Stable State for a considerable period of time without the use of alternate containment heat removal. To be considered a successful SAWM strategy that precludes the need for a severe accident capable drywell vent, the strategy must be able to preserve the wetwell vent long enough to:

- Preclude the need for venting from the drywell as a means of containment overpressure protection for at least seven days or
- Until alternate containment heat removal is in place that can maintain containment pressure below PCPL or design pressure, whichever is lower.

Some containment source term control is inherent with the longer term (>7 day or alternate means) containment heat removal function; however, addressing site source term control functionality will be governed by the ERO Recovery actions versus activities associated with NEI 13-02 or Order EA-13-109. This definition does not apply to Order EA-12-049 phase 1, 2, or 3 equipment unless the equipment is repurposed under Order EA-13-109.

A.2 Acronyms and Abbreviations

Acronym	Description
AC	Alternating Current
AOP	Abnormal Operating Procedure
AOV	Air Operated Valve
ASME	American Society of Mechanical Engineers
BDBE	Beyond Design Basis Event
BDBEE	Beyond Design Basis External Event
BWR	Boiling Water Reactor
BWROG	Boiling Water Reactor Owners' Group
CAP	Containment Accident Pressure
CLB	Current License Basis
CPRR	Containment Protection and Release Reduction
DBE	Design Basis Event
DBLOCA	Design Basis Loss of Coolant Accident
DC	Direct Current
DW	Drywell
ECCS	Emergency Core Cooling System
EDMG	Extreme Damage Mitigation Guideline
ELAP	Extended Loss of AC Power
EOP	Emergency Operating Procedure
EPGs	Emergency Procedure Guidelines
EPRI	Electric Power Research Institute
ERO	Emergency Response Organization
FSG	FLEX Support Guideline
GDC	General Design Criteria
GE	General Electric
HCVS	Hardened Containment Vent System
ISG	Interim Staff Guidance
LOCA	Loss of Coolant Accident
LUHS	Loss of Ultimate Heat Sink
MCCI	Molten Corium Concrete Interaction
MOV	Motor Operated Valve
NEI	Nuclear Energy Institute
NRC	Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System
NTTF	Near Term Task Force
OIP	Overall Integrated Plan
P&ID	Piping and Instrumentation Diagram
PCIV	Primary Containment Isolation Valve
PCPL	Primary Containment Pressure Limit
PSP	Pressure Suppression Pressure
RAI	[NRC] Request for Additional Information
RCIC	Reactor Core Isolation Cooling

Acronym	Description
RPV	Reactor Pressure Vessel
SADV	Severe Accident Drywell Vent
SAGs	Severe Accident Guidelines
SAMG	Severe Accident Management Guidelines
SAT	Systematic Approach to Training
SAWA	Severe Accident Water Addition
SAWM	Severe Accident Water Management
SBO	Station Blackout
SER	[NRC] Safety Evaluation Report
SOV	Solenoid Operated Valve
SRV	Safety Relief Valve
TMI	Three Mile Island
TOC	Table of Contents
UFSAR	Updated Final Safety Analysis Report
UHS	Ultimate Heat Sink

APPENDIX B – ROADMAP OF ORDER REQUIREMENTS

The purpose of this appendix is to provide a cross-reference of the requirements contained in the revised Order EA-13-109 against the requirements of the original Order EA-12-050 and identifies where the requirements are addressed in this guidance document.

B.1 Structure of Roadmap

Table B-1 lists each requirement of Order EA-13-109, "Order Modifying Licenses With Regard To Reliable Hardened Containment Vents Capable Of Operation Under Severe Accident Conditions" [Ref. B-1] against the requirements of the original Order [Ref. B-2] and the appropriate section in this document.

B.2 Order EA-13-109 Attachment 2:

Boiling-Water Reactors (BWRs) with Mark I and Mark II containments shall have a reliable, severe accident capable hardened containment venting system (HCVS)[6]. This requirement shall be implemented in two phases. In Phase 1, licensees of BWRs with Mark I and Mark II containments shall design and install a venting system that provides venting capability from the wetwell during severe accident conditions. Severe accident conditions include the elevated temperatures, pressures, radiation levels, and combustible gas concentrations, such as hydrogen and carbon monoxide, associated with accidents involving extensive core damage, including accidents involving a breach of the reactor vessel by molten core debris. In Phase 2, licensees of BWRs with Mark I and Mark II containments shall design and install a venting system that provides venting capability from the drywell under severe accident conditions, or, alternatively, those licensees shall develop and implement a reliable containment venting strategy that makes it unlikely that a licensee would need to vent from the containment drywell during severe accident conditions.

A. PHASE 1 (reliable, severe accident capable wetwell venting system)

The BWRs with Mark I and Mark II containments shall design and install a HCVS, using a vent path from the containment wetwell to remove decay heat, vent the containment atmosphere (including steam, hydrogen, carbon monoxide, non-condensable gases, aerosols, and fission products), and control containment pressure within acceptable limits. The HCVS shall be designed for those accident conditions (before and after core damage) 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 or

[6] Unless otherwise specified in this attachment, HCVS refers to a reliable, severe accident capable hardened containment venting system. The HCVS includes a severe accident capable containment wetwell venting system and may also, depending on the approach taken for Phase 2 include a severe accident capable containment drywell venting system.

extended loss of alternating current (AC) power. The HCVS shall meet the requirements in Sections 1, 2, and 3, below.

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.

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

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

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

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 one (1) percent of licensed/rated thermal power (unless a lower value is justified by analyses), and be able to restore and then maintain containment pressure below the primary containment design pressure and the primary containment pressure limit.

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

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.

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.[7]

1.2.5 The HCVS shall, in addition to meeting the requirements of 1.2.4, be capable of manual operation (e.g., reach-rod with hand wheel or manual operation of pneumatic supply valves from a

[7] For the purposes of these technical requirements, "sustained operations" means until such time that alternate reliable containment heat removal and pressure control is reestablished, independent of the HCVS, (e.g.. suppression pool, torus. or shutdown cooling) using installed or portable equipment.

shielded location), which is accessible to plant operators during sustained operations.

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

1.2.7 The HCVS shall include means to prevent inadvertent actuation.

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

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

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

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.

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.

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.

2. HCVS Quality Standards

The HCVS shall meet the following 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.

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.

3. HCVS Programmatic Requirements

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

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

B. PHASE 2 (reliable, severe accident capable drywell venting system)

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

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

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

1. HCVS Drywell Vent Functional Requirements

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

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

2. Containment Venting Strategy Requirements

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

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

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

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

B.3 References

B.3.1 USNRC, Order EA-13-109, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions," June 6, 2013 (ADAMS Accession No. ML13143A321).

B.3.2 USNRC, Order EA-12-050, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents," March 12, 2012 (ADAMS Accession No. ML12054A696).

Table B-1

Roadmap of Technical Requirements from Revised EA-12-050

EA-13-109 Order Requirement	Changes from EA-12-050	NEI 13-02 Applicable Guidance
HCVS Performance Objectives (Phase I)		
A.1.1.1 - Minimize the reliance on operator actions	No changes	4.2.6, HCVS-FAQ-01
A.1.1.2 - Minimize operators' exposure to occupational hazards	No changes	4.2.5, 6.1.1, Appendix I, HCVS-FAQ-01
A.1.1.3 – Account for radiological conditions that would impede event response	Wording change from "minimize radiological consequences" to "account for radiological consequences"	4.2.5, 6.1.1, Appendix D, F, G and I, HCVS-FAQ-01, 07 and 09, HCVS-WP-02
A.1.1.4 – Accessible controls and indications	New Item, Specified in order item previously in ISG. "The HCVS shall be accessible and functional under a range of plant conditions, including a severe accident environment, extended loss of AC power and inadequate containment cooling"	4.1.3, 4.2.2, 4.2.3, 4.2.4, 4.2.5, 6.1.1, Appendix F, G and I, HCVS-FAQ-01 and 02
HCVS Design Features		
A.1.2.1 - Capacity to vent 1 percent of thermal power	Added, "and the primary containment pressure limit (PCPL)." to end of sentence.	4.1.1
A.1.2.2 - Discharge the effluent to a release point above plant structures	No changes but renumbered (1.2.9 in EA-12-050)	4.1.5, Appendix H, HCVS-FAQ-04
A.1.2.3 - Design features to minimize cross flow	No changes but renumbered (1.2.6 in EA-12-050).	4.1.2, 4.1.4, 4.1.6, HCVS-FAQ-05
A.1.2.4 - Operation from control panel for sustained operations	Similar wording as 1.2.2 in EA-12-050, but included the definition of "sustained operation" in a footnote.	4.2.2, 4.2.4, 4.2.5, 5.1, 6.1, Appendix A and H, HCVS-FAQ-01 and 08

Table B-1

Roadmap of Technical Requirements from Revised EA-12-050

EA-13-109 Order Requirement	Changes from EA-12-050	NEI 13-02 Applicable Guidance
A.1.2.5 – Alternate manual operation capability	New Item, adds additional capability for system operation for defense in depth, not redundancy.	4.2.3, HCVS-FAQ-01, 03, 08 and 09
A.1.2.6 - Operation with permanently installed equipment for 24 hours	New Item, added prior ISG item. "The HCVS shall be capable of operating with dedicated and permanently installed equipment for at least 24 hours following the loss of normal power or loss of normal pneumatic supplies to air operated components during an extended loss of AC power."	2.5, 4.2.2, 4.2.4, 4.2.6, 6.1, Appendix A, HCVS-FAQ-02, HCVS-WP-01 and 02
A.1.2.7 – Prevention of inadvertent actuation	No changes but renumbered (1.2.3 in Order EA-12-050).	4.2.1
A.1.2.8 – Monitoring of vent status from control panel	No substantive changes but renumbered (1.2.4 in Order EA-12-050). Added, "from the control panel installed in accordance with requirement 1.2.4"	4.2.2, HCVS-FAQ-01, 08 and 09
A.1.2.9 - Means to monitor the effluent discharge	No substantive changes but renumbered 1.2.5 in Order EA-12-050). Added, "from the control panel installed in accordance with requirement 1.2.4"	4.2.4, HCVS-FAQ-08 and 09

Table B-1

Roadmap of Technical Requirements from Revised EA-12-050

EA-13-109 Order Requirement	Changes from EA-12-050	NEI 13-02 Applicable Guidance
A.1.2.10 - Design for severe accident & dynamic conditions	Significant changes from 1.2.8 in Order EA-12-050. Added design conditions to account for severe accident service of the HCVS to include temperature, radiation and combustible gas. Design consistent with limiting containment components.	2.3, 2.4, 4.1.1, 5.1, 5.2, Appendix I, HCVS-WP-02
A.1.2.11 - Flammability control	New item related to hydrogen control. "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."	4.1.7, 4.1.7.1, 4.1.7.2, Appendix H, HCVS-WP-03
A.1.2.12 - Designed to minimize hydrogen gas migration	New item related to hydrogen control programs. "The HCVS shall incorporate strategies for hydrogen control that minimizes the potential for hydrogen gas migration and ingress into the reactor building or other buildings.	4.1.6, Appendix H, HCVS-FAQ-05, HCVS-WP-03
A.1.2.13 - Operation, testing, inspection and maintenance	No changes, renumbered (1.2.7 in Order EA-12-050).	5.4, 6.2, HCVS-FAQ-05 and 06

Table B-1

Roadmap of Technical Requirements from Revised EA-12-050

EA-13-109 Order Requirement	Changes from EA-12-050	NEI 13-02 Applicable Guidance
Quality Standards		
A.2.1 – Design basis of containment isolation function	No changes.	5.3
A.2.2 - Reliable and rugged performance	No changes.	5.2, 5.3
Programmatic Requirements		
A.3.1 - Develop, implement, and maintain procedures	No significant changes. Changed prolonged SBO to extended loss of AC power.	6.1.2, 6.1.2.1
A.3.2 - Train appropriate personnel	No significant changes. Changed prolonged SBO to extended loss of AC power.	6.1.3
Drywell Vent Functional Requirements (Phase 2)		
B.1.1 Meet performance objectives, design features, quality requirements, and programmatic requirements	New guidance on Drywell venting.	Sections 2and 3, Appendix A and I, HCVS-FAQ-07 and 09, HCVS-WP-02
B.1.2 Justify confidence drywell vent is not necessary	New guidance on Drywell venting.	Appendix A, C and I, HCVS-FAQ-06, 07 and 09, HCVS-WP-02

APPENDIX C – SEVERE ACCIDENT WATER MANAGEMENT (SAWM)

The purpose of this appendix is to provide a description of the water management aspects of a strategy for complying with the requirements of B.2 of order EA-13-109.

C.1. Introduction

NRC Order EA-13-109 Section B requires Licensees with BWRs with Mark I and Mark II containments to either:

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

(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.

The purpose of this Appendix is to define guidance for implementation of water management for the second method. This guidance must address the following elements of the Order, Section B.2:

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

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

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

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

This Appendix recognizes the insights gained from EPRI Technical Report 3002003301, Technical Basis for Severe-Accident Strategies (Reference 27) that water addition in conjunction with containment venting during severe accident conditions can significantly reduce containment temperatures as shown in Figure 2-2. (SAWA requirements are addressed in Appendix I) Water addition in conjunction with containment venting will also prevent containment failure due to overpressure.

Existing EPG/SAG guidance includes containment flooding under conditions of RPV breach by core debris, SAWM will require SAG changes to support Phase 2 implementation.

C.2. Severe Accident Water Management

Reference 27 shows benefit is gained from water management strategies that retain the use of the wetwell vent and delay or prevent the need for a drywell vent path. The Order requires that, if no hardened drywell vent is provided, the containment venting strategy will make it unlikely that an HCVS drywell vent path is needed before *"alternate reliable containment heat removal and pressure control is reestablished"*. (Section B.2.1 of the Order)

SAWM defines how to use the hardware (Section B.2.3 of the Order and Appendix I) provided by SAWA to extend the use of the wetwell vent path, and will primarily be implemented through procedures and training. Under this water management strategy sufficient water flow must be supplied to reduce thermal challenges to the containment so that the containment capability remains intact, but water flow can be optimized, when appropriate, in order to avoid compromising the wetwell vent path. SAWM Instrumentation requirements will be addressed in this appendix to fulfill the requirements of Section B.2.3 of the Order.

Licensees implementing the SAWM strategy should have guidance that will be used to implement the strategy including required equipment and instrumentation. The guidance should include how operators will know that the functional requirements of SAWM are being achieved through the period of Sustained Operation and should include information such as:

- Expected SAWA flow rates from initiation of SAWA
- Expected Suppression Pool water level response (rate of pool increase based on pool geometry and SAWA flow (e.g., inches per hour)
- Suppression Pool Freeboard
- Minimum permitted flow rate for containment protection. If different from the 100 GPM used for the reference plant analysis. These minimum flow rates will be scaled from a ratio of the plant specific thermal power rating to the reference plant thermal power rating multiplied by 100 GPM.

A discussion of the guidance that will be provided to ensure SAWM functional requirements are being achieved through the period of Sustained Operation should be included in the Phase 2 OIP.

Generic evaluations performed and reported in Reference 27 document the requirement to demonstrate that containment failure as a result of overpressure can be prevented without a drywell vent during severe accident conditions. (Section B.2.2 of the Order)

C.3. Factors in SAWM Success

SAWA flow control and freeboard volume are the primary factors that impact long term use of the wetwell vent path for containment heat removal and pressure control. Due to the relative volume of the Torus (Suppression Pool) and SAWA flow rates, the change in Torus (Suppression Pool) level will be slow moving such that rapid, fine control of SAWA flow rate will not be required.

C.4. SAWA Flow Control

C.4.1. Initial Drywell Water Level

Prior to vessel breach, the initial source of water on the drywell floor comes from a combination of Reactor Recirculation pump seal leakage and condensation caused by containment heat sinks in contact with the steam environment. When present, this water provides an initial quenching mechanism for the core debris as it exits the RPV, if RPV breach occurs after SAWA has been initiated water is expected to follow the core debris from the RPV and provide additional quenching.

C.4.1.1. The maximum water depth will be dependent upon the height at which water flows from the drywell floor into the torus vent pipes (Mark I) or suppression chamber downcomers (Mark II), called "spillover height." This depth ranges between nine inches and approximately 40 inches for the Mark I fleet. The range for the Mark II fleet is from nine inches to 18 inches.

C.4.1.2. If not limited by the spillover height, the depth may be limited by the water accumulation rate versus the time that core debris reaches the drywell floor.

C.4.1.3 The Mark II downcomer arrangement is substantially different from the Mark I configuration because the downcomers provide a pathway for the core debris to drop down into and be quenched by the water in the Suppression Chamber for those plants where the under pedestal floor is at the same elevation as the drywell floor, or for the single example of one Mark II in which there are downcomers on the sunken pedestal floor. The remainder of the Mark II configurations have sunken pedestal floors with no downcomers which will enable water accumulation via the floor drain system piping in the under pedestal area. Since this is the most likely accumulation area for core debris, the configuration is not a limiting condition of or cause for a revision to the SAWA or SAWM strategies.

C.4.2 To implement the SAWM strategy, a means of controlling SAWA flow rate will need to be provided to address the following:

C.4.2.1 The means of controlling the SAWA flow rate (e.g., controlling pump speed or use of a throttle valve).

C.4.2.2 The instrumentation to be utilized to confirm desired flow rate.

C.4.3 SAWM implementing guidance should provide the direction needed to achieve desired SAWA flow rates, including the instrumentation that can be used to confirm the flow rate.

C.5. SAWM Flow Rates

C.5.1. The water management strategy under Phase 2 of Order EA-13-109 is a means to preserve the wetwell vent path by providing sufficient water flow to remove heat generated by the core debris and venting the resultant steam to atmosphere using the Severe Accident capable wetwell vent installed under Phase 1 of the Order. SAWA Flow rates are adequate based on EPRI-1025295, Severe Accident Guidance Technical Basis Report, 2012 (Reference 33), and EPRI-101869, Severe Accident Guidance Technical Basis Report, 1993 (Reference 34), Values for Candidate High Level Action for RPV Injection. The quantity of water initially injected is between the values for decay heat removal from injected water vaporization (Wvap) and decay heat removal from sensible heat rise only (Wsat) at the 8 hour point. The Wvap value is approximately 170 gpm and is stated to remove up to 3 times the decay heat based on capacity of the steam to absorb superheat. The 500 gpm value is roughly three times Wvap (nine times decay heat) and thus could remove significant reaction heat/Drywell materials superheat.

C.5.2. The addition of water during ex-vessel core melt scenarios provides the additional benefit of sufficiently limiting overall containment temperatures so that the pressure retaining function of the containment remains intact.

C.5.3. Rather than a detailed breakdown of water addition requirements over time to address a specific accident progression sequence, a more generic strategy of water addition is appropriate given the unpredictable nature of the beyond design basis condition that results in severe accident conditions with ex-vessel core debris. An example of a generic approach follows:

C.5.3.1 ELAP occurs with RCIC failure at T=0 hours.

C.5.3.2 Core damage commences at T=1 hour.

C.5.3.3 SAWA flow starts at T=8 hours at 500 GPM.

C.5.3.4 SAWA flow rate reduced at T=14 hours to 100 GPM for wetwell vent preservation.

C.5.3.5 Rising wetwell level, as indicated by containment water level instrumentation, indicates that further reduction in SAWA flow is permitted.

C.5.3.6 Stable or lowering wetwell level, as indicated by containment water level instrumentation, indicates that SAWA flow rate should be at or above the minimum required flow rate for maintaining containment capability.

Note: Licensees may perform site specific evaluations to justify alternative values for initial SAWA flow rates, action times for commencing SAWA flow and times for reducing SAWA flow to achieve a successful SAWM strategy.

Argonne National Laboratory (ANL) Experimental Results

Experiments have been conducted at Argonne National Laboratory as part of the OECD/MCCI Program to support the resolution of phenomena associated with ex-vessel debris coolability. Integral effect core concrete interaction tests have been performed to replicate plant conditions with water addition to the debris. Experimental results show an initial bulk cooling rate on the order of 1 Mw/m^2 during the period when a coherent crust is unable to form. As bulk cooling continues, the melt temperature begins to decrease and the conditions for developing an interfacial crust are observed to be satisfied. Long term cooling of the debris is found to rely on several mechanisms that include the penetration of water into the debris, formation of a particle bed above the crust layer due to eruptions, and the possible mechanical breach of the suspended crust. Experimental results show that the initial bulk cooling phase can last for approximately 60 minutes, followed by a long period of reduced heat flux on the order of 250 kw/m^2.

Using the initial bulk cooling rate of 1Mw/m^2, an estimate can be obtained for the rate of water addition to match the associated boil-off rate. Assuming the core debris is confined to the area beneath the reactor vessel, this bulk cooling rate equates to a water addition rate of approximately 200 gpm. Should the debris spread to also encompass ¼ of the drywell floor, using the same bulk cooling heat transfer rate, the larger surface area would then equate to a boil-off of 375 gpm. This provides an approximate range for water addition as limited by the experimental results for debris-to-water heat flux.

Using similar debris spreading assumptions, the longer term heat transfer rate of 250 kw/m^2 equates to a range of water addition rates from 50-100 gpm. As with the bulk cooling rate, this is the long term water addition rate that is limited by the measured debris-to-water heat flux.

Overall, the ANL experimental work would tend to confirm that an initial water addition rate on the order of 500 gpm is appropriate and that long term, a reduction to 100 gpm is consistent with the observed debris-to-water heat flux limitations.

Reference:

1. OECD/MCCI-2005-TR06, OECD MCCI Project Final Report, Feb 28, 2006, M.T. Farmer et al.

C.5.3.7 The initial water addition rate should be the maximum addition rate possible given the capacity of the water addition source. (e.g., FLEX pump) However, in no case does the water addition rate have to exceed 500 GPM to maintain containment below the maximum containment pressure, consistent with the pressure limitations of Phase 1 of the Order.

C.5.3.8 This high initial flow rate will provide for the initial removal of heat from the core materials via steam production and transfer to the wetwell vent. In addition, the resultant steaming will mix with the containment atmosphere and equalize drywell temperatures cooling local hot spots as well as lowering overall containment temperature (reference figure C-4).

C.5.3.9 Containment pressure and/or suppression pool level monitoring will indicate when the proper balance of water addition and containment heat removal by venting is achieved and should be used to determine when to reduce the SAWA flow rate (reference figures C-2 and C-3).

C.5.3.10 Initially, the rate of containment pressure rise may increase due to the quenching action of the added water followed by a reduction in the rate of pressure rise which will indicate that the sensible heat and decay heat are being properly managed.

C.5.3.11 The wetwell vent size is sufficient to prevent containment failure as a result of overpressure provided the wetwell vent is not flooded.

C.5.3.12 Containment pressure and/or suppression pool level monitoring should be used to indicate when further increases or reductions in water addition flow should be made.

C.6. Freeboard Volume

C.6.1. The available freeboard volume will help the licensee determine the current plant capability to maintain the wetwell vent in service given that SAWA must continue and be managed using SAWM to provide core debris cooling.

C.6.2. Licensees must determine an upper wetwell level indication that allows continued venting through the wetwell vent.

C.6.3. Successful SAWM has three scenarios related to suppression pool level for functional use of the WW vent until alternate containment heat removal and pressure control are established:

C.6.3.1. Scenario 1 is when the instrument level useful range allows sufficient wetwell vent preservation time from the normal level by managing SAWA flow with SAWM.

C.6.3.2. Scenario 2 is when the available instrument freeboard to the WW vent function allows sufficient wetwell vent preservation time from the normal level by managing SAWA flow with SAWM.

C.6.3.3. Scenario 3 is when the time from the normal SP level to containment pressure at PCPL is sufficient wetwell vent preservation time from the normal level by managing SAWA flow with SAWM. In this scenario, there is time available from when the wetwell vent capability is lost until containment pressure reaches PCPL. If credited, the licensee should provide the time available from loss of the wetwell vent path to containment pressure reaching PCPL in the Phase 2 OIP.

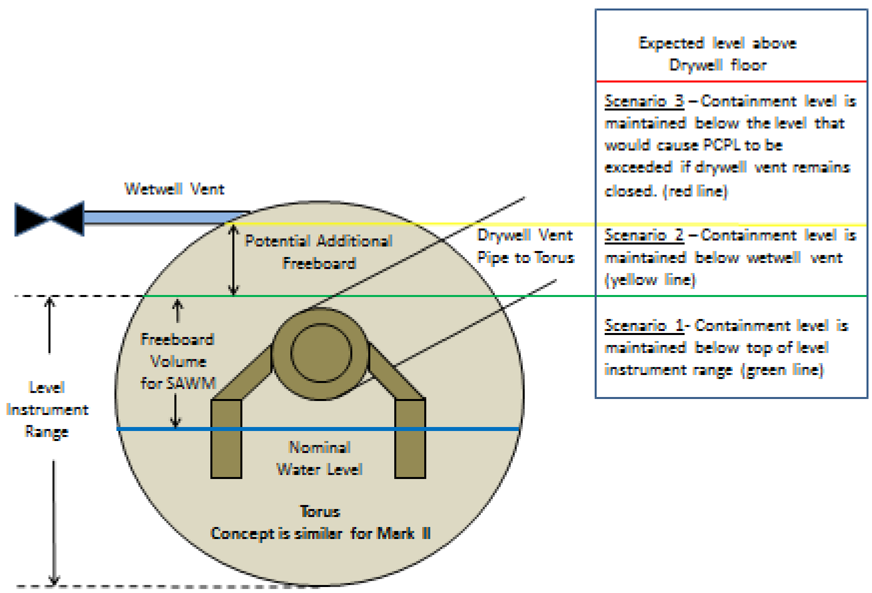


Figure C-1, Scenario 1, 2 and 3 for Preservation of Wetwell Vent

C.6.4. Extension of the freeboard may not be required if the SAWM strategy can be implemented to preserve the wetwell vent to reach an HCVS Stable State that allows 7 days of Sustained Operation or until alternate containment heat removal and pressure control is established.

C.6.5. Licensees may make modifications (examples below) to the facility to improve the available wetwell freeboard volume in the containment in order to expand the available time to reach a HCVS Stable State.

C.6.5.1. Re-span or replace the wetwell level instrument to increase the upper range of the instrument. This action will increase the available volume up to the level of the wetwell vent piping.

C.6.5.2. Relocate the wetwell level instrument tap to increase the upper range of the instrument. This action in combination with the re-span will increase the available volume up to the level of the wetwell vent piping.

C.6.5.3. Modify the wetwell vent piping to increase the available wetwell volume to support the SAWM strategy.

C.6.6. Plant–specific overall integrated plans submitted in response to Phase 2 of Order EA-13-109 will include information regarding spillover height, freeboard, torus volume versus level, and an estimate of the rate of level change in the suppression pool for various SAWA flow rates. The information should include instrumentation used to monitor containment water level and SAWA flow rate.

C.7. Tiered approach for using SAWM to meet 7 days of Sustained Operation or until alternate containment heat removal and pressure control is established.

There are three approaches for demonstrating a successful SAWM strategy that constitute 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.

The first approach is to demonstrate that the SAWM strategy can be implemented for the 7 day Sustained Operation period without the need for a drywell vent to maintain pressure below PCPL or containment design pressure, whichever is lower. Under this approach, no detail concerning plant modifications or procedures is necessary in the Phase 2 OIP with respect to how alternate containment heat removal will be provided.

The second approach is to demonstrate that the SAWM strategy can be implemented for greater than or equal to 72 hours but for less than the 7 day Sustained Operation period before containment pressure reaches PCPL or design pressure whichever is lower. Under this approach, the licensee will have to describe, at a functional level, how alternate containment heat removal might be established before containment pressure reaches PCPL or design pressure whichever is lower. Under this approach, physical plant modifications and detailed procedures are not necessary, but written descriptions of possible approaches for achieving alternate containment heat removal and pressure control should be developed concurrent with Phase 2 implementation and described in the Phase 2 OIP.

The third approach is to demonstrate that the SAWM strategy can be implemented but for less than 72 hours before containment pressure reaches PCPL or design pressure whichever is lower. Under this approach, the licensee should describe in the Phase 2 OIP specific permanent plant modifications necessary to implement alternate containment heat removal and pressure control and develop implementation procedures for placing the alternate containment heat removal and pressure control in service concurrent with Phase 2 implementation.

C.7.1. Approach 1 – SAWM for 7 day Sustained Operation period.

C.7.1.1. SAWM will lead to an HCVS Stable State for the drywell and wetwell for at least 7 days from the start of the ELAP as shown in Figures C-2 through C-6, which are based on a representative BWR-4 with Mark I containment using MAAP 5.02. The calculation assumed:

C.7.1.1.1. ELAP at T=0.

C.7.1.1.2. No RCIC or HPCI operation.

C.7.1.1.3. Initial pressure control between 800 – 1000 psig starting at 10 minutes.

C.7.1.1.4. Emergency depressurization at T+30 minutes due to low RPV level.

Note: Initial venting per SAMGs will likely occur near PSP (lower pressure) versus PCPL, but for the example a conservative initial vent pressure of PCPL was used.

C.7.1.1.5. Open the wetwell vent at 60 psig (PCPL).

C.7.1.1.6. SAWA addition starts at time of vessel breach at 500 gpm.

C.7.1.1.7. SAWA addition is reduced at T+13 hours to 100 gpm.

C.7.1.2. Figures C-2 through C-6 demonstrate that SAWA and SAWM in conjunction with the wetwell vent can stabilize containment parameters and prevent containment failure even with a delay in water injection that results in core debris breaching the reactor vessel. In addition, the wetwell vent is effective in removing non-condensable gases from containment, including any hydrogen generated by the core oxidation and the core-concrete interaction.

C.7.1.3. Representative Plant analysis provides evidence that containment parameters are reaching a stable or predictable state well before 72 hours. To be consistent with the definition of Sustained Operation, plants should utilize 7 days as the time frame for establishing a metric for compliance actions relative to NRC Order EA-13-109 Phase 1 and 2 using a Wetwell HCVS with SAWA and SAWM as defined in this guidance

C.7.1.4. Licensees utilizing this approach should provide the following in the Phase 2 OIP.

C.7.1.4.1. A description of how the plant is bounded by the reference plant analysis or plant specific analysis that shows the SAWM strategy is successful in making it unlikely that a drywell vent is needed.

C.7.1.4.2. A listing of instrumentation that will be utilized to implement the SAWM strategy and a functional level description of guidance to provide power to instrumentation needed to support SAWM through the Sustained Operation period.

C.7.1.4.3. A functional level description of guidance used to manage SAWA flow so that the wetwell vent is preserved through the Sustained Operation period. (The three scenario descriptions discussed in C.6.3 may be used to demonstrate a successful SAWM strategy for Sustained Operation.)

C.7.1.4.4. A timeline showing the sequence of HCVS/SAWA events from start of the ELAP at T=0 through the 7 day Sustained Operation period.

C.7.1.4.5. See Sections C.4.2, C.4.3 and C.5.3 for related detail to be included in the Phase 2 OIP for this approach.

C.7.2. Approach 2 – SAWM for greater than or equal to 72 hours but less than the Sustained Operation period and transition to alternate reliable containment heat removal.

C.7.2.1. In addition to the guidance for Approach 1, licensees using Approach 2 will need to provide additional information about how alternate reliable containment heat removal will be implemented from the time that the wetwell vent path can no longer be preserved until the end of the 7 day Sustained Operation period.

C.7.2.2. To transition to the alternate reliable containment heat removal and pressure control conditions, plants may utilize a combination of installed and portable equipment. Considerations for this transfer include:

C.7.2.2.1. Decay heat is significantly reduced within the first hours of the event.

C.7.2.2.2. Expected containment heat input from zirconium water reactions and MCCI is significantly reduced shortly after water addition from SAWA begins (Ref. 27).

C.7.2.2.3. Significant heat is transferred to the Suppression Pool within the first hours of the event. The suppression pool will absorb some energy, but the majority of the heat will be removed through the WW vent within the first 24 hours. (EA-13-109 Phase 1 compliance)

C.7.2.2.4. The Emergency Response Organization (ERO) will be at full staff at 24 hours (NEI 12-01, HCVS-FAQ-06) so that Command and Control is established to enable deployment of resources stored locally and arriving from the national response centers. This will enable the transition to alternate reliable containment heat removal and pressure control.

C.7.2.2.5. HCVS and SAWA/SAWM support equipment will be in-service and maintaining stable containment conditions until the transition to alternate reliable containment heat removal and pressure control is made.

C.7.2.3. National response center initial equipment delivery begins within 24 hours after notification (EA-12-049 compliance). All plant national response center equipment should be available for on-site use within 72 hours after notification. The following are examples of equipment that may be deployed for post-Severe Accident Coping conditions, i.e., the transition to alternate containment heat removal and pressure control.

C.7.2.3.1. Low pressure high flow portable pump from the national response centers. This pump may be used to flood the containment and to provide cooling water flow to the installed Residual Heat Removal (RHR) heat exchangers.

C.7.2.3.2. Medium voltage portable generators and associated distribution switchgear from the national response centers. These generators may be used to power on-site RHR pumps.

C.7.2.3.3. The above items are considered generic equipment and available to any nuclear power plant site in the United States for the purpose of mitigating a beyond design basis event.

C.7.2.4. Licensees utilizing this approach should provide the following in the Phase2 OIP.

C.7.2.4.1. Applicable elements of Section C.7.1.4.

C.7.2.4.2. A discussion of possible means (2 or 3 methods) of providing alternate reliable containment heat removal and pressure control. Plant modifications and detailed procedures are not required to implement the alternate reliable containment heat removal and pressure control strategy. However, licensees should include in the discussions of the possible methods of heat removal and pressure control, such information as equipment needed (e.g., heat exchangers and pumps), general locations of the equipment including power and piping connections, evaluation of accessibility to those areas, common tools and equipment needed to install the proposed method, and if applicable, special equipment needed that would not be typically available on site.

C.7.3. Approach 3 – SAWM for less than 72 hours and transition to alternate reliable containment heat removal.

C.7.3.1. In addition to the guidance for Approach 1 and 2 (C.7.1.4 and C.7.2.4.1), licensees using Approach 3 will need to provide detailed information about how alternate reliable containment heat removal will be implemented for one method from the time that the wetwell vent path can no longer be preserved until the end of the 7 day Sustained Operation period.

C.7.3.2. Licensees utilizing this approach should provide the following in the Phase 2 OIP.

C.7.3.2.1. Applicable elements of Section C.7.1.4 and C.7.2.4.2.

C.7.3.2.2. For the one method selected in C.7.3.1, a functional level description of guidelines that will be used to provide power to instrumentation needed to support alternate reliable containment heat removal and alternate pressure control through the Sustained Operation period.

C.7.3.2.3. A functional level description of procedures that will be used to manage SAWA flow so that the wetwell vent is preserved through the Sustained Operation period. The three scenario descriptions discussed in C.6.3 may be used to demonstrate a successful SAWM strategy for Sustained Operation.

C.7.3.2.4. A listing of installed, on-site and off-site portable equipment that will be utilized to support the alternate reliable containment heat removal and pressure control strategy including, for the one method selected in C.7.3.1, any modifications necessary to connect and utilize the equipment.

C.7.3.2.5. A listing of instrumentation that will be utilized to implement the alternate reliable containment heat removal and pressure control strategy.

C.7.3.2.6. A timeline showing the sequence of events from when the wetwell vent path is no longer preserved through the 7 day Sustained Operation period.

C.7.3.2.7. Plant specific analysis that demonstrates that the alternate reliable containment heat removal and pressure control strategy maintains containment pressure below PCPL or design pressure, whichever is lower, for the duration of the 7 day Sustained Operation period.

C.8. SAWM Instrumentation

Note: SAWA instrumentation function is described in Appendix I.

C.8.1. The instrumentation described in this document is part of the set of post-accident monitoring instruments and, for most plants, conforms to Regulatory Guide (RG) 1.97. Pre-RG 1.97 plants have similar qualification requirements for this set of instrumentation.

C.8.2. Containment pressure (Wetwell or Drywell) and wetwell level are indications needed to support water addition and water management in the SAWA/SAWM Severe Accident Coping phase.

C.8.2.1. These indications are addressed by Section 4.2.2.1.9 of this document and are adequate to support Phase 2 implementation

C.8.2.2. This instrumentation will initially be available post ELAP until DC or AC (e.g., provided through inverters) power is depleted. FLEX strategies implementing Order EA-12-049 provide the means to power this equipment before the normal power supply is depleted through the Sustained Operation period, thus this instrumentation does not need to be powered by dedicated equipment for the first 24 hours post ELAP.

C.8.2.3. Licensees should list instruments that will be relied on to implement SAWA/SAWM in the Phase 2 OIP.

C.8.2.4. Licensees should describe how containment pressure and wetwell level instrumentation will be repowered through the period of Sustained Operation and show that the timing supports the SAWM strategy in the Phase 2 OIP.

C.8.3. Licensees should also evaluate installed temperature instrumentation

C.8.3.1. DW Temperature monitoring is not a requirement for compliance with Phase 2 of the order, but some knowledge of temperature characteristics provides information for the operation staff to evaluate plant conditions under a severe accident and provide confirmation to adjust SAWA flow rates.

C.8.3.2. Many thermocouple and RTD instruments have a wider range than that currently used based on DW design temperature.

C.8.3.3. Typically DW design temperature is below 400°F, however many sites have thermocouples that have a greater nominal range and likely will be available for manual readings of DW temperature.

C.9. Licensees may identify other, similar actions to achieve a successful SAWM strategy. Actions taken by Licensees are subject to the review and approval of the NRC staff and should be identified in the Phase 2 Overall Integrated Plan (OIP).

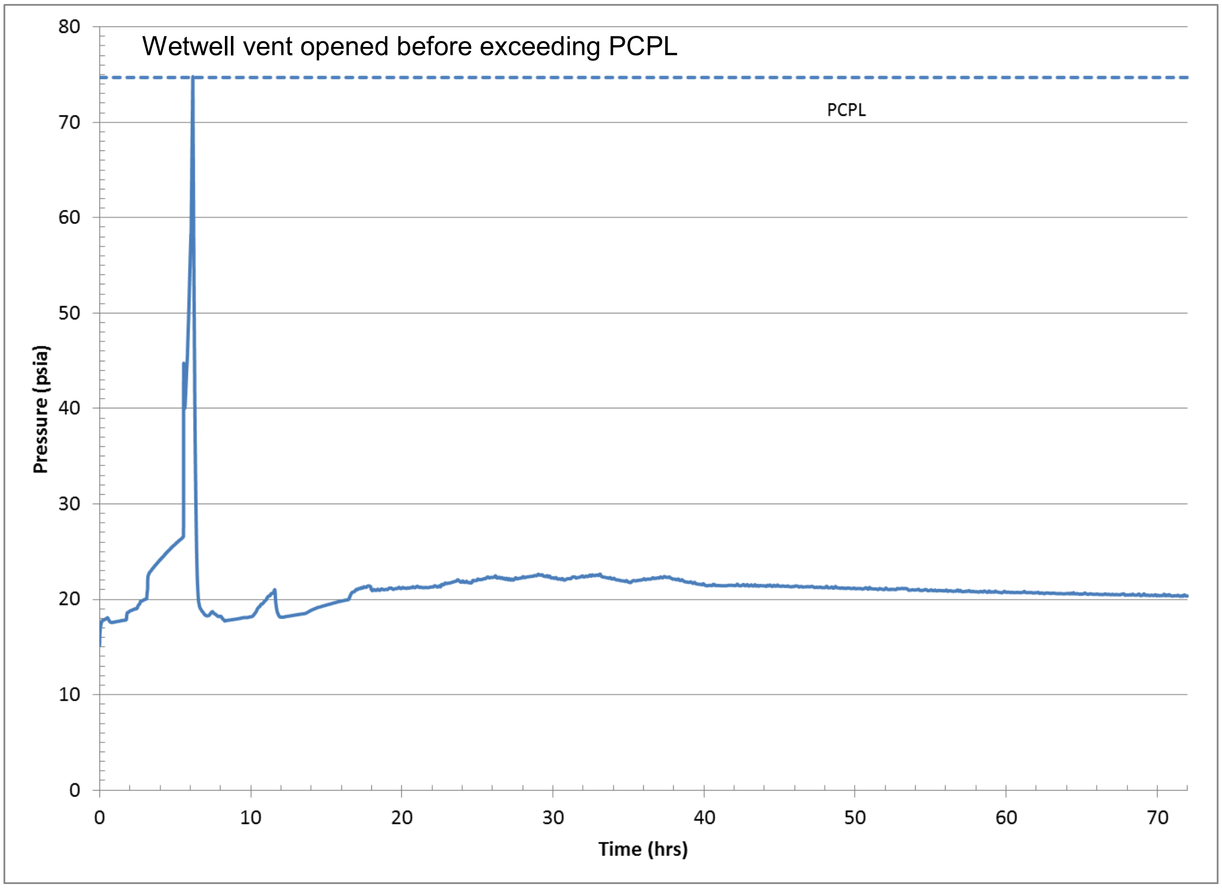


Figure C-2, MAAP 5.02 Containment Pressure for Section C 7.1 EA-13-109 Core Damage Scenario with SAWA at Reference Plant

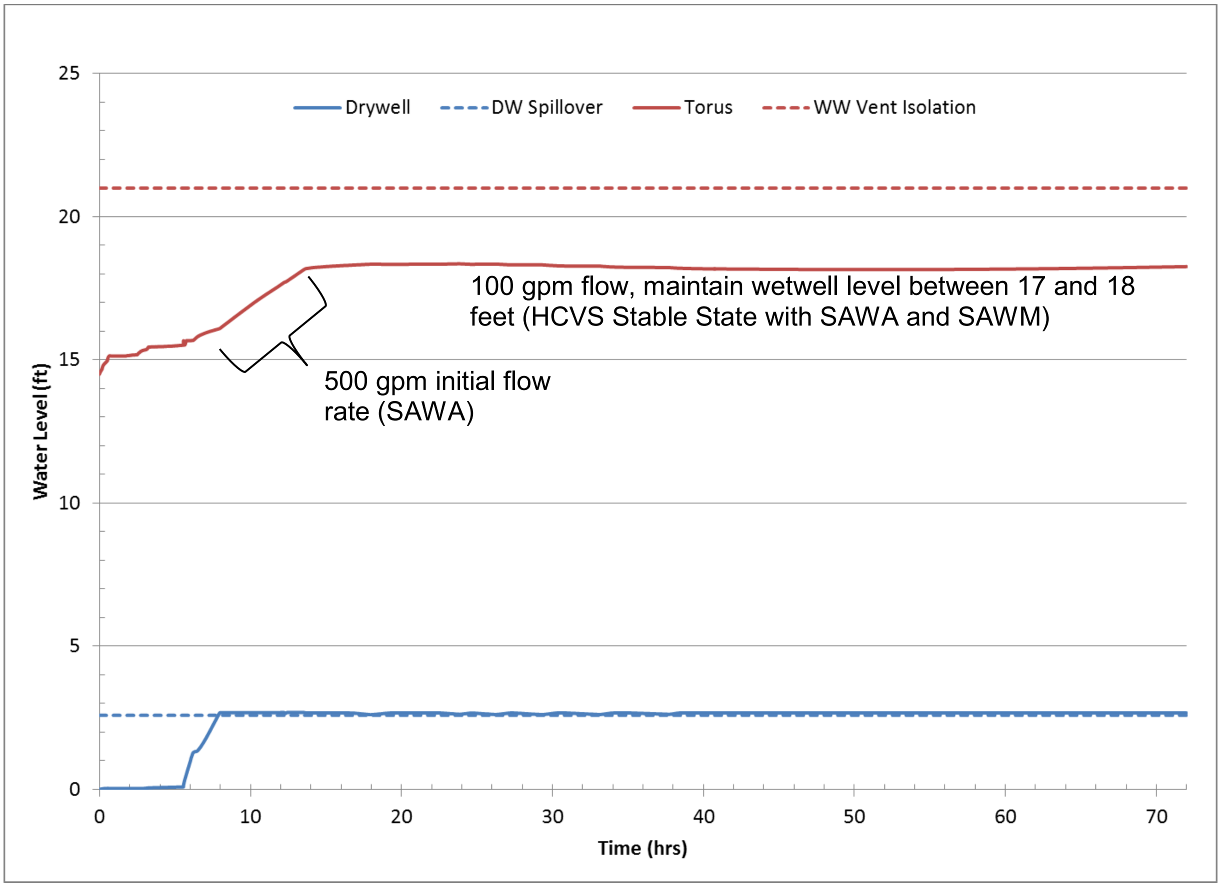


Figure C-3, MAAP 5.02 Drywell and Wetwell Level for Section C 7.1 EA-13-109 Core Damage Scenario with SAWA at Reference Plant

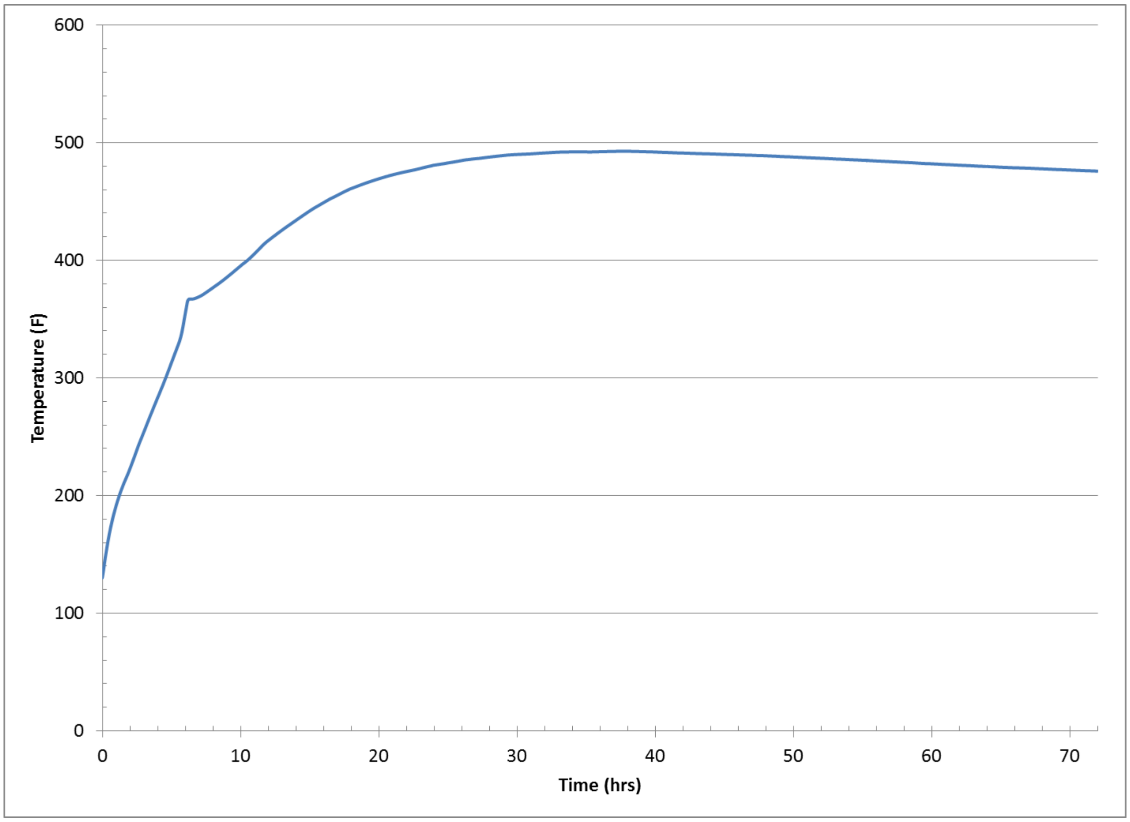


Figure C-4, MAAP 5.02 Peak Drywell Structure Temperature for Section C 7.1 EA-13-109 Core Damage Scenario with SAWA at Reference Plant

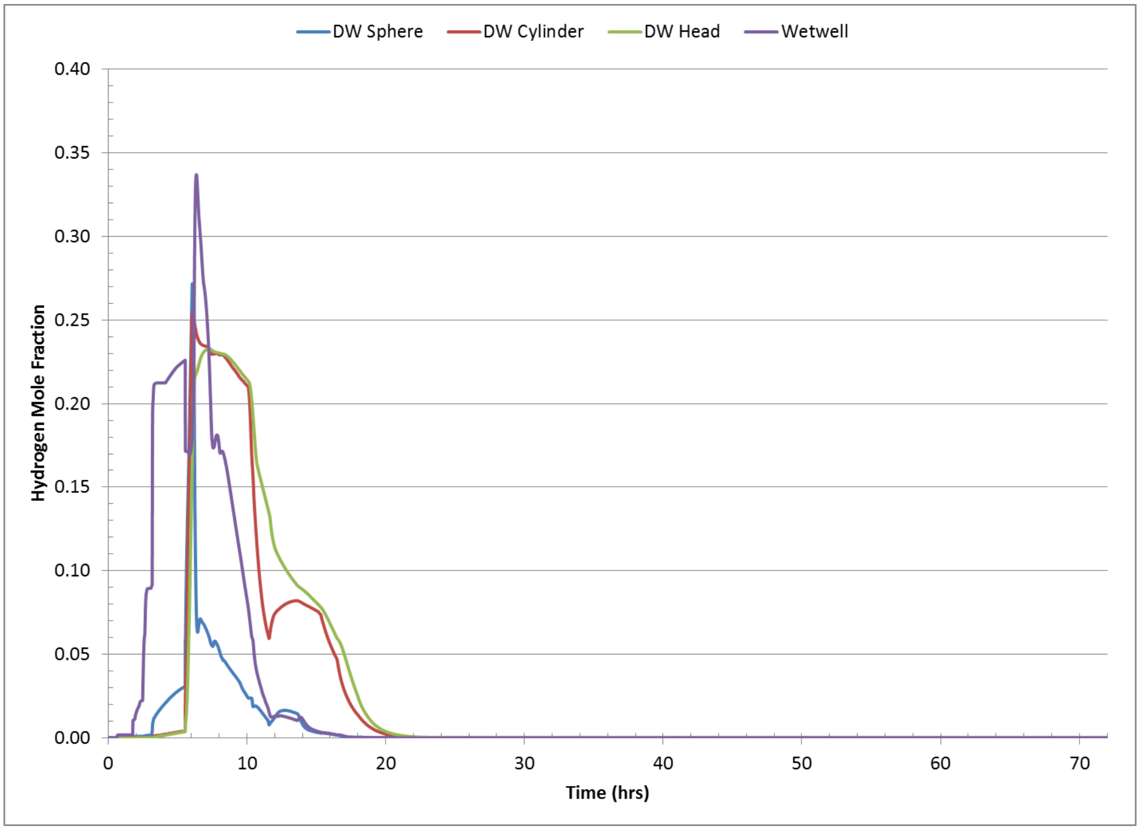


Figure C-5, MAAP 5.02 Hydrogen Gas Fraction for Section C 7.1 EA-13-109 Core Damage Scenario with SAWA at Reference Plant

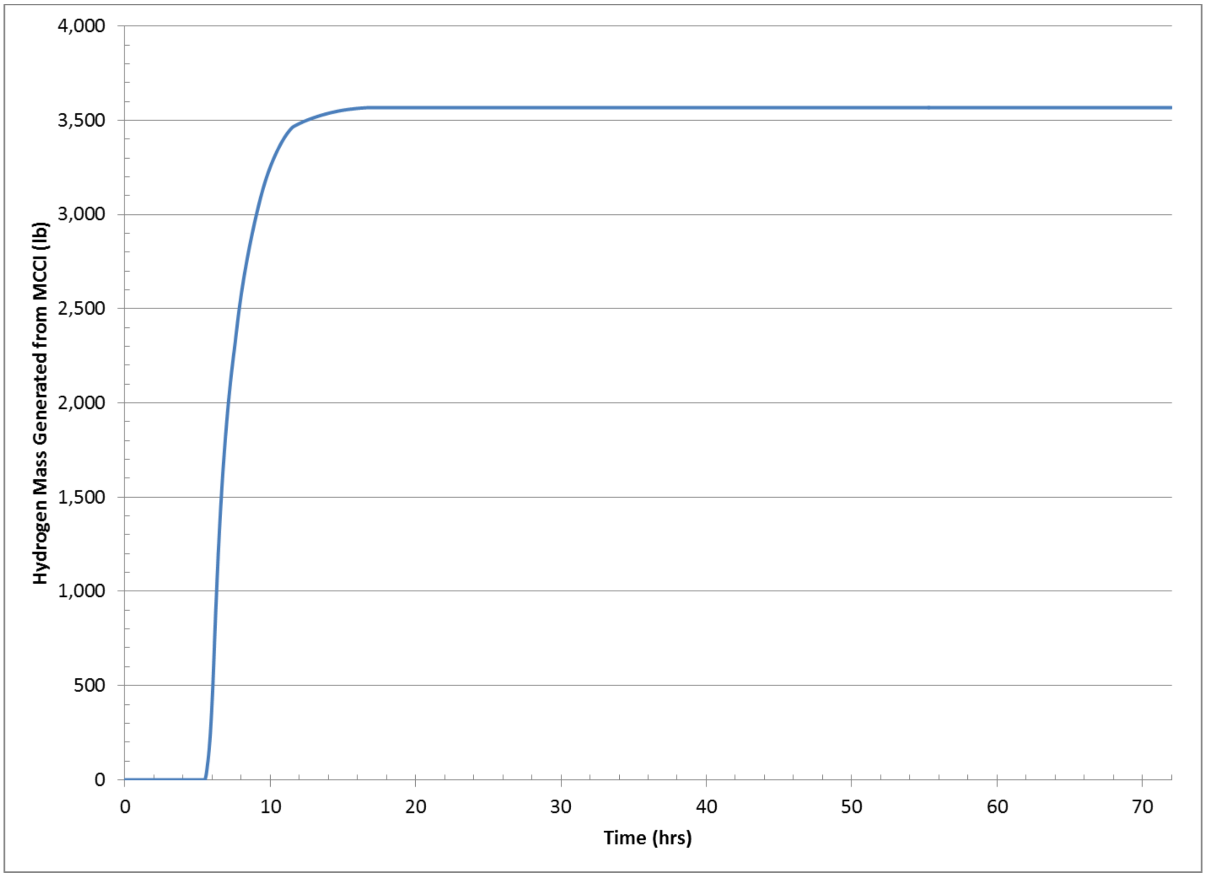


Figure C-6, MAAP 5.02 Total Hydrogen Gas Generation from MCCI for Section C 7.1 EA-13-109 Core Damage Scenario with SAWA at Reference Plant

APPENDIX D – INTERFACE WITH FLEX

Order EA-13-109 calls for very clear definition of the boundary conditions to be applied to the design and operational considerations required to implement the HCVS associated with a severe accident capable vent. Compliance with NRC Order EA-12-049, FLEX is clearly a mitigation strategy for a BDBEE without core damage.

D.1. Interaction Between Order EA-12-049 and EA-13-109

D.1.1. Complying with Order EA-13-109 using components allocated to FLEX do not change the compliance methods or requirements for all aspects of complying with Order EA-12-049 using FLEX.

D.1.2. References in this guidance to the criteria contained in NRC endorsed FLEX guidance, NEI 12-06, invoke those Order EA-12-049 criteria, such as the screened-in criteria for hazards for establishing boundary conditions applicable to compliance with Order EA-13-109 not the reverse.

D.1.3. Use of specific elements of FLEX to comply with Order EA-13-109 require only those specific elements to have additional criteria as defined in this guidance applied to ensure the credited function is available to meet the design, operational and maintenance criteria contained in this guide. The most likely FLEX functions that could be used for compliance to EA-13-109 are makeup air to the HCVS system connections (either primary or alternate control locations) and requisite power (either AC or DC) to either primary or alternate valve operating stations. Additionally FLEX AC generating equipment and pumping capacity may be used to support the SAWA/SAWM strategy. (HCVS-FAQ-06, generic assumption 049-11)

D.1.3.1. Connections, staging and deployment for portable equipment and support functions must comply with Order EA-13-109 requirements as clarified in this guidance.

D.1.3.2. Connections, staging and deployment established for FLEX do not have to be applicable for compliance with Order EA-13-109. If this is the case then additional actions are required to provide compliance with Order EA-13-109 requirements as clarified in this guidance.

D.1.3.3. Dual purpose connections meeting both the FLEX and HCVS Orders (e.g., FLEX decay heat removal and HCVS SAWA connections) should meet the requirements of both orders.

D.1.4. For ELAP and Loss of Ultimate Heat Sink (LUHS) BDBE that do not have core damage, FLEX analysis determines the timing for containment venting under Order EA-12-049 (ELAP/LUHS) conditions.

D.1.4.1. For ELAP and LUHS BDE that do not have core damage, FLEX will supply the analysis and method of water addition to the RPV. It also supplies AC/DC power and Key Parameter instrumentation, as defined in NRC endorsed guidance NEI 12-06 independent of HCVS

D.2. Onsite Portable Equipment Use

D.2.1. After 24 hours, the HCVS may use on-site FLEX Phase 2 portable equipment as replenishment source for motive force

D.2.2. After 24 hours, the HCVS may use on-site FLEX Phase 2 portable equipment as source of reliable DC power

D.2.3. After 24 hours, the HCVS may use on-site FLEX Phase 2 portable equipment as source of AC power

D.2.4. The HCVS Phase 2 SAWA/SAWM strategies may use on-site FLEX Phase 2 portable equipment as source of water addition

D.2.5. The HCVS may use required FLEX Key Parameter instruments for monitoring Suppression Pool (Torus)/DW parameters such as those listed in section 4.2.2.1.9.

D.2.6. The HCVS may use FLEX Phase 1 or 2 Safety Support Functions strategies, as defined in the plant's FLEX OIP, for habitability in HCVS areas

D.3. Offsite Portable Equipment Use

D.3.1. The HCVS and SAWA/SAWM strategies may use off-site FLEX Phase 3 portable equipment to support the 7 day period of Sustained Operation.

D.3.2. The HCVS and SAWA/SAWM strategies may use any available off-site portable equipment to support the 7 day period of Sustained Operation.

D.3.3. These sets of off-site equipment will have to perform the functions identified in other sections of this document and only have to address the radiological, and habitability conditions expected to be present at the location and time of connection. With severe accident conditions other setup/connections may be necessary due to associated radiological and habitability concerns.

D.3.4. Accessibility and deployment conditions under the Order EA-13-109 conditions expected at the time of deployment and use should be addressed when determining the appropriate usability of portable equipment.

APPENDIX E – INTERFACE WITH GENERIC LETTER 89-16, INSTALLATION OF A HARDENED WETWELL VENT

The purpose of this appendix is to provide a clear understanding of the interface between Generic Letter 89-16, Installation of a Hardened Wetwell Vent, and order EA-13-109, Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions.

In 1989, the NRC issued Generic Letter 89-16, "Installation of a Hardened Wetwell Vent," to all licensees of BWRs with Mark I containments to encourage licensees to voluntarily install a hardened wetwell vent. In response, licensees installed a hardened vent pipe from the wetwell to some point outside the secondary containment envelope (usually outside the reactor building). Some licensees also installed a hardened vent branch line from the drywell. Because the modifications to the plant were performed in accordance with 10 CFR 50.59, "Changes, tests and experiments," detailed information regarding individual plant configurations was not submitted to the NRC staff for review. Subsequently, the NRC has issued orders to each plant via EA-13-109 to install reliable hardened containment vents capable of operation under severe accident conditions to be implemented in two phases; Phase 1 addresses the Wetwell vent path and Phase 2 the Drywell vent path. A review of the requirements of EA-13-109 phase 1 and Phase 2 concludes the requirements of this order bounds the previous requirements of GL 89-16. As such, licensees have a basis for changing commitments to GL 89-16 in accordance with NEI 99-04, Guidelines for Managing NRC Commitment Changes.

Design Elements of GL 89-16 (based on the Pilgrim design included in 89-16)	EA-13-109 requirement equivalent or greater
Provide venting capability equal to approximately 1% decay heat	Item 1.2.1
Vent the wetwell vapor space to a suitable release point (e.g. stack, reactor building or turbine building roof).	Item 1.2.2
Provide operability independent of AC power (note 1)	Item 1.1.4
Prevent inadvertent operation	Item 1.2.7
No single operator error can actuate the system	Item 1.2.7
Provide indication of valve position in the main control room	Item 1.2.8
Piping is safety related and supported as Class I up to the vent valve	Section 2
Class II items with potential to degrade the integrity of a Class I are analyzed.	Section 2

Note 1: It was proposed in the staff recommendation in SECY 89-17 that the hardened vent isolation valves be capable of being opened from the control room under station blackout conditions beyond the then-established coping time; however, the generic letter only requested that the licensee include costs for electrical modifications in a plant-specific basis for why the vent was not cost beneficial if a vent was not voluntarily installed. The installed vents in most cases were dependent on AC power.

References: SECY 89-17

APPENDIX F – METHOD TO EVALUATE OPERATOR DOSES

The purpose of this appendix is to provide a link to information on methods that are already established in response to regulatory dose considerations for fuel damage and core ex-vessel. The approach proposed to use to evaluate operator dose under the severe accident conditions that may be present under an EA-13-109 order scenario is the information from the well-established NUREG 0737. An example of this is the Direct Shine component for Main Control Room Habitability in the NUREG is an acceptable application for Order EA-13-109. The following information provides a general overview of some of those elements for personnel not readily familiar with the NUREG and its application.

While this appendix purports using the existing regulatory basis it is understood that the severe accident conditions that may be present under a EA-13-109 order scenario are beyond design basis conditions and there is no express or implied change in the regulatory position on other guidelines because of the use of that guidance in this document.

F.1 Methodology for Computation of Operator Doses

Personnel safety and accessibility will be important during the mitigation of a severe core damage accident. Opening of a containment vent with elevated radiation levels will pose some challenges to the operating staff. Various methods for routing the vent piping can reduce the impact on plant operations. Shielding of portions of the vent pipe can also be used to reduce exposure to plant personnel.

Attenuation coefficients can be obtained for various materials such as concrete (0.181 cm^{-1}) and lead (1.289 cm^{-1}) to allow for estimating the local radiation doses to plant personnel. More sophisticated analysis tools are available to assist the plant in evaluation of radiation doses expected during the venting operation for their specific routing. Whether using sophisticated analysis tools or hand calculations, multiple release pathways must be considered when evaluating possible sources of dose for plant personnel. While selectively routing vent pathways may assist in the mitigation of radiation effects on plant personnel, the vent paths themselves must be properly shielded in order to prevent shine through the walls of the vent paths (pipe walls). Furthermore, fission products and aerosols released from the containment have the potential to escape the reactor building through a stack or other pathways, depending upon vent path routing preferences. Any radiation released from the reactor building has the potential to shine back into various compartments of the reactor building, such as the main control room. Thus, it is also important to evaluate the effects of fission products and aerosols that could have potentially been released from the reactor building. While such effects are partially dependent upon scrubbing capabilities prior to the release of any trace gases beyond the boundary of the reactor building walls, meteorological effects, such as wind patterns and precipitation, may also affect overall dose to plant personnel. Wind patterns that force fission products and aerosols to hover over the reactor building increase the amount of risk to plant personnel. Additionally, any precipitation can force airborne sources of radiation to settle on the roof of the reactor building or main control room. As previously mentioned, sophisticated analysis tools are available for calculating such effects.

F.2 Example Plant-specific Dose Calculation

Appendix G provides estimates for containment radiation levels during postulated severe core damage accidents. The above attenuation characterization can be used to estimate radiation levels due to shielding by new or existing structures to demonstrate an acceptable environment for plant staff.

For example, using the attenuation above for a one (1) foot concrete shield, a factor of 1000 reduction in the radiation level can be achieved.

F.3 References

F.3.1 Accident Source terms for Light-Water Nuclear Power Plants, NUREG-1465, February 1995

F.3.2 Clarification of TMI Action Plan Requirements, NUREG 0737, November 1980.

F.3.3 HCVS-WP-02, Sequences for HCVS Design and Method for Determining Radiological Dose from HCVS Piping

F.3.4 HCVS-FAQ-09, HCVS Toolbox Approach for Collateral Actions

APPENDIX G – METHOD TO EVALUATE SOURCE TERM FOR VENT

The purpose of this appendix is to provide a link to information on methods that are already established in response to regulatory source term considerations for fuel damage and core ex-vessel. The approach proposed to use to evaluate source terms for the HCVS under the severe accident conditions that may be present under a EA-13-109 order scenarios is the information from the various documents used for similar purposes in the industry, such as, Alternative Source Term, Part 100.11, NUREG 1465, SORCA. An example of this is the use of the Source Term from the NUREG 1465 assumption of short term core relocation inside containment because it is conservative for the piping source term application for Order EA-13-109that would occur from a core damage/vessel breach scenario at a later time several hours after SCRAM. The following information provides a general overview of some of those elements for personnel not readily familiar with the NUREG and its application.

While this appendix purports using the existing regulatory basis it is understood that the severe accident conditions that may be present under a EA-13-109 order scenario are beyond design basis conditions and there is no express or implied change in the regulatory position on other guidelines because of the use of that guidance in this document

G.1 Methodology for Computation of Source Term

The U.S. NRC Response Technical Manual RTM-96 (Ref G-1) contains simple methods for estimating the radiation levels within containment during a core damage event. RTM-96 provides expected containment radiation monitor readings based on fission product inventories as defined in NUREG-1465 (Ref G-2). The source terms defined in NUREG-1465 for cladding damage and overheating damage are summarized in Table G-1:

- Cladding damage releases the gap activity, consisting of approximately 5% of the total core inventory of noble gases and volatile fission products.
- Overheating damage, corresponding to the early in-vessel release phase, releases virtually all of the remaining noble gases and larger amounts of the volatile fission products from the fuel pellets themselves—approximately 25% of the total core inventory of iodine and 20% of the cesium. Smaller amounts of less volatile products may also be released primarily tellurium, strontium, and barium. The total radionuclide content in the primary containment following overheating damage is the sum of the gap activity and early in-vessel releases.

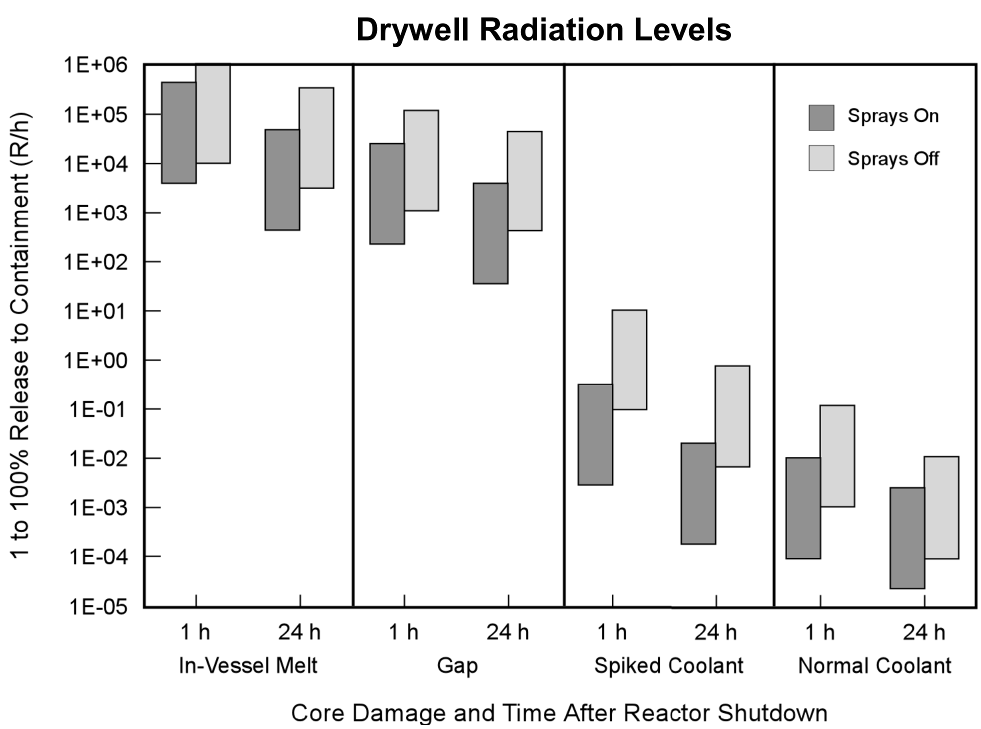
Table G-1: Fission Product releases into Containment

	Gap Release***	Early In-Vessel	Ex-Vessel	Late In-Vessel
Duration (Hours)	0.5	1.5	3.0	10.0
Noble Gases**	0.05	0.95	0	0
Halogens	0.05	0.25	0.30	0.01
Alkali Metals	0.05	0.20	0.35	0.01
Tellurium group	0	0.05	0.25	0.005
Barium, Strontium	0	0.02	0.1	0
Noble Metals	0	0.0025	0.0025	0
Cerium group	0	0.0005	0.005	0
Lanthanides	0	0.0002	0.005	0

* Values shown are fractions of core inventory.
** See Table 3.8 for a listing of the elements in each group
*** Gap release is 3 percent if long-term fuel cooling is maintained.

Equivalent plant-specific radiation levels may be calculated using any accepted analytical tool. HCVS-WP-02 is an acceptable method for performing plant specific calculations of radiation levels resulting from HCVS operation. Figure G-1 provides representative values for the Mark I and II containment design taken from RTM-96. In general, the radiation levels associated with the onset of cladding damage are expected to be at least two orders of magnitude greater than those attributable to coolant releases and the ranges associated with overheating damage are expected to be approximately one order of magnitude greater than those for cladding damage. The cladding damage and overheating damage ranges each span approximately two orders of magnitude.

G.2 Example Plant-specific Source Term Calculation



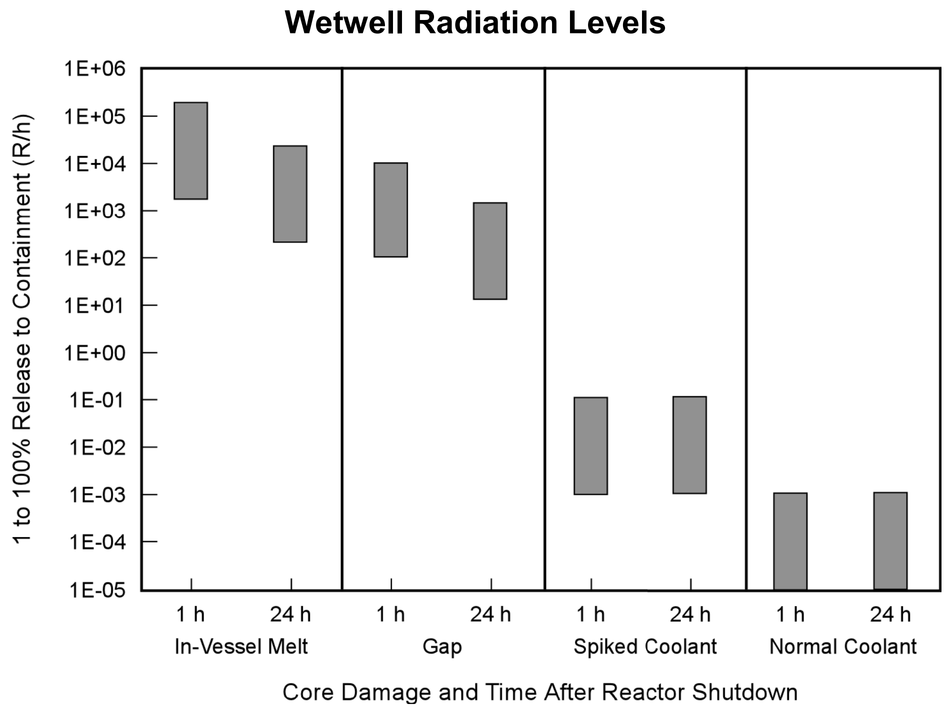


Figure G-1: Mark I/II Primary Containment Radiation Levels (Reference G-1)

The radiation monitor readings as defined in RTM-96 are assumed to provide an adequate estimate for designing the HCVS.

G.3 References

G.3.1 USNRC, “RTM-96, Response Technical Manual,” NUREG/BR-0150, Vol. 1, Rev. 4, March 1996.

G.3.2 Accident Source terms for Light-Water Nuclear Power Plants, NUREG-1465, February 1995

G.3.3 HCVS-WP-02, Sequences for HCVS Design and Method for Determining Radiological Dose from HCVS Piping

APPENDIX H – METHODS TO ADDRESS CONTROL OF FLAMMABLE GASES

H.1 Bases and Methodology

Order Reference: 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.

Hydrogen will be produced as a result of core damage during a severe accident. Although not cited in the requirements section of Reference H.4.1 (in particular Requirement 1.2.11 relative to consideration of “hydrogen deflagration and detonation”), carbon monoxide is cited as a combustible gas in the introduction paragraph to Attachment 2 to that reference. Carbon monoxide (CO) can be produced in sufficient quantities to deflagrate and potentially detonate (in a vent pipe) by the process of Molten Corium Concrete Interaction (MCCI). This would occur in the most severe of accidents once the reactor vessel is breached and corium has reached (and interacted sufficiently with) the pedestal or lower liner concrete.

Detonation or deflagration of either Hydrogen or CO is not expected to occur in containment, given existing plant controls to ensure the containment remains free of Oxygen. Such gas combustion in the HCVS may potentially occur if venting occurs and Oxygen is allowed to enter the HCVS discharge piping. Air/Oxygen would most likely enter the HCVS piping following a vent cycle, either through steam collapse or by rising Hydrogen leaving the HCVS piping (replaced by inflow of air).

Preventing a detonation or deflagration in the HCVS is possible, either through design of the HCVS to ensure Oxygen is not allowed to enter the piping, or by inerting the HCVS piping after venting. If a detonation is not prevented, the piping should be designed to withstand the detonation without failing.

The size of the vent must meet the criteria cited in Section 4.1.1 of this guidance for the primary design objective of the HCVS is to prevent overpressure failure of the containment prior to core damage and subsequent to core damage. The following sections provide high level methodology and discussion on possible approaches to either prevent or accommodate a detonation during or following venting through the HCVS. The approaches discussed below are not considered to be the only possible approaches to protecting the HCVS. Alternative design approaches are considered acceptable, provided that both deflagration and detonation in the HCVS is prevented or the system is designed to withstand the possible deflagration and detonation of Hydrogen and/or CO. Such alternative designs must be reviewed and accepted by the NRC.

The following sections of this appendix refer to the use of Argon as a purge gas for use in inerting the vent pipe. Argon is not the only acceptable purge gas so that the information regarding Argon can equally be applied to other purge gases such as Nitrogen or Carbon Dioxide.

H.2 Actions for Compliance

Strategies and options that "ensure the flammability limits of gases passing through the system are not reached" shall document the following items in a six month update:

1. Option or options selected (valid for use of Options 3, 4 and/or 5)
2. Any deviations relative to the selected option(s) along with justification
3. Synopsis of venting operation and design
4. Sketch of vent path from associated PCIVs to release point, with delineation of which option applies to each portion of the vent system

Strategies and options (as presented in Section H.3) that are "designed to withstand dynamic loading resulting from hydrogen deflagration and detonation" shall document the following items in a letter to the NRC requesting approval:

1. Synopsis of venting operation and design utilizing Option 1 and/or 2
2. Sketch of vent path, with delineation of which option applies to each portion of the vent system
3. Tabulation of the design parameters used for design of each portion of the vent system
4. Justification for selection of design parameters

If the design and operation does not meet the criteria as specified in either portion of order element 1.2.11 then the licensee must request special handling and potentially an Order exemption by the NRC in regard to the requirements of the Order.

H.3 Presentation of Options

A licensee may design an HCVS to address the hazards of flammable gases using one of two philosophies: 1) design the system so as to accommodate the expected loading produced by the ignition of a combustible gas mixture (Options 1 and 2), or 2) design it such that a combustible gas mixture is not reasonably expected (Options 3, 4 and 5). The first option alludes to a passive system, which will remain in place and operable as it is designed to the parameters derived from reasonably expected hydrogen deflagration and detonation. The second option would have more active features than the former. There are several variations of option two and there are several hybrid systems which may be considered.

The following table outlines the key options considered, and includes primary advantages and disadvantages of each. There are variations on these central themes which may be used along with other options which system designers may choose to pursue.

Evaluation of Design Options for the Control of Combustible Gases

Option	Description	Advantages	Disadvantages
1	Design the HCVS to withstand the reasonably expected hydrogen deflagration and/or detonation present in the system while venting under severe accident conditions, using both technical and OE lessons learned	1. Completely passive	1. Requires attention to detail as related to the specific design attributes
2	Design the entire vent piping beyond the primary containment isolation valves to withstand any flammable gas detonation.	1. Completely passive	1. May require higher rated valve(s) due to loading 2. Potentially requires thicker wall piping 3. May requires upgraded pipe supports 4. May requires complex dynamic analysis to develop pipe and support loads and design
3	Install a purge system to prevent flammable gas deflagration and detonation.	1. Requires minimal modification to existing or as designed system 2. Eliminates detonation concern	1. Active feature 2. Manpower requirement 3. Additional maintenance and testing 4. Additional failure mode 5. Potentially difficult to operate manually at the remote panel

Option	Description	Advantages	Disadvantages
4	Install an additional control valve downstream of the PCIVs and either design the system downstream of the control valve for detonation/purge (Options 2 or 3) or minimize length such that run-up distance is not achieved. Once CIVs are opened, subsequent vent start/stop cycles are controlled by the single downstream valve.	1. Minimizes piping potentially affected by detonation, or 2. Eliminates detonation concern (depending on placement of valve)	1. Active feature 2. Downstream portion of piping potentially still subject to disadvantages listed for Option 2 or 3 3. Additional maintenance and testing of the added valve 4. Additional failure mode (potential failure of the additional valve) 5. Adds challenges to support and maintain a large mass with an offset actuator at the end of the vent. 6. An external valve is susceptible to tornado missiles.
5	Install a check valve near or at the exhaust end of the vent stack to eliminate the ingress of air to the vent pipe when venting stops and the steam condenses.	1. Eliminates detonation concern 2. No operator action required	1. Additional maintenance challenges because of valve location 2. Additional failure modes (inability of check valve to open or to close once opened) 3. Adds additional mass at the end of the vent that needs to be supported.

H.3.1 General Notes Relative to the Options

H.3.1.1 In researching any given piping system's susceptibility to a hydrogen detonation, it was realized that there are many real world examples of common industrial evolutions that closely mimic the proposed venting scenario that could potentially allow for a deflagration to detonation transition (DDT) to occur. However, there have been no instances such that piping systems have failed when following approved design parameters for the combustible gas of interest. The most common use of this design is the venting of hydrogen from the generator at a power plant. As hydrogen is the typical cooling gas used in large industrial electrical generators, this evolution occurs quite frequently at both nuclear (BWR and PWR plants) and non- nuclear power plants. Such venting occurs when the purity of hydrogen (in a generator) diminishes and higher purity hydrogen is to be added. In such a process, some of the contained gas is vented out, pressing air out in front of it, and high purity hydrogen is injected into the generator. After such a process, the vent line is full of hydrogen. In the time period that follows, a scenario quite similar to that of the proposed HCVS post-venting evolution occurs. In the minutes to hours that follow, the hydrogen contained in the line, based on its diffusion and buoyancy properties, will escape from the vent line and be replaced with air. During that replacement/exchange process, this mixture is also susceptible to very similar conditions and mixing forces that would exist in an HCVS. Flames from the release point along with burnt paint on the outside of the piping have been reported extensively, but no damage to the piping has been reported. The best explanation is that the piping is able to withstand hydrogen deflagration (and/or that no detonation occurs).

H.3.1.2 If a defense-in-depth approach is considered, any piping upstream of the valve which controls the venting (opened to allow venting and closed to cease venting) is protected against a DDT based on the inability to get oxygen into that isolated volume. Effluent upstream of such a valve would be made up of steam, hydrogen, and trace nitrogen (and any other non-condensables available), but would not have an oxidizer due to isolation from normal atmosphere (such as from the reactor building or outside the plant buildings). Placing such a control valve further downstream is to the design's advantage with respect to protection against detonation. The piping up to the control valve will experience containment pressure during the time the vent is not in use (after initiation of the venting process). Options 4 and 5 utilize this type of DDT avoidance. With both options, this design philosophy may be taken a step further and the additional valves (isolation valve, control valve, or check valve) may be placed at the end of the vent pipe (which would remove the ability of any of the vent pipe to be susceptible to a DDT). See HCVS-WP-03 (Reference H.4.10) for further information on this subject along with the potential to extend the downstream piping based on DDT run-up distance.

H.3.1.3 Although the defense in depth option of designing for detonation beyond the last valve is passive in nature, it will require extensive dynamic analysis and modification to accomplish. Although many reasonably common grades and schedules of pipe are able to accommodate the equivalent static pressure of a detonation, components such as valves may require a higher pound class to accommodate a detonation, and a much more complex dynamic piping and support analysis must be used to design the system. Support systems for existing piping may need to be upgraded/modified.

H.3.2 Basis for and Discussion of Given Options

H.3.2.1 **Design Relative to Hydrogen Detonation Related OE and Lessons Learned -** This option involves using lessons learned from OE and other industry sources to design the HCVS for reasonably expected hydrogen deflagration and detonation.

Design Considerations for a Design using Related OE:

a. Smooth ID piping should be used in the vent application (inherent in typical HCVS design). Relative roughness of the pipe ID should not be greater than 0.01D (i.e., ~1/8” for a 12” pipe). In addition, any obstructions which could facilitate turbulent flow during a DDT should be avoided or eliminated (e.g., extraneous valves, rupture disc housing).

b. There should be no system ties to any system which would potentially contain loose catalyst which could migrate to the HCVS.

c. The use of non-sparking valves will provide additional assurance that there will be no viable ignition source.

d. There should be no system ties to any system which contains reactor steam during power operation. This will eliminate the potential for leakage into the vent system which could allow for steam condensation and radiolytic gas pocketing.

e. Vent piping may need to travel some distance horizontally to get to the release point (i.e., the release point will not be situated directly over the downstream controlling PCIV or (other) control valve). However due to the buoyancy of hydrogen, any piping that will have the potential to have a stagnant leg which contains hydrogen should be sloped up (as best possible) toward the release point. That will provide for a driving force (the buoyancy of the hydrogen) to move the hydrogen out and not pocket in the piping. If this is not done, hydrogen may collect in any high point in the piping. As such there would be some mixing at the interface of the hydrogen pocket and the heavier gases which may exist below it. However in such a case the creation of a section of a combustible gas mixture capable of supporting a DDT is extremely unlikely. This is due to the near complete absence of mixing forces available in such a situation and the stagnant gases will tend to stay separated.

Option 1 involves designing to the dynamic loading conditions of deflagration and/or detonation that are reasonably expected in the pipe. As detailed above, the experienced pressure would be expected to be no greater than normal system design pressure. Therefore any added design features are considered defense in depth.

H.3.2.2 **Design for any Detonation** –This defense in depth option addresses the possibility that detonations may occur in the vent system. The development of a mixed atmosphere which will support a DDT evolution is not mitigated in any way. As such, all piping, components, supports and other ancillary appurtenance of the system are designed with the understanding that multiple detonations may occur during periods of vent system use when the vent is isolated and outside atmosphere is drawn in.

In order to support this type of design, Reference H.4.2 was developed to provide basis for both an equivalent static pressure load for a hydrogen detonation and for a carbon monoxide detonation. These two gases were referenced in the Order relative to their potential to cause a detonation. In developing this reference, numerous texts and academic papers were used to develop a reasonable and defendable value. The main results of Reference H.4.2 were design values for hydrogen and carbon monoxide. The initial maximized static equivalent pressure loads at detonation (from Reference H.4.2) are as follows:

Hydrogen	– 1,204 psia (8,300 kPa)
Carbon monoxide	– 1,397 psia (9,631 kPa)*

* It must be noted further research (since the time of the generation of Reference H.4.2) into the area of carbon monoxide combustion behavior has provided assurance that the CO value from Reference H.4.2 was overly conservative. More recent information justifies dropping the aforementioned carbon monoxide static equivalent pressure such that the design value (which envelops the combustion effects of both gases) is that of hydrogen; 1,204 psia.

Based on Reference H.4.2, ASME based stress calculations were performed on several sizes and grades of commonly used piping with respect to accommodating such loads (from a hydrogen detonation). From these calculations, it is apparent that several common schedules and grades of pipe are able to accommodate such pressure loads using Service Level C allowables (see Service Level C discussion). It is however incumbent on the pipe and support design engineers to verify acceptability of such piping in this use with respect to actual pipe stress loading and specific site requirements.

The information presented above with respect to the equivalent static pressure load, and the accompanying information on piping loads, is presented to make the engineer aware of the potential magnitude of loading associated with a combustible gas detonation. It is not recommended that the information provided be taken as the sole basis for design for detonation. A dynamic analysis is recommended to assure that the actual system piping and support configuration is considered such that supports and piping geometry may be optimized. There is a reasonable potential that actual piping pressure loads will be less than that stated above but it is not the intent of this appendix is to provide a ‘cookbook’ method of performing such an analysis. Such an analysis is understood to be detailed for a relatively complex system.

The following is a comprehensive set of considerations that must be taken into account if such a system is to be designed and used:

Design Considerations for a Detonation Tolerant System:

a. Piping may require upgrading based on pressure pulse loading.

b. As per ASME B16.34 – 2009 (Reference H.4.3), butterfly valves which form any of the boundaries for (either PCIVs or boundary valves – e.g., to SGTS) may require upgrading to Class 900 or above (this would roughly double the weight of the valve depending on manufacturer).

c. Valve Class will also affect the associated valve actuator.

d. Consideration must be given to “Torus Attached Piping” if the system is completely designed for detonation. May not be required for systems with downstream control valves.

    i. See NUREG-0661 (for Mark I), Section 4.1, Subsection 3.

    ii. See NUREG-0487 (and Supplements) for Mark II plants.

e. Must consider finite element type analysis for stress and support design.

f. Instead of lumped mass, must consider a ‘traveling detonation’, need to perform a series of time history type dynamic loading cases to determine worst case for support design

    i. Reasonable example using ANSYS found in PVP 2011-57278 (Reference H.4.3)

Note – If a dynamic analysis is performed, advantage may be taken of the use of flexible supports and design using ‘expansion loops’ (much like is used with main steam piping). The use of non-rigid supports coupled with pipe bends upstream from a detonation location can significantly reduce support loadings that would be realized by more rigid supports and similarly supported valves. As such, this option may provide some advantage for those plants performing a complete (or near complete) system design.

Design Considerations as Related to Loads to Consider, Loading Combinations and Service Levels:

This type of design of the HCVS is required to withstand the dynamic loading resulting from hydrogen deflagration and detonation. For design purposes, the HCVS is not required to consider assumed simultaneous loads that would not be present or occur during the venting of hydrogen (e.g. seismic loads).

The following provides a list of steps to be considered to ensure the HCVS is properly designed to tolerate a possible hydrogen deflagration/detonation:

1. Review the history/commitments of associated site equipment
   a. Research existing/similar piping system(s) for:
      1) ASME Code commitments.
      2) Seismic Classification.
      3) Current Service Level of like/similar equipment.
2. Establish classifications of new piping or piping to be modified
   a. New loading combinations for pipe in standby (with Containment Isolation Valves -CIV(s) closed)
      1) Consider hydrogen detonation pressure loading (8300 kPa/1204 psia).
      2) Determine the additional loads (both dynamic and static) which should be considered the detonation load (if the option to design the vent to accommodate a detonation is chosen).
   b. New loading combinations for pipe in operation
      1) Determine max pipe metal temperature.
      2) Determine max pressure based on “Order” sections 1.2.1 and 1.2.8.
      3) Determine applicability of seismic loading.
      4) Determine the probability of occurrence and the ASME classification as suggested in the next section.
3. Establish configuration for new/modified pipe
   a. Configure piping to meet applicable requirements of the “Order.”
4. Determine maximum stresses on vent piping
   a. Considerations

1) Set load combination using detonation load as dominant for each stress category. For example:
   a) General membrane (pipe pressure retaining material shell).
   b) Local membrane.
   c) Bending.
2) Consider worst case thrust load due to detonation, for example:
   a) Maximum pressure.
   b) Maximum temperature.
   c) Acoustic wave load for each pipe segment.
   d) Dynamic responses and bending moments.
3) Design the pipe supports
   a) Evaluate the existing pipe supports (if applicable) and allowable loads.
   b) Perform stress analysis of the pipe to determine the support system so that all the stresses meet allowable limits.
   c) Perform support design and also determine whether the existing supports meet the design requirements.
4) There are many pipe stress analysis codes available in the market and each utility may have their own standard. Individual sites are expected to use pipe stress analysis codes that comply with that station's design process.

Suggested Classification and Load Combination Approach based on Contemporary Guidance:

This section provides a suggested Service Level classification and Load Combination for the particular case of detonation loading from a combustible gas detonation. Individual sites must determine the applicability of this approach with respect to their unique site requirements and piping design commitments.

Code Class - Document 10CFR50.55a recommends RG 1.26 (Reference H.4.5) as offering guidance for Quality Groups which provide an indication for ASME Code classifications. Per the cited regulatory guide (see Section 2. (d)), the piping associated with the HCVS downstream from the second containment isolation valve should be considered as Quality Group C based on the risk of ground level release due to vent integrity failure. This is considered analogous to ASME Code Class III. As such, ASME Section III, Subsection ND is used to provide guidance for the allowable stresses for this material. ND-3600 is used for piping design.

Service Level – NUREG-0661 (Reference H.4.6) provides guidance for consideration of service “limits” in Section 4.3. Note that “limit” and “level” are considered to be interchangeable. Both Service Level C and Service Level D are cited under sub-sections 4.3.1.3 and 4.3.1.4 (respectively). Both of these service levels are considered to be associated with low-probability events. However, combining this reference with Reference H.4.7 (RG 1.57), Service Level C is the only level which is cited as applicable to hydrogen detonations (see further information below relative to RG-1.57). As such, Service Level C is considered appropriate for this loading.

Load Combinations - In the “Background” Section of RG 1.57 (Reference H.4.7), 10 CFR 50.44(b)(5)(v)(B) is cited as the basis for a statement saying that, “systems and components necessary to…maintain containment integrity will be capable of performing their functions during and after exposure to the environmental conditions created by the burning of hydrogen, including local detonations, unless such detonations can be shown to be unlikely to occur.” This statement specifically refers to Mark III containments as Mark I and Mark II containments require an inert atmosphere. However, in the venting case considered, the isolated vent systems in these models can no longer rely on the inerted containment effluent to prevent hydrogen detonations; therefore, these loads typically reserved for Mark III containments should be considered for this isolated extension of containment in this particular scenario. Such a scenario (conducive to a local detonation) can only be typified as a severe accident.

With respect to the SSE it is understood that (based on the example of Fukushima Dai-ichi) a SSE may well be the precursor to an accident which could evolve into a severe accident (including core damage and hydrogen generation). And aftershocks will likely occur after the initial earthquake. However these aftershocks (along with the earthquake itself) are typically not long duration events. They are more typically lower in magnitude, short and sporadic. As discussed in I.B.3(c) in Part C of RG 1.57, the Service Level C load combinations, all consider the SSE except for those combinations which deal with pressure from hydrogen generation or hydrogen burning. Considering the minimal opportunity for a hydrogen detonation to occur in a vent pipe, that pipe would not be expected to experience these 2 unlikely loading conditions simultaneously.

With the SSE not considered in the loading combination, the remaining loading combination to be considered for combustible gas detonation load (based on Reference H.4.7 guidance) is as follows:

$$D + Pg_2 + T_0 + R_0$$

Or - Dead load+Detonation Pressure load+Thermal load+Pipe Reaction load

Where:

D = Dead loads

Pg_2 = Pressure resulting from uncontrolled hydrogen burning (this is considered as detonation pressure).

T_0 = Most critical thermal loads (assumed to be effluent temperature).

R_0 = Pipe reaction load (assumed to be thrust loading from detonation)

P_0 = Any external pressure loading based on variations in ambient pressure (outside of vent piping)

Note that peak temperature (due to detonation) will lag behind the detonation pressure load such that T_0 would be minimal. Pipe reaction load will be determined by pipe designers.

Methodology

The loading being considered (hydrogen detonation) is considered as a Service Level C (Emergency) condition. As such the allowable stress allowance provided in ND-3654.1 may be utilized. Section 4.3 of NUREG-0661, Service Level C is characterized as applicable to design basis type events. As the precursor to such a detonation (release of hydrogen during a severe accident) would be characterized as a well beyond design basis accident that deteriorates into a severe accident with core damage, and the aforementioned required conditions for an actual detonation to occur are so remote, Service Level D allowable stresses may be considered appropriate for this scenario. However, it is understood that the intent of the Level D limit is to withstand a single occurrence. It is expected that the vent be capable of withstanding multiple hydrogen detonations; therefore, Service Level D alone would not provide the margin required to ensure system functionality.

The purpose of this evaluation is not to consider the vent system function, only that the occurrence of hydrogen detonations (as stated in this document) will not cause a failure of the pipe's pressure retaining capability. System function and component survivability to perform that function will be addressed in the final design detailed analysis for the system.

H.3.2.3 **Install an Active Purge System** – This defense in depth option involves the installation of an active purge system. The purpose of this design (as opposed to that in Option 2) is to address the first portion of Order Element 1.2.11 so as to, "ensure the flammability limits of gases passing through the system are not reached." This is done by actively purging (injection of a gas which will displace the steam and hydrogen [plus any other incidentals] which may be present in the now isolated vent before condensation draws in a substantial amount of air/oxygen). Based on the relative atomic weights, argon is the gas of choice for this operation. It is typically available and reasonably inexpensive. And it will disallow oxygen to re-enter the vent line based on its atomic weight being higher than that of oxygen.

System Design Concept - The system provides an argon purge downstream of the PCIV (or downstream control valve) upon PCIV closure. The function may be automatic or manual. Such a system may be configured as simply as routing purge gas tubing from just downstream of the last PCIV (or alternate control valve) to a purge gas bottle station convenient for system operation.

Argon will stay at the bottom of the vent pipe up against the PCIV. As time passes from PCIV closure, the argon will remain in the bottom of the exhaust vent because there are no mechanisms to drive the argon out. Small amounts of hydrogen that may leak through the PCIV will not create a detonation potential because the leak rate will be low, there will not be any oxygen; and leaking hydrogen will move through the argon blanket and up the exhaust stack.

Upon reopening of the PCIV, the atmosphere in the pipe upstream will contain steam and may also contain hydrogen or carbon monoxide. The upstream mixture is absent of oxygen. Downstream of the PCIV the pipe is inerted with argon. The Staff has also postulated that the friction of opening a metal seated butterfly valve could provide an ignition source. The result of opening the PCIV does not cause a deflagration or detonation because there is no oxygen present. Thus using the PCIV for vent control with the argon purge precludes detonation in any portions of the HCVS.

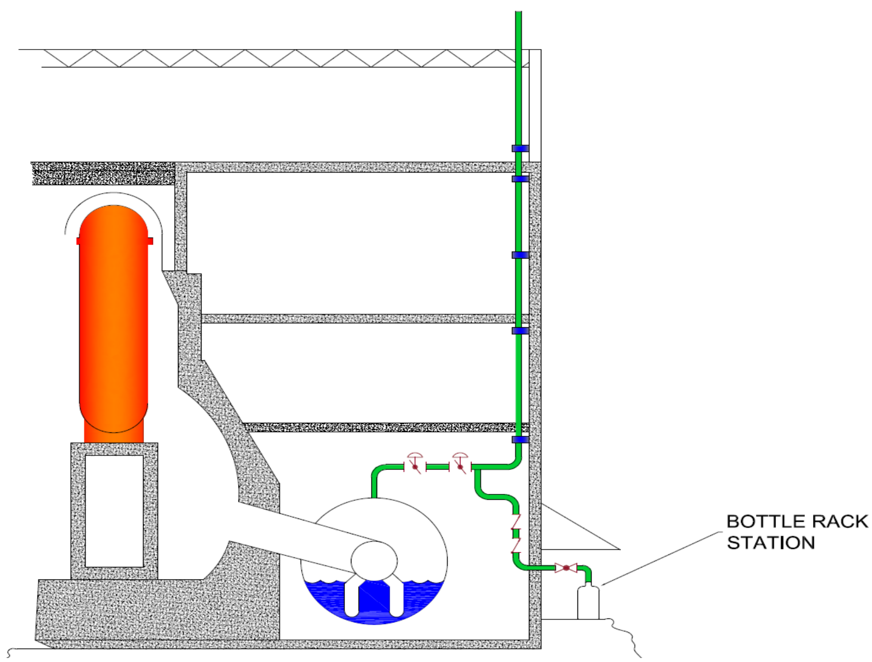
Design Considerations for an Active Purge System:

a. For the affected site, a maximum steam condensation rate must be calculated
    i. Worst case ambient temperature of outside must be considered
    ii. Worse case internal temperatures must be considered
    iii. Insulation must be considered.
b. Given the rate at which air could enter the piping and act to create a combustible gas mixture, the timing of either manual injection or automatic injection must be aligned to minimize or preclude such a mixture occurring.
c. The current accepted value for vent cycles is 4 – 5 cycles per day although site specific analysis may indicate deviations from this value. Although it is also accepted that operation of the vent

system will be tied to a given site's incorporation of affecting EPG/SAGs. It must be noted that purging a complete HCVS may require a significant amount of purge gas. And if this must occur multiple times, the complexity and potential for mistakes and failures increases. Another consideration with active purge systems is the understanding that gas injected at high velocity into a confined space with a combustible gas mixture may cause ignition of that mixture. As such, a site-specific evaluation of how quickly a combustible gas mixture may be realized should be performed (based on worst case ambient temperature along the vent pipe run). Purge gas injection should be performed prior to that timeframe.

d. Additionally, purge system operation should account for any piping elevation changes, where Oxygen, Hydrogen or Carbon Monoxide might accumulate at a high point in non-inerted piping in the HCVS.

e. Alternatively; the design may utilize an inert gas system which provides positive pressure in the vent pipe above atmospheric. Use of a continuously operating system should consider the elevation of the HCVS discharge to ensure positive flow through the system when containment venting is not occurring.



Simplified Sketch – Purge Concept

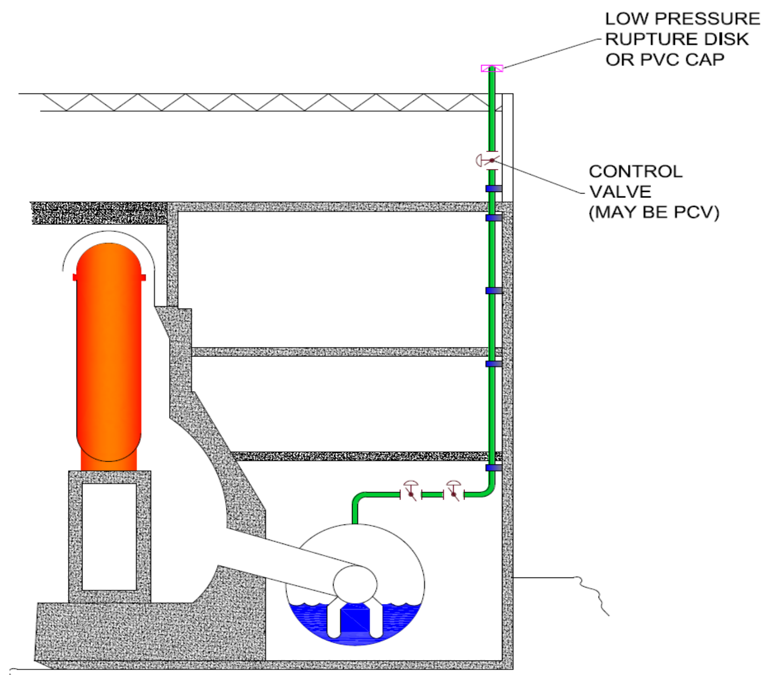
H.3.2.4 **Install a Secondary Control Valve Near or at the Exhaust End of the HCVS** – This option involves the design/operating concept involving the placement of a HCVS control valve well downstream of the PCIVs such that, once the HCVS has been placed into operation, the PCIVs will remain open and venting will be controlled by the aforementioned downstream control valve.

As has been noted previously, once the HCVS has been placed into service, the piping upstream of the control valve will not be subject to combustible gas deflagration/detonation as there will be no available oxidizer in that volume. It will essentially be an extension of containment once the HCVS is lined up to vent.

This option creates the opportunity to use either philosophy from Option 2 or 3 with respect to the remaining section of pipe downstream of the control valve. In situating the control valve location, the amount of downstream piping can be greatly minimized such that either a relatively short (and potentially uncomplicated) section of pipe may be designed for detonation or a short section may require a simple low capacity purge system. See Reference H.4.10 for the potential us of run-up distance in setting this pipe segment length.

Design Considerations for a System with a Downstream Control Valve:

a. With respect to Design for Detonation
    i. Consider placing the Control Valve just upstream of the last vertical section of pipe, this will simplify pipe stress analysis
    ii. As the Control Valve will need to potentially be Class 900, design for a support opportunity (close to existing substantial steel frame or structure or close to concrete beam or pier)
b. With respect to Design for Active Purge System
    i. Consider opportunity for easy tie-in to argon feed
    ii. Potentially consider manual system based on placement of valving (minimal purge time and opportune location)
c. HCVS-FAQ-05 (Reference H.4.9) should be consulted for valve and valve testing requirements.



Simplified Sketch – Downstream Control Valve Concept

H.3.2.5 **Install a Check Valve Near or at the Exhaust End of the HCVS** – The design concept of this option is to bottle up the steam and hydrogen in the pipe volume between a downstream check valve and the upstream control valve (typically a PCIV). There are check valves available currently which have near zero leakage for applications such as this. Such valves are typically configured with (but not limited to) a double door arrangement much like a tornado damper. Stainless steel soft seated versions of this type of valve could be mounted vertically (with the double doors swinging upward) up near the exit point of a HCVS (potentially at reactor building roof level such that they are available for maintenance) with a few feet of pipe left to the actual release point. Based on the run-up distance required for a DDT to occur (see Reference H.4.10 for further information), detonation loading would be ruled out for the downstream piping. With the 'doors' swinging up, gravity would assist the spring closure mechanism to limit leakage to an absolute minimum.

According to suppliers, this type of valve (capable of operating at wetwell venting design temperatures) can be expected to have an effective maximum leakage of approximately 2 cc/hr/inch of seat. As an example, a 14" valve this equates to 0.005ft^3/hr of inleakage (0. 001ft^3/hr of oxygen). With a pipe run using 14" pipe (volume = 1.07ft^3/ft of pipe length) it would take many weeks to reach an oxygen concentration which would support a DDT. In comparison, an expected usage cycle for venting during a severe accident would be on the order of 4 - 5 cycles per day. Considering this cycle interval, coupled with the referenced leakage, less than 2 in^3 (<33 cc) of oxygen would leak into the space behind the check valve. Any ancillary PCIV leakage from the other end of the system (made up of mainly steam, hydrogen, and trace nitrogen) would purge the system and slow the process toward supporting a flame. That leakage (past the PCIV) would be driven by the higher pressure containment volume on the upstream side.

With respect to potential fouling of the check valve due to release debris during a severe accident, scrubbing through the wetwell provides reasonable assurance that the soft seat valve will continue to perform its expected function. SECY-12-0157 (Reference H.4.8) provides a maximum particle size, downstream from the wetwell, of 0.3μm. These are minute particles. This type of valve is manufactured such that the irregularities of the seating surface of the valve are of greater magnitude than this particle size. As such, these particles would not be expected to adversely affect valve operation. Again these are soft seated valves; when the valve is closed the soft seat will conform to the aforementioned seating surface. The majority of vented effluent that will pass through this valve is expected to be at a substantial velocity. At such a velocity, the potential to have a buildup of material near or around such a valve will be inconsequential; and as such would not adversely affect the assumed valve leakage.

This type of valve has been used in various industries in gas applications in which they cycle multiple times during normal associated equipment and system operation. There is operating history on this type of valve assuring continued rugged, reliable operation.

Once venting has ceased, the atmosphere in the contained volume in the HCVS will become relatively stagnant with the only driving force for advection being condensation of steam in the contained mixture. As steam condenses, pressure in the pipe will lower and a small amount of air may slowly leak into the volume through the closed check valve. Initially, there will be extremely low differences in density between the fluid at the top of the pipe and that at lower levels (assuming a vertical pipe) so the only mechanism for gas movement will be diffusion. The air will slowly diffuse into and mix with the combustible gas (hydrogen or a hydrogen/carbon monoxide mix) in the piping as the result of differences in gas concentrations. At very low differences in density between the more dense top layer of air and the less dense lower layer of combustible gas there is insufficient driving force for buoyancy driven mixing of the layers (i.e., there is a limiting density gradient required for initiation of the previously described Rayleigh-Taylor instability). As more air accumulates in the upper section of the piping and bulk density differences are established, bulk fluid motion as a result of buoyancy forces will also become possible. As the density gradient between the upper and lower layers increases, buoyancy-driven flow will initially enter a counter-current flow regime in which there is separation between the downward travelling denser fluid and the upward travelling lighter fluid. While this flow will lessen the density difference (and occurs at a much higher rate than that driven by diffusive forces), diffusion would still tend to equalize gas concentrations across horizontal planes in the pipe. At higher density gradients, the buoyancy-driven flow enters convective-diffusive and turbulent-diffusive regimes, in which mixing occurs across the horizontal planes in the pipe. In summary, as steam condenses in the isolated vent pipe, lowering pressure may draw a small amount of air into the pipe by leakage through the check valve. This air will mix with the non-condensable combustible gas in the pipe due to the action of buoyancy and diffusion to reduce density and concentration gradients respectively. Due to the small amount of air available at the top of the pipe, and the very small density differences required for buoyancy-driven flow to mix the air throughout the pipe, there is an extremely remote possibility of developing a uniform combustible gas mixture capable of supporting a DDT within the isolated piping.

Design Considerations for a System with a Downstream Check Valve:

a. Consider placing the check valve just above roof level or adjacent to the parapet on a single plant system that either runs through the reactor building roof or up the side of the reactor building. This will allow ready access to the valve for maintenance and testing. It will also simplify support design. This valve may be moved upstream based on plant needs and convenience however run-up distance (or design for detonation or a purge system) must be considered. (The mass of the valve at that location may introduce design challenges to seismically support it.)

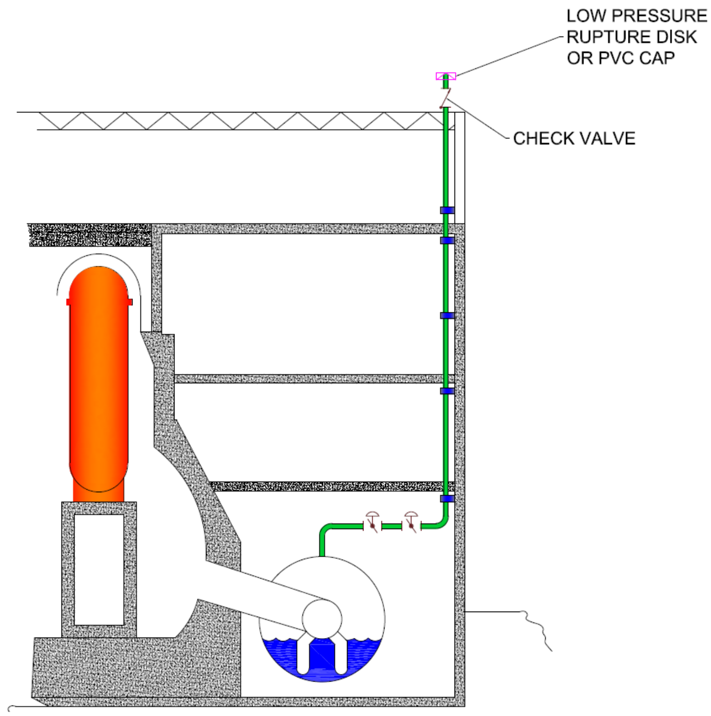
b. Consider placing a PVC cap or low pressure rupture disc downstream of the valve to protect it.

c. Consider installing a permanent work platform for maintenance. (Since the location may present maintenance challenges over the life of the plant.)

d. The pipe volume will experience negative pressure with respect to atmospheric. This must be evaluated.

e. HCVS-FAQ-05 (Reference H.4.9) should be consulted for interim valve and interim valve testing requirements.

f. It should be noted that a reasonable variation of this concept would be to place such a check valve upstream of the actual release point at a distance of just less than the run-up distance stated in 3.d above if such a configuration is more advantageous and convenient for the affected plant (see Reference H.4.10 for further information). If located further than the run-up distance then design for detonation or a purge system may need to be considered.



Simplified Sketch – Downstream Check Valve Concept

H.3.2.6 **Consideration of the Open and Leave Open Strategy:**

Although not considered as a 'formal option,' another possible approach to prevent detonation is to size the vent such that continuous venting occurs, once the vent is opened. This can also be accomplished through use of a flow-control valve restricting vent flow. This approach would be used if the containment would be expected to remain pressurized for an extended period (e.g., sustained operation) given a severe accident has occurred and no alternate containment cooling is provided.

H.3.2.7 Multi-Unit Venting Considerations:

Although this appendix is written to be used primarily to provide guidance relative to the design of a single unit vent system, concerns related to the venting of hydrogen (and carbon monoxide) bearing effluent at multi-unit sites must also be considered. This section is written relative to those sites which vent multiple units through a single Plant Stack (chimney). The typical configuration in such a case is for the HCVS from 2 or more units to be routed to a single (typically 100 meter tall) Plant Stack which services the HCVS pipes along with numerous other effluent sources (typically Offgas, Standby Gas Treatment System (SGTS), and other systems susceptible to contamination such as Radwaste Heating, Ventilation and Air Conditioning, etc.).

The concern for this type of vent configuration is based on accepted knowledge of the venting efforts at the Fukushima Daiichi Nuclear Plant in March of 2011. Fukushima Daiichi Units 3 and 4 used a similar configuration as is mentioned above in that they shared a single Plant Stack which was designed to provide a vent path for both units. During the course of the accident coping period, after venting was initiated in Unit 3, that unit experienced a substantial hydrogen explosion which extensively damaged the reactor building walls (both lower concrete walls and the upper steel panels). Some 19 hours later, with venting still occurring from the Unit 3 containment, Unit 4 (which was not operating at the beginning of the earthquake/tsunami event) experienced a similar hydrogen explosion. Evidence found during the investigation after the Fukushima units were stabilized pointed to hydrogen migration into the Unit 4 reactor buildings from the venting of Unit 3. This migration was understood as occurring through the common stack vent path. At Fukushima, the temperature inversion between the atmosphere both above and in the stack with respect to that of the vented effluent exacerbated the situation by working to slow the escape of the vented effluent from the elevated release point (i.e., the heavier air outside the Stack impeded the high temperature/lighter effluent from free flowing out the Stack). It must be understood that there had been no power to the HVAC fans that normally facilitated stack flow for at least 36 hours prior to Unit 3 beginning to vent. In the interim time, the stack (which was a metal pipe) had cooled and along with the stagnant air contained therein. This understanding of flow being routed back into the buildings is based on understanding of the associated systems' configuration at the time of the accident (with an open path back into the reactor building areas) coupled with post-accident radiation readings of both units' standby gas treatment systems. Had there been better isolation of the associated valving of related systems which connected to the Unit 4 reactor buildings, those explosions would not (in all likelihood) have occurred.

As such, there are special and unique circumstances which must be considered during the venting of a single unit using a common stack. In addition to the 'boundary valve' discussion from HCVS-FAQ-05 (Reference H.4.9), all valving associated with systems which flow into a common plant stack must be closed and leak tight to the point that they will not allow leakage of vented effluent into their associated systems. That is to say, any and all valves which serve to form a boundary to an affected unit's HCVS vent path must be guaranteed closed (either procedurally or by interlock) prior to venting commencing. (These elements are addressed specifically in order requirements for multi-unit venting and interfacing systems which will not be covered in this appendix) Due to the nature of a typical plant stack mixing chamber, these valves need not be designed to venting temperature and pressure. However they must have the capability to prevent significant amounts of hydrogen from migrating into those systems should venting be necessary. If venting from multiple units is to occur through the main Plant Stack/Chimney, this same consideration (closed and effectively leak tight valves) must apply to all other isolation valves that are associated with the vent path boundary.

There are other stipulations that must be considered when using the Plant Stack as an elevated release point. If there are dilution fans involved in the venting at the Plant Stack, priority must be given to providing suitable power to those fans once venting has been initiated such that hydrogen will not collect in the base of the Stack. These fans should also be seismically rugged such that they can be depended on to perform this function. If the vent from the HCVS and the flow from the dilution fans flow into a mixing chamber, it is important to ensure that the mixing chamber is of rugged construction. Such a release point will inherently be fed by underground piping. Such piping is typically quite robust and well confined structurally, based on its typically being heavy grade carbon steel pipe bedded in highly compacted safety related fill (based on the shared function of the piping). Although deflagrations may be considered as possible, this piping will maintain cool, damp interior surfaces due to ambient soil temperatures coupled with high humidity effluent (and potentially vented steam). This would serve to minimize the possibility of ignition sources. It is noted that the use of the Plant Stack as the containment vent release point is in agreement with the design philosophy specified in Option 1.

H.4 References

H.4.1. USNRC, Order EA-13-109, “Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions,” June 6, 2013 (ADAMS Accession No. ML13143A321)

H.4.2. BWROG Document GEH #000N2731, “Guidance for Vent Pipe Design Considering Potential Hydrogen Deflagration and Detonation”

H.4.3. PVP2011-57278, “Forces on Piping Bends Due to Propagating Detonations,” Ligon, Gross, Shepherd, July 2011

H.4.4. Regulatory Guide 1.26, “Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants,” Revision 4

H.4.5. NUREG-0661, “Safety Evaluation Report, Mark I Containment, Long-Term Program,” March 1980

H.4.6. Regulatory Guide 1.57, “Design Limits and Loading Combinations for metal Primary Reactor Containment System Components,” Revision 2

H.4.7. SECY-12-0157, “Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments,” November 2012

H.4.8. HCVS-FAQ-05, “HCVS Control and ‘Boundary Valves’ “

H.4.9. HCVS-WP-03, “Hydrogen/Carbon Monoxide Control Measures”

APPENDIX I – SEVERE ACCIDENT WATER ADDITION (SAWA)

The purpose of this appendix is to provide guidance for implementing SAWA, which may be used in combination with a severe accident capable drywell vent designed to 545°F as described in Section 2 or in combination with Severe Accident Water Management as described in Appendix C.

I.1 Severe Accident Water Addition (SAWA)

While this Appendix is specific to SAWA, there are functional, operational and monitoring guidance in Section 4. Additionally, quality, procedure, training and maintenance guidance for SAWA are contained in Sections 5 and 6. These sections in addition to this Appendix should be used to develop implementation plans for the Phase 2 OIP.

I.1.1 This section will define the hardware requirements necessary to support SAWA including:

- Water addition point
- Flow path (piping system, hose, etc.)
- RPV Pressure Control
- Water addition source
- Motive force
- Instrumentation
- Severe accident considerations

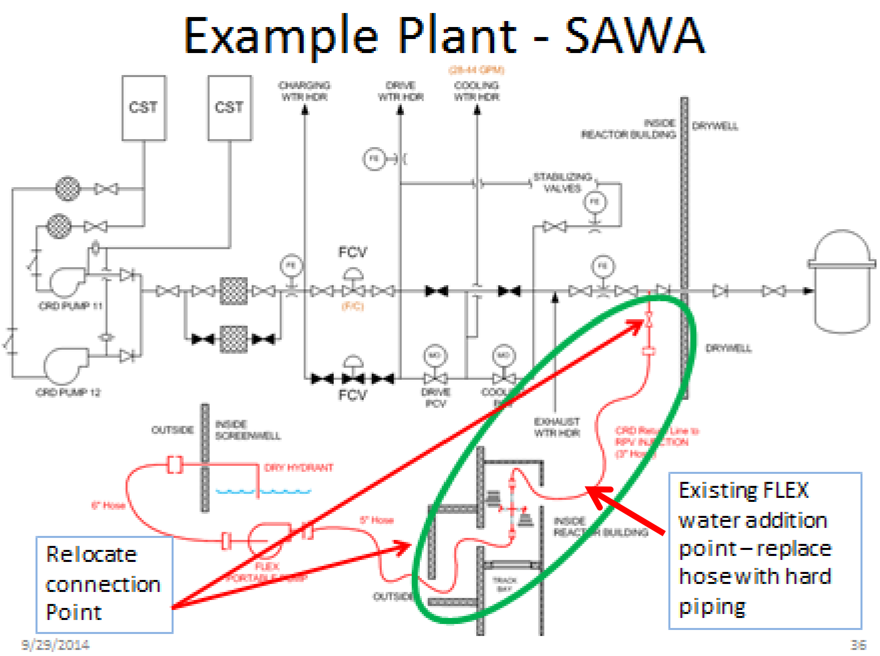
I.1.2 Water Addition Point

I.1.2.1 The water addition point may be either to the RPV or to the Drywell.

I.1.2.1.1 RPV water addition is preferred because it:

- Provides quenching and cooling for fuel remaining in-vessel, core debris and deposited fission products/aerosols remaining within the RPV.
- Provides in-vessel retention (no RPV breach) of core debris for a subset of dominant accident sequences as demonstrated in the CPRR technical analysis.
- Will follow the path of core debris exiting the RPV on a breach resulting in water reaching and cooling the core debris, and
- Limits impact of modeling uncertainties related to mode of vessel breach and extent of debris spreading.

I.1.2.1.2 There are other plant specific factors that may make the Drywell addition point acceptable, such as accessibility under severe accident conditions and as described in I.1.3.1.2. If the selected addition point will be based on plant specific design features, the licensee should state the selection and reason in the Phase 2 OIP.



I.1.2.1.3 The above diagram shows an example method for making a FLEX water addition point accessible under severe accident conditions. The FLEX connection, located in the reactor building near the containment wall, is relocated using hard pipe to a suitable distance away from the radiation source and behind available shield walls. The relocated FLEX connection is now suitable for pre (FLEX) and post (SAWA) core damage water addition.

I.1.2.1.4 Licensees should describe how the SAWA addition point is accessible under severe accident conditions in the Phase 2 OIP. (Additionally refer to sections 4, 5 and 6)

I.1.3 RPV Pressure Control

I.1.3.1 All plants will have methods available to extend the operational capability of manual pressure control using SRVs. Assessment of manual SRV pressure control capability for use of SAWA during the Order defined accident is unnecessary for the following reasons.

I.1.3.1.1 RPV depressurization is directed by the EPGs in all cases prior to entry into the SAGs.

- This is true even in the case where RPV depressurization is terminated to preserve steam driven injection in the EOPs.
  - Upon loss of the steam driven injection, the RPV depressurization is completed before entry into the SAGs, and this is accomplished by use of the SRVs dedicated to the Automatic Depressurization System (ADS).
- Once the ADS SRVs are opened, they remain open with no further cycling. The ADS system is comprised of DC powered solenoids, dedicated pneumatic tanks and controls and instrumentation necessary to support the system.
- The mitigating strategies developed to support Order EA-12-049 provide AC power to battery chargers to maintain critical DC loads, which includes the ADS system. Order EA-13-109 assumption that severe accident conditions exist with ex-vessel core debris, RPV pressure will remain approximately the same as containment pressure.

I.1.3.1.2 If a Drywell water addition point is selected, water addition will be possible independent of RPV pressure.

I.1.4 Water Addition Source

I.1.4.1 The water addition source, whether to RPV or drywell, should be capable of the flow rate and pressures needed for water addition. The EPRI Technical Report (Reference 27) validated that 500 gpm (the reference plant FLEX flow rate) was sufficient for SAWA, therefore no additional plant-specific analysis is required. See Section 4 for additional guidance on SAWA flow capability.

I.1.4.2 The time to establish the water addition capability in I.1.4.1 should be less than 8 hours from the onset of the loss of all injection sources.

I.1.4.2.1 This timing includes margin to potential containment failure following RPV breach in the worst case scenario presented in NUREG/CR7110, Volume 1; specifically, the short term station blackout without RCIC black start.

I.1.4.3 Plant connection points and portable pumps satisfying the requirements of EA-12-049 may be credited for meeting I.1.4.1 and I.1.4.2 provided the actions necessary to deploy and maintain equipment can be performed under the thermal and radiological conditions that exist during a severe accident as defined by EA-13-109 and this document. See Sections 4.1 and 4.2 for additional guidance on SAWA functional requirements, feasibility and accessibility.

I.1.4.3.1 Evaluation of the radiological conditions should be performed. (Refer to HCVS-WP-02)

I.1.4.3.2 Actions to improve accessibility for deployment of SAWA equipment may be evaluated (Refer to Appendix D and HCVS-FAQ-09).

I.1.4.4 The SAWA flow path should contain backflow prevention to minimize the possibility of combustible gases entering the SAWA system. The backflow prevention will also minimize the backflow of hot and radioactive fluids from the containment to the SAWA connection point. This function may be either part of the installed system or part of the portable system and may credit existing installed backflow prevention. The method of backflow prevention should be described in the Phase 2 OIP.

I.1.5. Motive Force

I.1.5.1 Power and pneumatic sources supporting the wetwell vent path are defined in Sections 2.5, 4.2.2, 4.2.6 and 6.1 of this document. These requirements are not changed by this Appendix.

I.1.5.2 Diesel or electric driven installed or portable pumps used to implement Order EA-12-049 (FLEX) may be used as water sources. As described in I.1.4.3, pumps used to satisfy the requirements of EA-12-049 may be credited for meeting I.1.4.1 and I.1.4.2.

I.1.5.3 Electrical generators satisfying the requirements of EA-12-049 may be credited for powering components and instrumentation needed to establish a flow path from the water source to the addition point provided the actions necessary to deploy and maintain equipment can be performed under the thermal and radiological conditions associated with a severe accident as defined by EA-13-109 and this document.

I.1.5.3.1 Evaluation of the radiological conditions should be performed. (Refer to HCVS-WP-02)

I.1.5.3.2 Actions to improve accessibility for deployment of electrical generation equipment may be evaluated (Refer to Appendix D and HCVS-FAQ-09).

I.1.5.3.2 Refer to Sections 4, 5 and 6 for additional guidance related to the feasibility and accessibility of installed and portable SAWA equipment.

I.1.6 Instrumentation

I.1.6.1 Instrumentation supporting the wetwell vent path is defined in Sections 4.2.2 and 4.2.4 of this document. These requirements are adequate to support Phase 2 SAWA implementation and are not changed by this Appendix.

I.1.6.2 Monitoring wetwell level will provide feedback to the operator that a flow path has been established.

I.1.6.2.1 Wetwell level will initially be available post ELAP until DC or AC (e.g., provided through inverters) power is depleted. FLEX strategies implementing Order EA-12-049 provide the means to power this equipment before the normal power supply is depleted through the Sustained Operation period thus this instrumentation does not need to be powered by dedicated equipment for the first 24 hours post ELAP.

I.1.6.2.2 Licensees should describe how wetwell level will be repowered through the period of Sustained Operation and show that the timing supports the transition to the 545°F SADV after the wetwell vent is flooded or when reduction in SAWA flow is needed to support wetwell vent preservation as part of the SAWM strategy in the Phase 2 OIP.

I.1.6.2.3 Operators will have additional indications available at the installed or portable pump location to determine that flow is occurring. These indications may include one or more of the following:

- Changes in pump discharge pressure indicated by pressure gages on portable pumps and comparison of discharge pressure to pump performance curves to approximate pump flow rate.
- Local flow indication provided by portable in-line flow instruments or skid mounted flow instruments.

- Local flow indication provided by flow noise through hose, valves or piping.

I.1.6.2.4 Instruments used to support pump operation (typically skid mounted) and determination of pump flow are expected to be in areas accessible to operators during severe accident conditions and may be commercial grade. These instruments should be maintained in protected locations as defined in NEI 12-06.

I.1.6.2.5 The instruments and guidance used to determine pump (SAWA) flow rate should be described in the Phase 2 OIP. The means to provide power (e.g., skid mounted diesel engine/alternator, batteries or small portable AC generators) to these instruments for the Sustained Operation period should also be described in the Phase 2 OIP.

I.1.7 Severe Accident Considerations

I.1.7.1 Severe accident considerations for water addition are limited to the thermal and radiological impacts on operator actions that may exist under severe accident conditions assumed in Order EA-13-109 and as defined in this document.

I.1.7.1 Water addition elements are not considered susceptible to the effects of combustible gas detonation or extreme high temperature associated with severe accident conditions because of the back flow prevention described in I.1.4.4.

I.1.7.2 Guidance for addressing radiological and thermal impacts on operator actions is provided in applicable sections of this Appendix, Sections 4.2 and 6.1 of this document, and HCVS-FAQ-07, HCVS-FAQ-09, and HCVS-WP-02.

APPENDIX J – FREQUENTLY ASKED QUESTIONS

A. TOPIC: HCVS Primary and Alternate Controls and Monitoring locations   Inq. No.: HCVS-FAQ-01

Source document: NEI 13-02   Sections: Order EA-13-109, Element 1.2.4, 1.2.5, 1.2.6, NEI 13-02 Section 4.2.2 and 4.2.3

B. DESCRIPTION:

What radiological and thermal conditions have to be considered in the design and location of the Primary (1.2.4) and Alternate (1.2.5) Controls locations?

Order Element 1.2.4 states, "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."

Order Element 1.2.5 states, "The HCVS shall, in addition to meeting the requirements of 1.2.4, 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.

C. PROPOSED ANSWER (Include additional pages if necessary. Total pages: 3)

Use of Main Control Room (MCR) as the preferred location for primary and/or alternate control stations is acceptable because the MCR is designed to conform to GDC 19/Alternate Source Term (AST) for radiation shielding considerations. Not having power for MCR ventilation and emergency filter trains is not a factor. During an ELAP event, there is no motive force to move source term contaminants into the control room envelope with the exception of natural circulation. Adequate protective clothing and respirators are available near the MCR to address contamination issues. Thus no evaluation is required for use of the MCR as the preferred location.

Primary and/or Alternate Control locations located outside the main control room must be determined to be readily accessible locations by performing an evaluation that includes:

- Accessibility
- Habitability
- Staffing sufficiency
- Communication capability with vent use decision makers

When evaluating accessibility and habitability of control locations outside the Control Room, consider the following:

Environmental Conditions:

Thermal Considerations: (Response support Order Elements 1.1.2 and 1.1.4):

- Temperature and heat load that exist from operation of the HCVS system
- Temperature and heat load that exist due to proximity to the undercooled containment including under severe accident conditions.

- Temperature and heat load that exists due to the ELAP condition (loss of ventilation). Action taken to provide ventilation may be considered when evaluating habitability.
- Thermal impact to the Spent Fuel Pool Area caused by the ELAP condition, but for at least one unit per site full core off load need not be considered since HCVS operation is not required when a reactors core is off loaded into the SFP.

Radiological Considerations: (Response support Order Elements 1.1.3)

- Radiological conditions that exist from operation of the HCVS system

The specific event progression that leads to the Severe Accident is NOT specified and does not have to include source terms from loss of Spent Fuel Pool Cooling as this would presume that the event progression that leads to the Severe Accident also prevents or causes the mitigating measures for loss of Spent Fuel Pool Cooling to fail. Order element 1.1.3 does discuss the requirement to consider the dose and radiological conditions caused by operation of the HCVS system but not failure of Mitigating systems related to Spent Fuel Pool Cooling.

Operator conditions: This would be governed by the above environmental conditions. Temperature conditions should be such that occupancy stay times consistent with the time to conduct HCVS operation and monitoring (instrumentation controls and displays) functions from the primary and/or alternate locations.

Communication capability does not necessarily have to be direct between the operator performing the HCVS operations and the decision maker but must be reliable and accessible while HCVS operation is required.

Time frame:

Time frames are typically associated with pre and post 24 hour actions as illustrated in Order element 1.2.6, which states: “The HCVS shall be capable of operating with dedicated and permanently installed equipment for at least 24 hours following the loss of normal power or loss of normal pneumatic supplies to air operated components during an extended loss of AC power.”

This means that with minimal operator action the equipment should be capable of operating in the thermal and radiological environment for at least 24 hours. Other provisions of NEI-13-02 such as the definition of “Sustained Operations” extend this time but do NOT preclude mitigating measures from FLEX or offsite support for reduction of thermal impacts (e.g. portable fans, AC power for ventilation, possible cooling water supplies to the area coolers if part of the FLEX mitigating measures). The restriction to credit permanently installed equipment only exists for the 24 hour period to ensure HCVS functionality for at least a 24 hour mission time without significant operator action to maintain functionality. However, all portable equipment usage needed for HCVS operation will be evaluated to be capable of operating in the thermal and radiological environment during severe accident conditions. See FAQ HCVS-02 on Order Element 1.2.6 use of “dedicated equipment”. This time frame concept may be applied to operator accessibility and habitability for primary control locations outside of the control room. The HCVS OIP should include the actions relied upon for HCVS initiation and if the actions are coming from some other guidance such as FLEX, provide a cross reference to where the information can be found.

Radiological conditions will also vary with the source term over time and could either drop or rise depending on deposition of source term in the HCVS system and vent system use. This will have to be accounted for over the time frame during which the HCVS system is being used. The definition of “sustained operation” prescribes this time frame based on when other containment cooling measures are put in place and when HCVS system operation ceases.

D. RESOLUTION: (Include additional pages if necessary. Total pages: 3)

The proposed resolution is correct. Discussed with NRC in Public meetings in January, February and March 2014. Discussed MCR rewrite on May 22 conference call. This FAQ applies to Phase 1 and Phase 2 545°F SADV option.

A. TOPIC: HCVS Dedicated Equipment

Inq. No.: HCVS-FAQ-02

Source document: EA-13-109 / NEI 13-02

Sections: EA-13-109, Element 1.2.6, NEI 13-02 Sec 4.1.2, 4.2.1.1, 4.2.6.1.2

B. DESCRIPTION:

What is the meaning of "Dedicated" in order element 1.2.6, "**Order Reference: 1.2.6** – The HCVS shall be capable of operating **with dedicated and permanently installed equipment for at least 24 hours** following the loss of normal power or loss of normal pneumatic supplies to air operated components during an extended loss of AC power."?

This FAQ does not address "dedicated" motive force which is addressed in white paper HCVS-WP-01.

C. PROPOSED ANSWER (Include additional pages if necessary. Total pages: 2)

The classical definition of "dedicated" is "*used only for one particular purpose [function]".*

- Dictionary.com – *set apart or reserved for a specific use or purpose*
- Merriam-webster.com – *used only for one particular purpose, given over to a particular purpose*

Using this literal interpretation, the words of Order element 1.26 means that all equipment associated with the HCVS should be permanently installed and only serve the HCVS function. This is inconsistent with other Order elements that permit shared component functions as discussed below:

- HCVS components may serve multiple functions described in the plant Current License Basis (CLB). Examples include:
  - ✓ Piping, valves and penetrations for both Drywell and Wetwell may be used for Drywell/Wetwell vent and purge prior to or following refueling outages or for pressure control during normal plant operation.
  - ✓ Containment Isolation valves in the HCVS system may provide a containment isolation function independent of the HCVS function.
  - ✓ Containment Isolation valve position indication for valves in the HCVS may be used for post-accident indications.
  - ✓ Instrumentation supporting HCVS and non HCVS functions.
- Some components in the HCVS system are powered electrically or pneumatically by non-dedicated sources to support non-HCVS functions as described in the plant CLB documents. Examples include:
  - ✓ Power to solenoids for Primary Containment Isolation valves.
  - ✓ Plant safety related air or nitrogen systems to operate isolation valves.
  - ✓ DC power from station batteries to instrumentation and indications for valves.

In summary, the correct interpretation of the word "dedicated" in the context of the HCVS order is essential for the proper implementation of the order.

The following components are examples of what does not have to be dedicated to the HCVS function and may be shared with other systems and support functions:

- Containment penetrations
- Containment isolation valves
- System boundary valves
- Piping
- Instrumentation
- Wiring, conduit and connection points used to service non-dedicated components

While the above components need not be dedicated, they need to be available to support HCVS function when containment venting using the HCVS system is required. Compliance with NEI 13-02 guidance will ensure that this condition is met.

D. RESOLUTION: (Include additional pages if necessary. Total pages: __2____)

The proposed resolution is correct and discussed with NRC in Public meetings in January and February 2014. This FAQ applies to Phase 1 and Phase 2 545°F SADV option.

A. TOPIC: HCVS Alternate Control Operating Mechanisms

Inq. No.: HCVS-FAQ-03

Source document: NEI 13-02

Sections: Order EA-13-109, Element 1.2.5, 1.2.6, NEI 13-02 Section 4.2.3

B. DESCRIPTION:

What means of alternate manual operation is allowable for use in the HCVS system?

Order Element 1.2.5 states, "The HCVS shall, in addition to meeting the requirements of 1.2.4, 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."

C. PROPOSED ANSWER (Include additional pages if necessary. Total pages: 1)

The examples of alternate operating mechanisms provided in Order element 1.2.5 (e.g., reach-rod with hand wheel or manual operation of pneumatic supply valves from a shielded location) are only intended to be examples. Other means of alternate manual operation (mechanical or single electrical source and single solenoid pneumatic supply valve independent) are acceptable including but not limited to:

- Separate electrical components with diverse and flexible power supplies (such as the normal valve operators with FLEX power)*
- Solenoid valves with manual overrides that may be used to manually operate vent valves without electrical power
- Manual valves in pneumatic supply and vent lines that may be used to manually operate vent valves independent of solenoid valves or electrical power
- Hydraulic operators

The inclusion of direct operation capability for valves is acceptable.

* NEI 13-02 Section 6.1 – "…At least one method of operation of the HCVS should be capable of operating with permanently installed equipment for at least 24 hours during the extended loss of AC power. The system should be designed to function in this mode with permanently installed equipment providing electrical power (e.g., DC power batteries or electrical or pneumatic operation) valve motive force (e.g., N_2/air cylinders)" A method (primary or alternate) of HCVS operation may use an alternative method to that described by the 1.2.5 requirement.

D. RESOLUTION: (Include additional pages if necessary. Total pages: 1)

The proposed resolution is correct. Discussed with NRC in Public meetings in January, February and March 2014. NRC conference call on May 22, 2014. This FAQ applies to Phase 1 and Phase 2 545°F SADV option.

A. TOPIC: HCVS Release Point

Inq. No.: HCVS-FAQ-04

Source document: NEI 13-02

Sections: Order EA-13-109, Element 1.2.2, and NEI 13-02 Section 4.1.5

B. DESCRIPTION:

What is the meaning of "release point above main plant structures" in order element 1.2., "**Order Reference: 1.2.2** – The HCVS shall discharge the effluent to a release point above main plant structures."?

To be more specific, how high should the vent release point be above the building that it is based upon/emanates from and what considerations apply with respect to adjacent buildings/structures?

C. PROPOSED ANSWER (Include additional pages if necessary. Total pages: 5)

As is stated in Attachment 2 to the Order, "the HCVS shall be designed for those accident conditions (before and after core damage) for which containment venting is relied upon to reduce the probability of containment failure…". To paraphrase, the vent is designed to protect the containment against overpressurization in a beyond design basis accident such that the release of radioactive effluent will be maintained as a controlled process. This control would be lost if primary containment fails.

It is understood that the existing Plant Stack provides an acceptable release point. This is considered valid so long as it is the highest elevated release point existing at the site. It is also understood that, if the Plant Stack is used for this purpose, measures to prevent combustible gas cross-flow between plant units and into other systems must be adequately evaluated and corrective measures must be in place (if shared with another unit's HCVS).

This response is written to address plants that have a single independent release pipe/vent per unit. This would be typically mounted onto (or emanating from) the Reactor Building, the Turbine Building, or other adjacent building convenient for the HCVS routing. This release point should only be used when venting during events which are outside of the design basis of the plant (i.e., venting for conditions from normal operation up to and including design basis accidents should be performed using 'normal' containment venting systems rather than the severe accident capable hardened containment venting system).

Guidance for HCVS elevated release points is separated out into a series of topics which are presented below. A synopsis of the bases for each recommendation is presented with each topic. The individual sites are encouraged to utilize this guidance as seen fit but also understand that they may take exception to any such guidance they choose with reasonable basis. This is also applicable to site specific conditions which are outside the bounds of this guidance. Note that in the case of multi-unit sites with single vents for each unit, adjacent unit emergency intake and exhaust pathways should also be considered relative to each of these 3 topics separately.

1. Release Point Height –

   The elevated release point should be at least 3' above the roof and related structures of the building (Ref: 2012 NFPA 211). Related structures, in this case, is intended to be any appurtenances associated with the building proper (e.g., parapet walls, etc.). This value agrees with accepted industry practice for roof vents/chimneys. This is also considered as reasonable based on the minimal frequency at which this system is considered to be used along with the relative buoyancy, relative temperature and potentially high flowrate of the released effluent (would tend to be minimally affected by building and structure effects). Exhaust stack design considerations are dependent on the purpose for containment venting.

a) Anticipatory venting to maintain core cooling

- When venting is performed at low containment pressure to maintain core cooling using FLEX strategies, there is no minimum required exhaust stack exit velocity, since without core damage there will be negligible levels of radionuclides and/or combustible gas in the effluent. Therefore, there is no concern with entrainment of the stack effluent into the roof or downstream recirculation zones associated with airflow around the building.

b) Severe accident venting to maintain containment integrity

- The potential presence of significant quantities of radionuclides and/or combustible gas in the vent stack effluent requires additional restrictions to be applied to the design and operation of the vent under severe accident conditions.
- ASHRAE HVAC Applications and Fundamental Handbooks discuss design requirements of exhaust vent stacks, but over the years the focus of the design of the vent stack was changed from the perspective of an ‘Industrial Exhaust System’ to that of a ‘Building Exhaust System’. The 1995 ASHRAE HVAC Applications was the last edition that emphasized the design of the vent stack from an industrial ventilation perspective. Hence, the 1995 ASHRAE HVAC Applications Handbook Chapter 26, section on “Exhaust Stack” is used as the guidance document, and it says that an effluent release velocity of 8000 fpm will assure that the effluent plume will not be entrained into the roof recirculation zone of a given building. Vent pipe design (e.g., pipe diameter at the exit) and conditions under which the vent is operated (e.g., minimum containment pressure at which the vent is operated; use of flow control devices) should be considered to ensure this is the predominant minimum release velocity under severe accident conditions.
  - It should be noted at this point however that strict adherence to all available guidance is not considered practical or reasonable for all aspects of the beyond design basis venting operation. It is realized that, at some point during the venting process, the containment pressure may continue to drop such that effluent flow will be reduced and effluent release velocity may drop below the stated 8000 fpm value.
  - However it must also be realized that venting of the containment volume at the accident pressures is considered to be predominately a high velocity evolution such that for the vast majority of time the effluent will be jetted up beyond the affected building recirculation zone. Effluent will not simply waft across a building roof as if released by a predominantly buoyancy driven exhaust stack but will be jetted upward from the vent due to momentum. Hence, it should be understood that by nature of any venting strategy there may be times when the effluent release velocity may drop below the stated 8000 fpm.
  - Under severe accident conditions the main purpose of the vent is to protect the containment function and use of the vent should not be limited by an effluent release velocity of 8000 fpm (e.g., venting at low pressure may be required to optimize the timing of a release or to optimize a venting strategy). In such cases, the margin in containment pressure gained by venting is more important than dispersion of the effluent.

- Under severe accident conditions while venting is in progress, the effluent release velocity is expected to be much higher than 8000 fpm for most of the venting period. Typically, near the end of a vent cycle when the releases are expected to be less concentrated, there will be a small period of time when the effluent release velocity may fall below the 8000 fpm and as a result there may be some localized increase in fallout from the effluent releases. This is not viewed as a concern during the venting cycle, since the first responders with access to the plant site will be knowledgeable of the plant emergency status and have access to adequate protection such as protective clothing and respirators. Additionally, during emergency response, health physics personnel will actively monitor for changing and developing conditions using ALARA principals. Refer to HCVS-FAQ-08 and HCVS-FAQ-09 for additional protective measures applicable during the venting period

- This discussion is supported by an evaluation based on several references (e.g., “Turbulent Jets and Plumes: A Lagrangian Approach,” Lee & Chu, 2003, “Evaluation of the Effects and Consequences of Major Accidents in Industrial Plants,” Casal, 2008) and this provides further basis that the momentum driven flow from a vent will neither be appreciably affected by the roof recirculation zone nor will the effluent be effectively entrained into air in the recirculation zone.

2. Release Point Structural Requirements -

   Missile protection evaluation is required for piping segments outside of Seismic Class I structures. This evaluation, referenced by NEI 13-02, section 5.1.1.6.2, can utilize; NRC Reg. Guide 1.76 R1, Design-Basis Tornado And Tornado Missiles For Nuclear Power Plants, which limits automobile missile impact to “all altitudes less than 30 feet”; the plants current licensing bases; or other pertinent information.

   In accordance with the guidance of NEI 13-02, section 4.1.5.2.3, the vent piping and appurtenances such as valve actuators, required instruments and associated instrument lines exposed to the outside (i.e., located outside of substantial seismic class I structures) should be designed or protected to withstand missiles that could be generated by the external events that screen in for the plant site using the guidance of NEI 12-06 as endorsed by JLD-ISG-12-01. As stated in NEI 13-02, section 5.1.1.6, the current design of (substantial) seismic class I structures provides adequate wind and missile protection for piping routed through it, as does current plant elevated release points (e.g., meteorological stack). An evaluation demonstrating reasonable protection for the vent system is an acceptable method of demonstrating compliance with this requirement.

3. Distance from Release Point to Nearest Structure -

   Typical points of vent exit from the power block are the reactor building or turbine building. As such, this topic is intended to address distances from adjacent buildings and/or structures associated with the building the vent is emanating from (e.g., equipment housings such as for elevator equipment, tanks, etc.). The distance from the vent release point to such a structure should be at least 25’ (horizontal distance). This is a reasonable separation distance and is based on the ability of the effluent stream to overcome wind effects above the roof (and cited appurtenances) elevation and agrees with accepted industry practice for roof vents. The same additional basis as stated above (for Topic 1), relative to effluent release, are considered to apply in this case.

4. Potential for Damage due to Deflagration/Detonation in Effluent Plume –

   Although momentum and buoyancy will work to drive the vented effluent upward once it has exited the release point, there is the possibility that any vented hydrogen may deflagrate or possibly detonate if an ignition source is available. Based on the guidance and philosophy presented in Topics 1 and 2, there is reasonable assurance that if such an event would occur, then any impact from vented hydrogen would be well away from building equipment. However, flammable or heat sensitive equipment should not be located in the general vicinity of the release point.

5. Distance and Elevation Relative to Emergency Filtration Intake and exhaust pathways -

   This topic is written relative to intake and exhaust pathways for systems which may be powered up from emergency power associated with facilities used in accident mitigation (e.g., EOF/TSC filter trains, CBEAF). It should not be considered applicable to normal building (such as reactor building HVAC) intake and exhaust pathways. A general “rule of thumb” of 1:5 zone of influence (5’ of horizontal travel versus 1’ of vertical drop) of the effluent from the release point to the potential downwind vortices/ recirculation zones is a reasonable method of release point configuration determination (2011 ASHRAE HVAC Applications Handbook, Chapter. 45). Although this defense-in-depth approach is more conservative than the vent/jet philosophy established in topic 1, it does provide a reasonable set of guidelines that the industry can use in locating their release points. This “rule of thumb” should be applied to such intake and exhaust pathways associated with the power block. For example, if a subject intake or exhaust is 100’ away from the release point, it should be situated such that it is at least 20’ below the tip of the release point. As is stated, this is considered as conservative guidance which may be used with no further engineering justification or validation. Based on Topic 1, there is reasonable leeway such that plants may deviate from this guidance with adequate engineering justification or evaluation.

   Good engineering judgment or sound engineering principals should be applied (relative to this ratio) for protection of such intake and exhaust pathways located away from the power block such as the TSC and EOF. There is reasonable assurance (considering good engineering judgment) that no appreciable re-entrainment of HCVS effluent will occur for intake or exhaust pathways located 100’ away from the vent release point and 20’ below the tip of the release point. It must be noted that this information should also be applied to changes made (such as open doors) to facilitate ventilation air for the Main Control Room. The considerations listed above relative to the buoyancy, temperature, and flowrate of the effluent should be included in associated basis. It should be considered in any evaluation performed, that such ventilation systems are qualified to remove the vast majority of radionuclides associated with on-site releases.

Notes relative to this guidance –

- Buildings outside of the site’s main power block should not be considered relative to the above. Administrative buildings, warehouses, and other support buildings would typically not be staffed during a BDBE unless they house an accident mitigation type emergency facility (in which case the aforementioned information should be used as stated).
- Cooling towers, by nature of their location requirements, are situated well away from the power

block such that they are not able to detrimentally affect HCVS effluent flow.

D. RESOLUTION: (Include additional pages if necessary. Total pages: __5____)

The proposed resolution is correct. Discussed with NRC in Public meetings in February and March 2014. Addressed NRC comments and discussed on NRC-NEI conference call May 22, 2014. Resolved reference to RG 1.76 R1. This FAQ applies to Phase 1 and Phase 2 545°F SADV option.

A. TOPIC: HCVS and SAWA valve testing

Inq. No.: HCVS-FAQ-05

Source document: NEI 13-02

Sections: Order EA-13-109, Element 1.2.3, 1.2.12 & 1.2.13, NEI 13-02 Section 4.1.4, 4.1.6 & 6.2

B. DESCRIPTION:

The cited NEI-13-02 sections address the prevention of cross flow between units, the prevention of effluent migration between systems (HCVS to connected systems) in a common unit, and testing of the HCVS to assure continued functionality. This FAQ addresses valving integrity relative to leakage as applicable to these Order elements.

More specifically, this FAQ addresses the operational philosophy, HCVS and SAWA specific requirements and testing of those valves which include; Primary Containment Isolation Valves (PCIVs) associated with the HCVS, PCIVs not associated with HCVS (e.g., purge lines not associated with the HCVS, piping routed to an independent set of SGTS trains), control valves (if other than PCIVs), boundary valves (which isolate other systems from the HCVS) and check valves used for prevention of combustible gas mixtures internal to the HCVS and SAWA piping.

Questions to be answered are:

- Which valves are considered as control valves and which are boundary valves, and why?
- What are the testing criteria for the various valves cited?

C. PROPOSED ANSWER (Include additional pages if necessary. Total pages: 5)

Valve Definitions as related to HCVS function (see sketch below) –

1. Control Valve – Any valve used to open the containment to the HCVS vent path such that venting may commence. This valve will also have the function of closing thereby effectively halting the venting process. This may be either of the two (PCIVs) associated with the vent system penetration or it may be a single valve installed downstream of the PCIVs used for the purpose of commencing and ceasing the venting process. Note that these downstream valves may also be pressure control valves. Control valve testing described in this FAQ is not applicable to SAWA.
2. Boundary Valve – Any valve which serves to isolate the HCVS from another system. Depending on the application these valves may be safety related or (potentially in limited cases) non-safety related. The most typical instance of a boundary valve such as this would be to isolate the Standby Gas Treatment System (SGTS) from the HCVS vent path (in which case such valves would be safety related). This category also applies to valves which isolate the vent system of one plant from that of another. Boundary valve testing described in this FAQ is not applicable to SAWA.
3. Backflow Prevention Check Valve - A check valve installed as an option to prevent the formation of a combustible gas mixture within the HCVS piping following containment venting. Note that this valve is not shown on the sketch. If it is used, it will be located downstream of the Radiation Element (RE) at a point very close to the exit point of the vent pipe. It may also be used for SAWA backflow prevention.

Testing Criteria to be Used for Valve Types –

Valve Types by Design Function (see sketch below) -

Several types of valves have been discussed in the definitions but there are two fundamental valve types (not yet differentiated) which must be considered when addressing leakage testing. These 2 types are (1) PCIVs and (2) all others cited. Note that these types are not directly related to the Control or Boundary function (as related to the HCVS) but to the safety function (or potentially non-safety function) of the valve as related to the licensing of the plant.

1. All PCIVs – These valves have a safety related function and are tested for that function as required by 10 CFR 50, Appendix J. Their safety related function is to maintain the containment pressure boundary (within a site-specific prescribed leakage range) during a design bases accident.
2. Non-PCIV HCVS Control and Boundary valves – This category includes all valves that are not PCIVs and provide a boundary function or a control function for the HCVS to be effectively operated. Basically they may be expected, at some point in the use of the HCVS, to prevent the leakage of effluent from containment to an undesirable location in the affected unit (or other unit on the plant site), or prevent leakage of effluent to the atmosphere surrounding the affected unit. These valves will typically be safety related (although there may be exceptions). The safety function of these valves is typically to open and allow flow for the reactor building ESF (engineered safety feature) system. This is typically known as the Standby Gas Treatment System (SGTS). These valves may fail open during a loss of power based on their current license base function (for example, in order to align for SGTS operation once power has been restored). As such, they must be closed and secured closed in order to be credited as an HCVS boundary valve.
3. Backflow Prevention Check Valves – This valve may be included in the HCVS design to limit backflow of air into the HCVS system that may result in a combustible gas mixture within the HCVS piping. It is one of several options for prevention of deflagration and detonation within the piping and may not be included for all systems. If included, the Severe Accident function of this valve is open to pass required containment vent flow as required by Order EA-13-109 and closed to prevent backflow of air sufficient to prevent a combustible gas mixture from forming within the HCVS piping. A means of backflow prevention is also required for SAWA to prevent the entry of combustible gases, hot and radioactive fluid from entering the SAWA system.

Testing Criteria and Valve Requirements by Valve Type –

1. PCIVs – Testing criteria for PCIVs will not change. They will continue to be tested per Appendix J criteria.
2. Non-PCIVs HCVS valves (boundary or control) – Testing criteria for these valves will be based on the individual site's Appendix J test criteria for PCIVs associated with the HCVS. The allowable leakage may be set equal to the allowable leakage for the PCIV of the valve pair associated with the HCVS containment penetration which exhibits the highest accepted leakage rate during current Appendix J testing cycle or to the leakage of the single PCIV which is to serve as a control valve for the HCVS (if a PCIV is used as such). In this way, expectations set for boundary valves will not be set higher than those for the existing safety related Primary Containment Isolation Valves. Another option which a site may consider is to test such valves in accordance with the criteria listed in the NEI 13-02, Section 6.2.3.3. Note that although minimal leakage may be expected, such leakage would be into a stagnant environment (an unused pipe or a SGTS train). Leakage into a stagnant environment such as an unused pipe or SGTS train (filter, fan housing, ducting) may be more

potentially problematic than into the general reactor building environment. A small leakage of steam and combustible gas into the reactor building would likely see some condensation of the steam and a mixing of the hydrogen such that there is no large volume combustible atmosphere mixture while a small leak rate of steam and combustible gas into a "dead end" pipe or ducting run may have the steam condense and the combustible gas concentration rise to combustible levels over time along with having the air originally in the "dead end" or stagnant volume. When determining an acceptable leakage rate for these boundary valves, this possibility should be considered.

These valves should be purchased or modified such that they are or can be qualified to operate and/or remain closed (depending on their function, either control or purely isolation) at HCVS design temperature and pressure. They should be tested at a frequency as specified in NEI 13-02, Section 6.2.4. They need not be tested at HCVS design temperature and pressure but at ambient temperature and per Appendix J as formerly stated. Note that leakage requirements are to be applied separately to each valve such that cumulative consideration of the leak testing of the individual valves will suffice as leak testing of the system. As an example, consider that an HCVS is connected both upstream and downstream of the SGTS (2 isolation valves, one on either side of SGTS), is opened to containment during HCVS operation by the 2 associated PCIVs, and has a downstream control valve which controls venting and acts as an extension to containment upon halting of venting (with the upstream PCIVs remaining open during HCVS operation and isolation). The worst case leakage from that system with the vent system isolated by the control valve would be the combined leakage values of both boundary valves plus that of the control valve. Again the allowable leakage of each of these valves would be that of the associated HCVS PCIV with the highest measured leakage (of the last Appendix J applicable test cycle). Note that this total leakage would not typically be going to the same location or attached system.

It is understood that this may require evaluation and possible modification of existing site systems besides the HCVS itself (including Boundary Valves associated with those systems). System modifications such as flanged connections (for temporary blind flange installation) or maintenance valves may be required to facilitate leak testing. Test taps may also be required in the existing piping system to support boundary valve testing.

3. Backflow Prevention Check Valves – When used in the HCVS these valves are similar to Non-PCIV HCVS valves (boundary or control) in terms of leak tightness needed to control the migration of gases to limit the potential for the formation of combustible gas mixtures. Testing these valves may follow the guidance above for non-PCIV HCVS valves with the leakage criteria for check valves used in this application established so that the maximum allowable leakage will not create a combustible gas mixture in the piping being protected. When used in the SAWA system, any backflow of gases from containment will be inerted and into a water filled system. The valve allowable leakage should be based on preventing the migration of containment gases and hot radioactive fluid from causing adverse impacts to SAWA during such evolutions as a brief interruption in SAWA flow. Adverse impacts to SAWA include combustible gases mixing with oxygen causing a combustible mixture or increases in temperature or radiation levels that inhibit access to areas that need to be accessible for SAWA Sustained Operation. These considerations will be factored into design and procurement specifications for SAWA backflow prevention valves such that limiting allowable valve leakage to vendor specifications is acceptable. If leakage exceeds vendor specifications, licensees may evaluate and determine the additional leakage is acceptable provided the backflow prevention function is maintained (i.e., formation of combustible

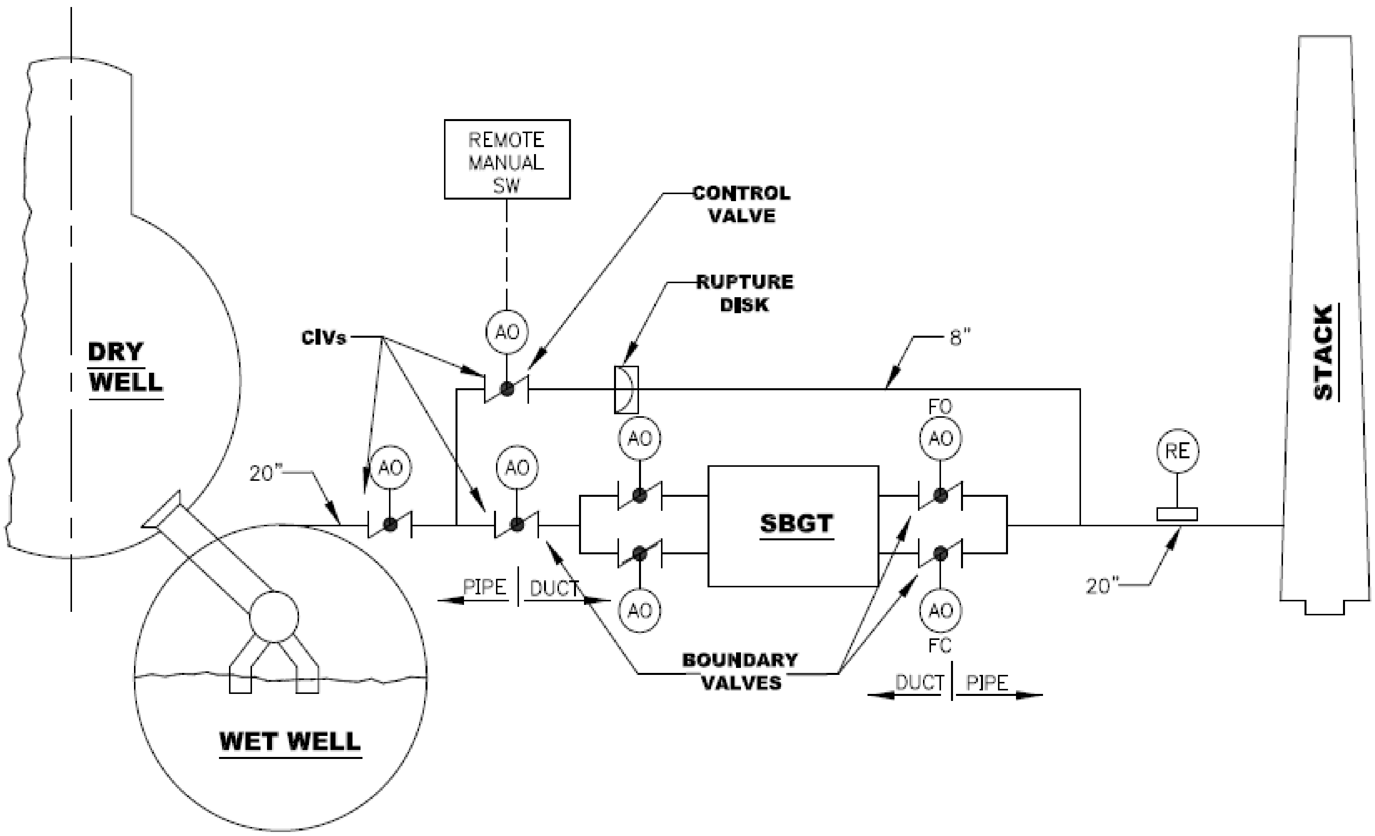
gas mixture in the applicable system (HCVS or SAWA) is prevented and HCVS and SAWA control locations remain accessible under Severe Accident conditions). For SAWA backflow prevention valves leakage tested under Appendix J, the allowable leakage criterion under Appendix J is acceptable for the SAWA backflow prevention function.

SUMMARY OF THE VALVES NEEDED FOR HCVS OPERATION

VALVE TYPE/LIST	FUNCTION	NORMAL POSITION	POSITION FOR HCVS or SAWA OPERATION	TESTING CRITERIA
PCIV	Isolates primary Containment on Isolation signal	Normal Close, Fail Close	Open	Per Appendix J (No change)
Control Valve	Operates to activate HCVS Operation	Normal Close, Fail Close	Open and Close as needed	Per Appendix J (New Criteria)
Boundary Valve	Isolates SGTS or the other system	Plant Specific	Close	Per Appendix J (New Criteria)
Backflow Prevention Check Valve	Prevent combustible gas mixture in HCVS or SAWA system	Normal Close, Fail Close	Open	Per vendor specifications[8] or Appendix J

[8] If leakage exceeds vendor specifications, licensees may evaluate and determine the additional leakage is acceptable provided the backflow prevention function is maintained (i.e., formation of combustible gas mixture in the applicable system (HCVS or SAWA) is prevented and HCVS and SAWA control locations remain accessible under Severe Accident conditions).

HARDENED CONTAINMENT VENT SYSTEM (HCVS) EXAMPLE



NOTE:
THIS SKETCH IS BASED ON THE SKETCH IN ENCLOSURE 1, GL89-16.

D. RESOLUTION: (Include additional pages if necessary. Total pages: __5____)

The proposed resolution is correct. Discussed with NRC in Public meetings in January, February and March 2014. This FAQ applies to Phase 1 and Phase 2.

A: TOPIC: HCVS FLEX and Generic Assumptions

Inq. No.: HCVS-FAQ-06

Source document: EA-13-109/NEI 12-06

Sections: Various in 13-02 and 3.2.1.2, 3.2.1.3 and 3.2.1.4 in 12-06

B. DESCRIPTION:

Provide key assumptions and characteristics associated with implementation of HCVS Phase 1 actions in a durable reference source.

C. PROPOSED ANSWER (Include additional pages if necessary. Total pages: 3)

While certain core cooling features of the site response to EA-12-049 are assumed to not function such that core damage occurs, many of the diverse and flexible actions planned for the mitigation actions (FLEX) have a high confidence of being performed and should be assumed to be available unless directly stated as not available in order EA-13-109 (i.e., portable equipment may not be used to provide motive force to HCVS components for the first 24 hours of Sustained Operation).

Applicable EA-12-049 assumptions:

049-1. Assumed initial plant conditions are as identified in NEI 12-06 section 3.2.1.2 items 1 and 2

049-2. Assumed initial conditions are as identified in NEI 12-06 section 3.2.1.3 items 1, 2, 4, 5, 6 and 8

049-3. Assumed reactor transient boundary conditions are as identified in NEI 12-06 section 3.2.1.4 items 1, 2, 3 and 4

049-4. No additional events or failures are assumed to occur immediately prior to or during the event, including security events except for failure of RCIC or HPCI. (Reference NEI 12-06 3.2.1.3 item 9)

049-5. At Time=0 the event is initiated and all rods insert and no other event beyond a common site ELAP is occurring at any or all of the units. (NEI 12-06, section 3.2.1.3 item 9 and 3.2.1.4 item 1-4

049-6. At {Site Specific Time} (time critical at a time greater than {Site Specific time}) an ELAP is declared and actions begin as defined in EA-12-049 compliance

049-7. DC power and distribution can be credited for the duration determined per the EA-12-049 (FLEX) methodology for battery usage, ({Site Specific Time}) (NEI 12-06, section 3.2.1.3 item 8)

049-8. Deployment resources are assumed to begin arriving at hour 6 and fully staffed by 24 hours

049-9. All activities associated with plant specific EA-12-049 FLEX strategies that are not specific to implementation of the HCVS, including such items as debris removal, communication, notification, SFP level and makeup, security response, opening doors for cooling, and initiating conditions for the event, can be credited as previously evaluated for FLEX.

Applicable EA-13-109 generic assumptions:

049-10. Site response activities associated with EA-13-109 actions are considered to have no access limitations associated with radiological impacts while RPV level is above 2/3 core height (core damage is not expected).

049-11. Portable equipment can supplement the installed equipment after 24 hours provided the portable equipment credited meets the criteria applicable to the HCVS. An example is use of FLEX portable air supply equipment that is credited to recharge air lines for HCVS components after 24 hours. The FLEX portable air supply used must be demonstrated to meet the “SA Capable” criteria that are defined in NEI 13-02 Section 4.2.4.2 and Appendix D Section D.1.3. This assumption does not apply to Phase 2 SAWA/SAWM because SAWA equipment needs to be connected in 8 hours from the time of the ELAP.

049-12. SFP Level is maintained with either on-site or off-site resources such that the SFP does not contribute to the analyzed source term (Reference HCVS-FAQ-07)

049-13. Existing containment components design and testing values are governed by existing plant primary containment criteria (e.g., Appendix J) and are not subject to the testing criteria from NEI 13-02 (reference HCVS-FAQ-05 and NEI 13-02 section 6.2.2).

049-14. Classical design basis evaluations and assumptions are not required when assessing the operation of the HCVS. The reason this is not required is that the order postulates an unsuccessful mitigation of an event such that an ELAP progresses to a severe accident with ex-vessel core debris which classical design basis evaluations are intended to prevent. (Reference NEI 13-02 section 2.3.1).

049-15. HCVS manual actions that require minimal operator steps and can be performed in the postulated thermal and radiological environment at the location of the step(s) (e.g., load stripping, control switch manipulation, valving-in nitrogen bottles) are acceptable to obtain HCVS venting dedicated functionality. (reference HCVS-FAQ-01) This assumption does not apply to Phase 2 SAWA/SAWM because SAWA equipment needs to be connected in 8 hours from the time of the ELAP and will require more than minimal operator action.

049-16. HCVS dedicated equipment is defined as vent process elements that are required for the HCVS to function in an ELAP event that progresses to core melt ex-vessel. (reference HCVS-FAQ-02 and White Paper HCVS-WP-01). This assumption does not apply to Phase 2 SAWA/SAWM because SAWA equipment is not dedicated to HCVS but shared to support FLEX functions.

049-17. Use of MAAP Version 4 or higher provides adequate assurance of the plant conditions (e.g., RPV water level, temperatures, etc.) assumed for Order EA-13-109 BDBEE and SA HCVS operation. (reference FLEX MAAP Endorsement ML13190A201) Additional analysis using RELAP5/MOD 3, GOTHIC, PCFLUD, LOCADOSE and SHIELD are acceptable methods for evaluating environmental conditions in areas of the plant provided the specific version utilized is documented in the analysis. MAAP Version 5 was used to develop EPRI Technical Report 3002003301 to support drywell temperature response to SAWA under severe accident conditions.

049-18. Utilization of NRC Published Accident evaluations (e.g. SOARCA, SECY-12-0157, and NUREG 1465) as related to Order EA-13-109 conditions is acceptable as references. (Reference NEI 13-02 section 8).

049-19. Permanent modifications installed or planned per EA-12-049 are assumed implemented and may be credited for use in EA-13-109 Order response.

049-20. This Overall Integrated Plan is based on Emergency Operating Procedure changes consistent with EPG/SAGs Revision 3 as incorporated per the sites EOP/SAMG procedure change process. This assumption does not apply to Phase 2 SAWM because SAWM is expected to require changes to the EPG/SAGs. This may be in the form of a revision or an issue resolution between revisions.

049-21. Under the postulated scenarios of order EA-13-109 the Control Room is adequately protected from excessive radiation dose due to its distance and shielding from the reactor (per General Design Criterion (GDC) 19 in 10CFR50 Appendix A) and no further evaluation of its use as the preferred HCVS control location is required. In addition, adequate protective clothing and respiratory protection is available if required to address contamination issues. (reference HCVS-FAQ-01)

D. RESOLUTION: (Include additional pages if necessary. Total pages: 3)

The proposed resolution is correct. Discussed with NRC in Public meetings in January, February and March 2014. Addressed NRC comments from 05-14-14 as discussed on May 22, 2014. This is a conforming change to the NRC OIP template. This FAQ applies to Phase 1 and Phase 2 545°F SADV option. This FAQ also applies to Phase 2 SAWA/SAWM option unless specifically noted.

A. TOPIC: HCVS Source Term from SFP

Inq. No.: HCVS-FAQ-07

Source document: EA-13-109/NEI 13-02/NEI 12-02/NEI 12-06

Sections: Various

B. DESCRIPTION:

What impact of the SFP source term is required to be considered for environmentally sensitive actions supporting HCVS operation?

C. PROPOSED ANSWER (Include additional pages if necessary. Total pages: 1)

SFP Level is maintained above EA-12-051 Level 2 with either on-site or off-site resources such that no contribution to analyzed source term need be considered.

The following statements support this position:

- Actions under Order EA-12-049 provides multiple mitigation actions to protect SFP cooling and Order EA-12-051 provides redundant instrumentation to plant decision makers to allow correct prioritization of any action needed for the SFP. Every site has to be in compliance with these Orders.
- There is no assumption or criteria in the EA-13-109 Order that relates to a "SFP accident". The Order only mentions core damage and protection of Mk I & II containments, i.e., "reactor severe accident".

If action is required for HCVS in the SFP area then the environment (i.e., temperature and humidity) in the vicinity and ingress/egress must be evaluated as identified in FAQ HCVS-01.

D. RESOLUTION: (Include additional pages if necessary. Total pages: 1)

The proposed resolution is correct and discussed with NRC in Public meetings in January and February 2014. This FAQ applies to Phase 1 and Phase 2 545°F SADV option. This FAQ also applies to Phase 2 SAWA/SAWM option.

A. TOPIC: HCVS Instrument Qualification

Inq. No.: HCVS-FAQ-08

Source document: Order EA-13-109 and NEI 13-02

Sections: Order EA-13-109, Element 1.1.1, 1.1.2, 1.1.3, 1.2.4, 1.2.5, 1.2.6, NEI 13-02 Section 4.2.2, 4.2.3 4.2.4

B. DESCRIPTION:

Note: This FAQ addresses the environmental and radiological impacts on the ability of HCVS instrumentation to remain functional during the sustained operational period. Environmental and radiological impacts on accessibility and habitability for system operation are addressed in HCVS-FAQ-01, HCVS Primary Controls and Alternate Controls and Monitoring Locations.

What conditions have to be considered in the design and siting of HCVS Controls and monitoring equipment?

Order Element 1.2.4 states, "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."

Order Element 1.2.5 states, "The HCVS shall, in addition to meeting the requirements of 1.2.4, 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."

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

C. PROPOSED ANSWER (Include additional pages if necessary. Total pages: 3)

Environmental Conditions:

The Primary/Alternate controls and monitoring equipment design must consider the following:

Thermal Considerations: (See Order Elements 1.1.2 and 1.1.4):

- Main Control Room (MCR) temperature and heat load that exist for operation of the HCVS.
  - Temperature and heat load that exist due to proximity to the undercooled containment.
    - MCR Temperatures considered for Order EA-12-049 (FLEX) are reasonable to use since any changes as the result of a severe accident are not expected to have an adverse impact on the MCR due to Control Room location in a separate air space and FLEX ventilation methods applied to the MCR
  - Temperature and heat load that exists due to the ELAP condition (loss of ventilation).
    - Utilize toolbox actions (e.q., portable fans, opening of doors, etc.) and EA-12-049 (FLEX) mitigation strategies. (Ref HCVS-FAQ-09)
    - HCVS controls and instrumentation will be similar to other instrumentation and controls found in most MCRs. Unless the licensee uses controls and instrumentation in the HCVS system that are known to be susceptible to failure from elevated temperatures but within habitability limits, no evaluation of temperature effects needs to be performed for

HCVS components located in the MCR.

- No portable equipment should be required to operate the HCVS within the first 24 hours per the criteria in order EA-13-109.

- Primary or Alternate Control location (if other than MCR) temperature and heat load that exist for operation of the HCVS.
  - Temperature and heat load that exist due to proximity to the undercooled containment and spent fuel pool.
  - Temperature and heat load that exists due to the ELAP condition (loss of ventilation).
    - If this location is NOT in the Reactor Building or other buildings where HCVS piping is located then the heat load impact is similar to the MCR when the location is in a separate air space.
    - HCVS controls and instrumentation located outside the MCR will be similar to other instrumentation and controls found in plant locations outside the MCR. Unless the licensee uses controls and instrumentation in the HCVS system that are known to be susceptible to failure from elevated temperatures but within habitability limits, no evaluation of temperature effects needs to be performed for HCVS components located outside of the Reactor Building or other buildings where HCVS piping is located.

Radiological Considerations: (See Order Elements 1.1.3)

- Main Control room radiological conditions that exist from operation of the HCVS system.
  - MCR complies with the intent of General Design Criteria (GDC) 19 or the Alternate Source Term (AST) which provides reasonable assurance of protection from radiological consequences.
- Primary or Alternate Control location (if other than Control Room) radiological conditions that exist for operation of the HCVS system.
  - This analysis may be bounded by the required dose considerations for Control Room design in General Design Criteria (GDC) 19 or the Alternate Source Term (AST) analysis if this location is outside the Reactor Building due to Reactor Building to Auxiliary Building Shielding design.
  - If the location is inside the Reactor Building, then it will need to be evaluated for radiological impact due to HCVS system operation under severe accident conditions.
- The specific event progression that leads to the Severe Accident is NOT specified and does not have to include multiple path source terms from loss of Spent Fuel Pool Cooling as this would presume that the event progression that leads to the Severe Accident also prevents or causes the mitigating measures for loss of Spent Fuel Pool Cooling to fail. Order element 1.1.3 does discuss the requirement to consider the dose and radiological conditions caused by operation of the HCVS system but not failure of Mitigating Strategies related to Spent Fuel Pool Cooling.

Time frame:

The instrumentation should be capable of operating in the thermal and radiological environment for at least 24 hours without significant operator action (see HCVS-FAQ-02, HCVS Dedicated Equipment, for a discussion of significant operator action considerations for the first 24 hours of the sustained operational period). Other provisions of NEI-13-02 such as the definition of "Sustained Operations" extend this time but do NOT preclude mitigating measures from FLEX or offsite support for reduction in thermal or radiological impacts (e.g. portable fans, AC power for ventilation, possible cooling water supplies to the area coolers if part of the FLEX mitigating measures. The restriction on permanently installed equipment and simple and easily performed operator actions only exists for the 24 hour period to ensure HCVS viability for at least a 24 hour mission time. See HCVS-FAQ-02 on Order Element 1.2.6 use of "dedicated equipment" and HCVS-WP-01, HCVS Dedicated Power and Motive Force.

D. RESOLUTION: (Include additional pages if necessary. Total pages: 3)

The proposed resolution is correct. Discussed with NRC in Public meetings in February and March 2014. Discussed NRC 05-14-14 comments in May 22, 2014 conference call. This FAQ applies to Phase 1 and Phase 2 545°F SADV option. This FAQ also applies to Phase 2 SAWA/SAWM option as it applies to SAWA/SAWM instrumentation.

A. TOPIC: HCVS Toolbox Approach for Collateral Actions

Inq. No.: HCVS-FAQ-09

Source document: NEI 13-02

Sections: Order EA-13-109, Element 1.2.4, 1.2.5, 1.2.6, NEI 13-02 Section 4.2.2, 4.2.3 4.2.4

B. DESCRIPTION:

Document the use of Toolbox approach for collateral actions that will be symptom based but are within the skill of the craft or general personnel knowledge.

Order Element 1.2.4 states, "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."

Order Element 1.2.5 states, "The HCVS shall, in addition to meeting the requirements of 1.2.4, 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."

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

C. PROPOSED ANSWER (Include additional pages if necessary. Total pages: 1)

Examples of acceptable toolbox approach for collateral actions are:

- Opening doors when room temperatures become elevated
- Using flashlights to supplement pathway use
- Exchange of personnel, use of ice vests, etc. when action is in degrading levels of heat and humidity environment, not life threatening
- Utilizing small fans for air movement
- Utilization of protective clothing and respirators to address localized contamination concerns

D. RESOLUTION: (Include additional pages if necessary. Total pages: 1)

The proposed resolution is correct. Discussed with NRC in Public meetings in February and March 2014. Discussed NRC 05-14-14 comments on May 22, 2014 conference call. This FAQ applies to Phase 1 and Phase 2 545°F SADV option. This FAQ also applies to Phase 2 SAWA/SAWM option.

APPENDIX K – PHASE 1 OVERALL INTEGRATED PLAN TEMPLATE

Table of Contents:

Introduction

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

On March 19, 2013, the Nuclear Regulatory Commission (NRC) Commissioners directed the staff per Staff Requirements Memorandum (SRM) for SECY -12-0157 to require licensees with Mark I and Mark II containments to "upgrade or replace the reliable hardened vents required by Order EA-12-050 with a containment venting system designed and installed to remain functional during severe accident conditions." In response, the NRC issued Order EA-13-109, *Issuance of Order to Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accidents*, June 6, 2013. 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 maintain control of containment pressure within acceptable limits following events that result in the loss of active containment heat removal capability while maintaining the capability to operate under severe accident (SA) conditions resulting from an Extended Loss of AC Power (ELAP).

The Order requirements are applied in a phased approach where:

- "Phase 1 involves upgrading the venting capabilities from the containment wetwell to provide reliable, severe accident capable hardened vents to assist in preventing core damage and, if necessary, to provide venting capability during severe accident conditions." (Completed "no later than startup from the second refueling outage that begins after June 30, 2014, or June 30, 2018, whichever comes first.")
- "Phase 2 involves providing additional protections for severe accident conditions through installation of a reliable, severe accident capable drywell vent system or the development of a reliable containment venting strategy that makes it unlikely that a licensee would need to vent from the containment drywell during severe accident conditions." (Completed "no later than startup from the first refueling outage that begins after June 30, 2017, or June 30, 2019, whichever comes first.")

The NRC provided an acceptable approach for complying with Order EA-13-109 through Interim Staff Guidance (JLD-ISG-2013-02) issued in November 2013. The ISG endorses the compliance approach presented in NEI 13-02 Revision 0, *Compliance with Order EA-13-109, Severe Accident Reliable Hardened Containment Vents*, with clarifications. Except in those cases in which a licensee proposes an acceptable alternative method for complying with Order EA-13-109, the NRC staff will use the methods described in this ISG (NEI 13-02) to evaluate licensee compliance as presented in submittals required in Order EA-13-109.

The Order also requires submittal of an overall integrated plan which will provide a description of how the requirements of the Order will be achieved. This document provides the Overall Integrated Plan (OIP) for complying with Order EA-13-109 using the methods described in NEI 13-02 and endorsed by NRC JLD-ISG-2013-02. Six month progress reports will be provided consistent with the requirements of Order EA-13-109.

The Plant venting actions for the EA-13-109 severe accident capable venting scenario can be summarized by the following:

- The HCVS will be initiated via manual action from the Main Control Room (MCR) or Remote Operating Station (ROS) at the appropriate time based on procedural guidance in response to plant conditions from observed or derived symptoms.
- The vent will utilize Containment Parameters of Pressure, Level and Temperature from the MCR instrumentation to monitor effectiveness of the venting actions
- The vent operation will be monitored by HCVS valve position, temperature, [pressure] and effluent radiation levels.
- The HCVS motive force will be monitored and have the capacity to operate for 24 hours with installed equipment. Replenishment of the motive force will be by use of portable equipment once the installed motive force is exhausted.
- Venting actions will be capable of being maintained for a sustained period of up to 7 days or a shorter time if justified.

Part 1: General Integrated Plan Elements and Assumptions
Extent to which the guidance, JLD-ISG-2013-02 and NEI 13-02, are being followed. Identify any deviations. *Include a description of any alternatives to the guidance. A technical justification and basis for the alternative needs to be provided. This will likely require a pre-meeting with the NRC to review the alternative.* **Ref: JLD-ISG-2013-02**
Compliance will be attained for {Site Name} with no known deviations to the guidelines in JLD-ISG-2013-02 and NEI 13-02 for each phase as follows: • Phase 1 (wetwell): by the startup from the second refueling outage that begins after June 30, 2014, or June 30, 2018, whichever comes first. Currently scheduled for {Quarter and Year} • Phase 2: Later *[you may want to enter your dates for drywell]* { no later than startup from the first refueling outage that begins after June 30, 2017, or June 30, 2019, whichever comes first. Currently scheduled for {Quarter and Year}} *[may need to add more bullets for multi-unit sites]* *[Describe and justify any alternative approaches to the guidelines in JLD-ISG-2013-02]* If deviations are identified at a later date, then the deviations will be communicated in a future 6 month update following identification.
State Applicable Extreme External Hazard from NEI 12-06, Section 4.0-9.0 *List resultant determination of screened in hazards from the EA-12-049 Compliance.* **Ref: NEI 13-02 Section 5.2.3 and D.1.2**
The following extreme external hazards screen-in for {Site Name} • Seismic, External Flooding, Extreme Cold, High Wind, Extreme High Temperature (only list those that screen-in) The following extreme external hazards screen out for {Site Name} • External Flooding, Extreme Cold, High Wind, Extreme High Temperature (only list those that screen out)

Part 1: General Integrated Plan Elements and Assumptions

Key Site assumptions to implement NEI 13-02 HCVS Actions.

Provide key assumptions associated with implementation of HCVS Phase 1 Actions

Ref: NEI 13-02 Section 1

Mark I/II Generic HCVS Related Assumptions:

Applicable EA-12-049 assumptions:

049-22. Assumed initial plant conditions are as identified in NEI 12-06 section 3.2.1.2 items 1 and 2

049-23. Assumed initial conditions are as identified in NEI 12-06 section 3.2.1.3 items 1, 2, 4, 5, 6 and 8

049-24. Assumed reactor transient boundary conditions are as identified in NEI 12-06 section 3.2.1.4 items 1, 2, 3 and 4

049-25. No additional events or failures are assumed to occur immediately prior to or during the event, including security events except for failure of RCIC or HPCI. (Reference NEI 12-06, section 3.2.1.3 item 9)

049-26. At Time=0 the event is initiated and all rods insert and no other event beyond a common site ELAP is occurring at any or all of the units. (NEI 12-06, section 3.2.1.3 item 9 and 3.2.1.4 item 1-4)

049-27. At {48 minutes} (time critical at a time greater than {1 hour}) an ELAP is declared and actions begin as defined in EA-12-049 compliance

049-28. DC power and distribution can be credited for the duration determined per the EA-12-049 (FLEX) methodology for battery usage, (greater than {12} hours with a calculation limiting value of {14.5} hrs.) (NEI 12-06, section 3.2.1.3 item 8)

049-29. Deployment resources are assumed to begin arriving at hour 6 and fully staffed by 24 hours

049-30. All activities associated with plant specific EA-12-049 FLEX strategies that are not specific to implementation of the HCVS, including such items as debris removal, communication, notifications, SFP level and makeup, security response, opening doors for cooling, and initiating conditions for the event, can be credited as previously evaluated for FLEX.

Applicable EA-13-109 generic assumptions:

109-1. Site response activities associated with EA-13-109 actions are considered to have no access limitations associated with radiological impacts while RPV level is above 2/3 core height (core damage is not expected).

109-2. Portable equipment can supplement the installed equipment after 24 hours provided the portable equipment credited meets the criteria applicable to the HCVS. An example is use of FLEX portable air supply equipment that is credited to recharge

Part 1: General Integrated Plan Elements and Assumptions

air lines for HCVS components after 24 hours. The FLEX portable air supply used must be demonstrated to meet the "SA Capable" criteria that are defined in NEI 13-02 Section 4.2.4.2 and Appendix D Section D.1.3.

109-3. SFP Level is maintained with either on-site or off-site resources such that the SFP does not contribute to the analyzed source term (Reference HCVS-FAQ-07)

109-4. Existing containment components design and testing values are governed by existing plant containment criteria (e.g., Appendix J) and are not subject to the testing criteria from NEI 13-02 (reference HCVS-FAQ-05 and NEI 13-02 section 6.2.2).

109-5. Classical design basis evaluations and assumptions are not required when assessing the operation of the HCVS. The reason this is not required is that the order postulates an unsuccessful mitigation of an event such that an ELAP progresses to a severe accident with ex-vessel core debris which classical design basis evaluations are intended to prevent. (Reference NEI 13-02 section 2.3.1).

109-6. HCVS manual actions that require minimal operator steps and can be performed in the postulated thermal and radiological environment at the location of the step(s) (e.g., load stripping, control switch manipulation, valving-in nitrogen bottles) are acceptable to obtain HCVS venting dedicated functionality. (reference HCVS-FAQ-01)

109-7. HCVS dedicated equipment is defined as vent process elements that are required for the HCVS to function in an ELAP event that progresses to core melt ex-vessel. (reference HCVS-FAQ-02 and White Paper HCVS-WP-01)

109-8. Use of MAAP Version 4 or higher provides adequate assurance of the plant conditions (e.g., RPV water level, temperatures, etc.) assumed for Order EA-13-109 BDBEE and SA HCVS operation. (reference FLEX MAAP Endorsement ML13190A201) Additional analysis using RELAP5/MOD 3, GOTHIC, PCFLUD, LOCADOSE and SHIELD are acceptable methods for evaluating environmental conditions in areas of the plant provided the specific version utilized is documented in the analysis.

109-9. Utilization of NRC Published Accident evaluations (e.g. SOARCA, SECY-12-0157, and NUREG 1465) as related to Order EA-13-109 conditions are acceptable as references. (reference NEI 13-02 section 8)

109-10. Permanent modifications installed per EA-12-049 are assumed implemented and may be credited for use in EA-13-109 Order response.

109-11. This Overall Integrated Plan is based on Emergency Operating Procedure changes consistent with EPG/SAGs Revision 3 as incorporated per the sites EOP/SAMG procedure change process.

Part 1: General Integrated Plan Elements and Assumptions

109-12. Under the postulated scenarios of order EA-13-109 the Control Room is adequately protected from excessive radiation dose per General Design Criterion (GDC) 19 in 10CFR50 Appendix A and no further evaluation of its use as the preferred HCVS control location is required. (reference HCVS-FAQ-01) In addition, adequate protective clothing and respiratory protection is available if required to address contamination issues.

Plant Specific HCVS Related Assumptions/Characteristics:

[Plant specific assumptions, particularly related to plant configuration or special design attributes]

PLT-1. {The main stack at Plant PLT can handle the HCVS flow from both units simultaneously. Once outside the reactor building, effluent lines slope downward toward main stack.

PLT-2. All load stripping is accomplished within one hour and fifteen minutes of event initiation and will occur below the core area at locations not impacted by a radiological event.

PLT-3. The rupture disk will be manually breeched within 7.3 hours of event initiation}

Part 2: Boundary Conditions for Wet Well Vent

Provide a sequence of events and identify any time or environmental constraint required for success including the basis for the constraint.

HCVS Actions that have a time constraint to be successful should be identified with a technical basis and a justification provided that the time can reasonably be met (for example, action to open vent valves).

HCVS Actions that have an environmental constraint (e.g. actions in areas of High Thermal stress or High Dose areas) should be evaluated per guidance.

Describe in detail in this section the technical basis for the constraints identified on the sequence of events timeline attachment.

See attached sequence of events timeline (Attachment 2)

Ref: EA-13-109 Section 1.1.1, 1.1.2, 1.1.3 / NEI 13-02 Section 4.2.5, 4.2.6. 6.1.1

The operation of the HCVS will be designed to minimize the reliance on operator actions in response to hazards listed in Part 1. Immediate operator actions will be completed by plant personnel and will include the capability for remote-manual initiation from the HCVS control station. A list of the remote manual actions performed by plant personnel to open the HCVS vent path can be found in the following table (2-1). A HCVS Extended Loss of AC Power (ELAP) Failure Evaluation table, which shows alternate actions that can be performed, is included in Attachment 4.

Table 2-1 HCVS Remote Manual Actions

Primary Action	Primary Location / Component	Notes
1. Isolate Standby Gas Treatment System (SGTS) by closing inlet valve 1/2T48-F081 and outlet isolation valves 1T46-F005 & 2T46-F002A & F002B	Hand switches located in the MCR	or at the Remote Operating Station (ROS), depending on where operator of HCVS is stationed
2. Disable PCIV interlocks by Installing electrical jumpers for PCIVs (ref. Procedures 31EO-EOP-101-1 and 31EO-EOP-101-2	Panels in MCR containing PCIV interlocks	
3. Confirm closed HCVS condensate drain valve 2T48-F085	Hand switch located in the MCR for condensate drain valve	Unit 2 only. Unit 1 N/A And at ROS

Part 2: Boundary Conditions for Wet Well Vent

		panel
4. Breach the rupture disk by opening the argon cylinder valve & valve 1/2T48-F407	Manual hand wheels for valves at the argon bottle and at the piping at the argon bottle station	Not required during SA event Only required if performing early venting for FLEX
5. Close argon cylinder valve & valve ½T48-F407	Manual hand wheels for valves at the argon bottle and at the piping at the argon bottle station	Not required during SA event Only required if performing early venting for FLEX
6. Open Wetwell PCIVs 1/2T48-F318 & ½T48-F326	Hand switches located in the MCR panel	And at ROS
7. Open HCVS vent control valve ½T48-F082	Hand switch for valve in the MCR	And at ROS
8. Align power supplies for all valves and instruments via Inverters 1/2R44-S006 & ½R44-S007.	Instruments and controls located in the MCR	Prior to depletion of station batteries, actions will be required to swap to dedicated HCVS power supply. And at ROS
9. Replenish pneumatics with replaceable nitrogen bottles	Nitrogen bottles will be located in an area that is accessible to operators, preferable near the ROS.	Prior to depletion of the pneumatic sources actions will be required to connect back-up sources at a time greater than 24 hours.
10. Re-align power supplies for all valves and instruments via Inverters ½R44-S006 & ½R44-S007.	Instruments and controls located in the MCR	Prior to depletion of the installed power sources actions will be required to connect back-up sources at a time

Part 2: Boundary Conditions for Wet Well Vent

		greater than 24 hours. And at ROS

A timeline was developed to identify required operator response times and potential environmental constraints. This timeline is based upon the following three cases:

1. Case 1 is a based upon the action response times developed for FLEX when utilizing anticipatory venting in a BDBEE without core damage.
2. Case 2 is based on a SECY-12-0157 long term station blackout (LTSBO) (or ELAP) with failure of RCIC after a black start where failure occurs because of subjectively assuming over injection.
3. Case 3 is based on NUREG-1935 (SOARCA) results for a prolonged SBO (or ELAP) with the loss of RCIC case without black start.

Discussion of time constraints identified in Attachment 2 for the 3 timeline cases identified above

- XX Hours, Initiate use of Hardened Containment Vent System (HCVS) per site procedures to maintain containment parameters below design limits and within the limits that allow continued use of RCIC - The reliable operation of HCVS will be met because HCVS meets the seismic requirements identified in NEI 13-02 and will be powered by DC buses with motive force supplied to HCVS valves from {installed accumulators and portable nitrogen storage bottles.} Critical HCVS controls and instruments associated with containment will be DC powered and operated from the MCR or a Remote Operating Station on each unit. The DC power for HCVS will be available as long as the HCVS is required. {Station batteries will provide power for greater than 12 hours,} HCVS battery capacity will be available to extend past 24 hours. In addition, when available Phase 2 FLEX Diesel Generator (DG) can provide power before battery life is exhausted. Thus initiation of the HCVS from the MCR or the Remote Operating Station within XX hours is acceptable because the actions can be performed any time after declaration of an ELAP until the venting is needed at XX hours for BDBEE venting. This action can also be performed for SA HCVS operation which occur at a time further removed from an ELAP declaration as shown in Attachment 2.
- XX Hours {greater than 24 hours}, installed nitrogen bottles will be valved-in to supplement the Nitrogen tank supply. The Nitrogen bottles can be replenished one at a time leaving the other 2 supplying the HCVS. This can be performed at any time prior to 24 hours to ensure adequate capacity is maintained so this time constraint is not limiting.
- XX Hours {greater than 24 hours}, temporary generators will be installed and connected to {the pigtail to power up battery chargers} using a portable DG to supply power to

Part 2: Boundary Conditions for Wet Well Vent
HCVS critical components/instruments - Time critical after ZZ hours. Current battery durations are calculated to last greater than 24 hours. DG will be staged beginning at approximately {8-10 hour time frame (Reference FLEX OIP). Within Two (2) hours later the DG will be in service.} Thus the DGs will be available to be placed in service at any point after 24 hours as required to supply power to HCVS critical components/instruments. A DG will be maintained in on-site FLEX storage buildings. DG will be transferred and staged via haul routes and staging areas evaluated for impact from external hazards. Modifications to will be implemented to facilitate the connections and operational actions required to supply power within {XX} hours which is acceptable because the actions can be performed any time after declaration of an ELAP until the repowering is needed at greater than 24 hours. • *[Site Specific actions that are time critical for HCVS initiation]* Discussion of radiological and temperature constraints identified in Attachment 2 • {XX Hours, Operators override the …….. • At ZZ hours, based on battery depletion, power supply will be swapped from station batteries to dedicated HCVS batteries to ensure power to the inverters. Access to the transfer switch will be in the control building.} • At >24 hours, {installed nitrogen bottles will be valved-in to supplement the} air {accumulator} supply as stated for the related time constraint item. {Nitrogen bottles will be located in an area that is accessible to operators, preferable near the ROS.} • At >24 Hours, temporary generators will be installed and connected {to the pigtail to power up battery chargers} using a portable DG to supply power to HCVS critical components/instruments - Time critical after {XX} hours. Current battery durations are calculated to last greater than {GG} hours (Reference X). DG will be staged beginning at approximately {8-10} hour time frame (Reference Y). Within Two (2) hours of deployment the DG will be in service. Thus the DGs will be available to be placed in service at any point after 24 hours as required to supply power to HCVS critical components/instruments. The connections, location of the DG and access for refueling will be located in an area that is accessible to operators {in the Control Building or in the yard area because the HCVS vent pipe is underground once it leaves the Reactor Building.}

Part 2: Boundary Conditions for Wet Well Vent

Provide Details on the Vent characteristics

Vent Size and Basis (EA-13-109 Section 1.2.1 / NEI 13-02 Section 4.1.1)

What is the plants licensed power? Discuss any plans for possible increases in licensed power (e.g. MUR, EPU).

What is the nominal diameter of the vent pipe in inches/ Is the basis determined by venting at containment design pressure, Primary Containment Pressure Limit (PCPL), or some other criteria (e.g. anticipatory venting)?

Vent Capacity (EA-13-109 Section 1.2.1 / NEI 13-02 Section 4.1.1)

Indicate any exceptions to the 1% decay heat removal criteria, including reasons for the exception. Provide the heat capacity of the suppression pool in terms of time versus pressurization capacity, assuming suppression pool is the injection source.

Vent Path and Discharge (EA-13-109 Section 1.1.4, 1.2.2 / NEI 13-02 Section 4.1.3, 4.1.5 and Appendix F/G)

Provides a description of Vent path, release path, and impact of vent path on other vent element items.

Power and Pneumatic Supply Sources (EA-13-109 Section 1.2.5 & 1.2.6 / NEI 13-02 Section 4.2.3, 2.5, 4.2.2, 4.2.6, 6.1)

Provide a discussion of electrical power requirements, including a description of dedicated 24 hour power supply from permanently installed sources. Include a similar discussion as above for the valve motive force requirements. Indicate the area in the plant from where the installed/dedicated power and pneumatic supply sources are coming

Indicate the areas where portable equipment will be staged after the 24 hour period, the dose fields in the area, and any shielding that would be necessary in that area. Any shielding that would be provided in those areas

Location of Control Panels (EA-13-109 Section 1.1.1, 1.1.2, 1.1.3, 1.1.4, 1.2.4, 1.2.5 / NEI 13-02 Section 4.1.3, 4.2.2, 4.2.3, 4.2.5, 4.2.6, 6.1.1 and Appendix F/G)

Indicate the location of the panels, and the dose fields in the area during severe accidents and any shielding that would be required in the area. This can be a qualitative assessment based on criteria in NEI 13-02.

Hydrogen (EA-13-109 Section 1.2.10, 1.2.11, 1.2.12 / NEI 13-02 Section 2.3,2.4, 4.1.1, 4.1.6, 4.1.7, 5.1, & Appendix H)

State which approach or combination of approaches the plant will take to address the control of flammable gases, clearly demarcating the segments of vent system to which an approach applies

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Unintended Cross Flow of Vented Fluids (EA-13-109 Section 1.2.3, 1.2.12 / NEI 13-02 Section 4.1.2, 4.1.4, 4.1.6 and Appendix H)

Provide a description to eliminate/minimize unintended cross flow of vented fluids with emphasis on interfacing ventilation systems (e.g. SGTS). What design features are being included to limit leakage through interfacing valves or Appendix J type testing features?

Prevention of Inadvertent Actuation (EA-13-109 Section 1.2.7/NEI 13-02 Section 4.2.1)

The HCVS shall include means to prevent inadvertent actuation

Component Qualifications (EA-13-109 Section 2.1 / NEI 13-02 Section 5.1, 5.3)

State qualification criteria based on use of a combination of safety related and augmented quality dependent on the location, function and interconnected system requirements

Monitoring of HCVS (Order Elements 1.1.4, 1.2.8, 1.2.9/NEI 13-02 4.1.3, 4.2.2, 4.2.4, and Appendix F/G)

Provides a description of instruments used to monitor HCVS operation and effluent. Power for an instrument will require the intrinsically safe equipment installed as part of the power sourcing

Component reliable and rugged performance (EA-13-109 Section 2.2 / NEI 13-02 Section 5.2, 5.3)

HCVS components including instrumentation should be designed, as a minimum, to meet the seismic design requirements of the plant.

Components including instrumentation that are not required to be seismically designed by the design basis of the plant should be designed for reliable and rugged performance that is capable of ensuring HCVS functionality following a seismic event. (reference ISG-JLD-2012-01 and ISG-JLD-2012-03 for seismic details.)

The components including instrumentation external to a seismic category 1 (or equivalent building or enclosure should be designed to meet the external hazards that screen-in for the plant as defined in guidance NEI 12-06 as endorsed by JLD-ISG-12-01 for Order EA-12-049.

Use of instruments and supporting components with known operating principles that are supplied by manufacturers with commercial quality assurance programs, such as ISO9001. The procurement specifications shall include the seismic requirements and/or instrument design requirements, and specify the need for commercial design standards and testing under seismic loadings consistent with design basis values at the instrument locations.

Demonstration of the seismic reliability of the instrumentation through methods that predict performance by analysis, qualification testing under simulated seismic conditions, a combination of testing and analysis, or the use of experience data. Guidance for these is based on sections 7, 8, 9, and 10 of IEEE Standard 344-2004, "IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating

Part 2: Boundary Conditions for Wet Well Vent

Stations," or a substantially similar industrial standard could be used.

Demonstration that the instrumentation is substantially similar in design to instrumentation that has been previously tested to seismic loading levels in accordance with the plant design basis at the location where the instrument is to be installed (g-levels and frequency ranges). Such testing and analysis should be similar to that performed for the plant licensing basis.

Vent Size and Basis

The HCVS wetwell path is designed for venting steam/energy at a nominal capacity of 1% or greater *{or another value of <1%, include the analysis basis of the selected value}* of *{CLTP or Projected Power Uprate at time of implementation}* MWt thermal power at pressure of *{YY}* psig. *[Insert any clarification statements of this power level if it is not the current licensed power level.]* _ *[If not CLTP then add]* *{The thermal power assumes a power uprate of XX% above the currently licensed thermal power of YYYY MWt.}* This pressure is the lower of the containment design pressure and the PCPL value. The size of the wetwell portion of the HCVS of {XX} inches in diameter {until combines with the common HCVS piping sized at YY inches} which provides adequate capacity to meet or exceed the Order criteria.

Vent Capacity

The 1% {or another value of <1%} value at {Site Name} assumes that the suppression pool pressure suppression capacity is sufficient to absorb the decay heat generated during the first 3 hours. The vent would then be able to prevent containment pressure from increasing above the containment design pressure. As part of the detailed design, the duration of suppression pool decay heat absorption capability {has been / will be} confirmed.

{[Open Item -1:] Confirm suppression pool heat capacity}

Vent Path and Discharge

{Existing} HCVS vent path at {Plant Name will consist(s)} of a {wetwell and drywell vent on each unit. The drywell vent exits the Primary Containment into the Reactor Building and proceeds down to the torus bay. Wetwell and drywell vent piping merges into a common header in the torus bay. Vent path for both wetwell and drywell exits the reactor building through an underground pipe. This pipe travels approximately 500 feet from both units and combines in a mixing chamber at the base of the main stack. All effluents exit out the main stack.}

The HCVS discharge path uses the plant stack.

- Or –

The HCVS discharge path {will be / is} routed to a point above any adjacent structure *[state any exceptions, for example: The cooling towers have a higher elevation but they are not adjacent to the Reactor Building. The Station's chimney is an adjacent structure, but it is impractical to raise the HCVS above the chimney.]* This discharge point is *{just above that*

Part 2: Boundary Conditions for Wet Well Vent

unit's Reactor Building} *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 a ELAP and BDBEE, and emergency response facilities; however, these must be considered in conjunction with other design criteria (e.g., flow capacity) and pipe routing limitations, to the degree practical *[Describe basis for routing that does not avoid these areas, i.e., current routing, best position considering all items*]

The detailed design {will / addresses} missile protection to a maximum height of 30 feet from ground elevation, from external events as defined by NEI 12-06 for the outside portions of the selected release stack or structure. *[this should be a design element using reasonable protection features for the screened in hazards from NEI 12-06, engineering should use design basis missile hazards methods in the calculations. Examples could be specific details from the sites FSAR.](reference FAQ HCVS-04)*

Power and Pneumatic Supply Sources

All electrical power required for operation of HCVS components will be routed through {two Inverters, one for each electrical division. These inverters will be sized at 7.5 kW each and will convert DC power from installed batteries into AC power for the end users (instruments, solenoid valves, etc.).} Battery power will be provided by {the existing station service batteries for the first 12 hours following the ELAP event. At about 12 hours, power will be transferred to dedicated batteries that will supply power for an additional 12 hours.} At 24 hours, power will transfer {back to the station batteries, at which time it is expected that FLEX generators will be in service to recharge station batteries.}

Pneumatic power is normally provided by {the non-interruptible air system with backup nitrogen provided from installed nitrogen supply tanks. Following an ELAP event, station air system is lost, and normal backup from installed nitrogen supply tanks is isolated. Therefore, for the first 24 hours, pneumatic force will be supplied from newly installed air accumulator tanks. These tanks will supply the required motive force to those HCVS valves needed to maintain flow through the HCVS effluent piping.}

1. The HCVS flow path valves are *{air-operated valves (AOV) with air-to-open and spring-to-shut. Opening the valves requires energizing an AC powered solenoid operated valve (SOV) and providing motive air/gas. The detailed design will provide a permanently installed power source and motive air/gas supply]* adequate for the first 24 hours *[state if you are crediting FLEX to sustain DC power for >24 hours (If that option is selected during the detailed design, state the capability under the FLEX effort to maintain the DC source is still applicable under the EA-13-109 Order Elements)].* The initial stored motive air/gas will allow for a minimum of *{XX}* valve operating cycles for the HCVS valves for the first 24-hours
2. An assessment of temperature and radiological conditions *{has been / will be}* performed to ensure that operating personnel can safely access and operate controls at the {Remote Operating Station} based on time constraints listed in Attachment 2. *[controls not in the MCR]*

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3. All permanently installed HCVS equipment, including any connections required to supplement the HCVS operation during an ELAP (i.e., electric power, N2/air) [*are / will be*] located in areas reasonably protected from defined hazards listed in Part 1 of this report.
4. All valves required to open the flow path *or valves that require manual operation to be closed to prevent diversion or cross-flow into other systems/units[will be / are]* designed for remote manual operation following a ELAP, such that the primary means of valve manipulation does not rely on use of a hand wheel, reach–rod or similar means that requires close proximity to the valve (reference FAQ HCVS-03). *[Describe how you are ensuring accessibility for radiological and environmental conditions, such as use of ice vests or shielding]* Any supplemental connections will be pre-engineered to minimize man-power resources and address environmental concerns. Required portable equipment will be reasonably protected from screened in hazards listed in Part 1 of this OIP.
5. Access to the locations described above will not require temporary ladders or scaffolding.

   [If the design provides any additional design features, add the information.]
6. {Following the initial 24 hour period, additional motive force will be supplied from nitrogen bottles that will be staged at a gas cylinder rack located (near the ROS in the control building or outside) such that radiological impacts are not an issue. Additional bottles can be brought in as needed.}

Location of Control Panels

The HCVS design allows initiating and then operating and monitoring the HCVS from the Main Control Room (MCR) and *[specify the alternate location].* The MCR location is protected from adverse natural phenomena and the normal control point for Plant Emergency Response actions. *[Address dose and temperature items for the non-MCR location, Utilize FAQ HCVS-01 in the response]*.

Hydrogen

As is required by EA-13-109, Section 1.2.11, the HCVS must be designed such that it is able to either provide assurance that oxygen cannot enter and mix with flammable gas in the HCVS (so as to form a combustible gas mixture), or it must be able to accommodate the dynamic loading resulting from a combustible gas detonation. Several configurations are available which will support the former (e.g., purge, mechanical isolation from outside air, etc.) or the latter (design of potentially affected portions of the system to withstand a detonation relative to pipe stress and support structures).

State which approach or combination of approaches the plant will take to address the control of flammable gases, clearly demarcating the segments of vent system to which an approach applies

Part 2: Boundary Conditions for Wet Well Vent

Unintended Cross Flow of Vented Fluids

[Response if dedicated containment isolation valves are used] {The HCVS uses PCIVs for containment isolation. These containment isolation valves are AOVs that are air-to-open and spring-to-shut. An SOV must be energized to allow the motive air to open the valve. A containment isolation signal will automatically de-energize the SOV causing the AOVs to shut. In a beyond design basis event, steps to manually override the containment isolation function have been incorporated into operating procedures to allow for operation of the HCVS.[for dedicated systems, an option is to maintain the valves closed and de-energized in lieu of having a containment isolation signal}

{Response if "shared" containment isolation valves are used} {The HCVS uses the Containment Purge System containment isolation valves for containment isolation. These containment isolation valves are AOVs and they are air-to-open and spring-to-shut. An SOV must be energized to allow the motive air to open the valve. Although these valves are shared between the Containment Purge System and the HCVS, separate control circuits are provided to each valve for each function. Specifically:

- *The Containment Purge System control circuit will be used during all "design basis" operating modes including all design basis transients and accidents.*
- *Cross flow potential exists between the HCVS and the Standby Gas Treatment System (SGTS). Resolution involves evaluation of SGTS isolation valve leakage for both inlet and outlet valves, as both interface with the HCVS. If necessary, these valves will be replaced with leak-tight valves. Testing and maintenance will be performed to ensure that the valves remain leak-tight.*
- *An addition cross-flow avenue exists between the HCVS of the two units at the mixing chamber in the shared Main Stack. With the Main Stack being open to the atmosphere, there is no motive force to push effluent from the mixing chamber back to the plant, thus it is assumed this avenue of cross flow is not a reasonable assumption. } [insert high level explanation describing why HCVS effluent will not backup into other plant systems/units that discharge to the stack. This explanation should include why the buoyancy of the vent process fluid will not be sufficient motive force to create backflow]*

Prevention of Inadvertent Actuation

EOP/ERG operating procedures provide clear guidance that the HCVS is not to be used to defeat containment integrity during any design basis transients and accident. In addition, the HCVS {is/will be} designed to provide features to prevent inadvertent actuation due to a design error, equipment malfunction, or operator error such that any credited containment accident pressure (CAP) that would provide net positive suction head to the emergency core cooling system (ECCS) pumps will be available (inclusive of a design basis loss-of-coolant accident (DBLOCA)). However the ECCS pumps will not have normal power available because of the starting boundary conditions of an ELAP. *[If the unit credits CAP, state specific CAP requirement that is maintained, otherwise state your site does not rely on CAP*

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to maintain NPSH for ECCS pumps.]

- The features that prevent inadvertent actuation are *[site specific list]* {two PCIV's in series powered from different division, a rupture disk, or key lock switches. [*If using a rupture disk for this purpose, but is NOT serving as primary containment boundary (in series with closed valves include "To serve this purpose, the rupture disk burst pressure is set above the maximum calculated design basis accident pressure" OR if rupture disk is serving as primary containment isolation boundary (in series with open valve(s) include "To serve this purpose, the rupture disk burst pressure is set above design pressure,]* Procedures also provide clear guidance to not circumvent containment integrity by simultaneously opening torus and drywell vent valves during any design basis transient or accident. In addition, the HCVS will be designed to provide features to prevent inadvertent actuation due to a design error, equipment malfunction, or operator error.}

Component Qualifications

The HCVS components downstream of the second containment isolation valve {and components that interface with the HCVS} are routed in seismically qualified structures {except for components x, y, z. For those components, the structure {has been / will be} analyzed for seismic ruggedness to ensure that any potential failure would not adversely impact the function of the HCVS or other safety related structures or components} *[i.e. seismic category II over category I criteria]*. HCVS components that directly interface with the pressure boundary will be considered safety related, as the existing system is safety related. The containment system limits the leakage or release of radioactive materials to the environment to prevent offsite exposures from exceeding the guidelines of 10CFR100. During normal or design basis operations, this means serving as a pressure boundary to prevent release of radioactive material.

Likewise, any electrical or controls component which interfaces with Class 1E power sources will be considered safety related up to and including appropriate isolation devices such as fuses or breakers, as their failure could adversely impact containment isolation and/or a safety-related power source. The remaining components will be considered Augmented Quality. Newly installed piping and valves will be seismically qualified to handle the forces associated with the seismic margin earthquake (SME) back to their isolation boundaries. Electrical and controls components will be seismically qualified and will include the ability to handle harsh environmental conditions (although they will not be considered part of the site Environmental Qualification (EQ) program).

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

The HCVS instruments, including valve position indication, process instrumentation, radiation monitoring, and support system monitoring, will be qualified by using one or more of the three methods described in the ISG, which includes:

Part 2: Boundary Conditions for Wet Well Vent

1. Purchase of instruments and supporting components with known operating principles from manufacturers with commercial quality assurance programs (e.g., ISO9001) where the procurement specifications include the applicable seismic requirements, design requirements, and applicable testing.
2. Demonstration of seismic reliability via methods that predict performance described in IEEE 344-2004
3. Demonstration that instrumentation is substantially similar to the design of instrumentation previously qualified.

Instrument	**Qualification Method***
HCVS Process Temperature	ISO9001 / IEEE 344-2004 / Demonstration
HCVS Process Pressure	ISO9001 / IEEE 344-2004 / Demonstration
HCVS Process Radiation Monitor	ISO9001 / IEEE 344-2004 / Demonstration
HCVS Process Valve Position	ISO9001 / IEEE 344-2004 / Demonstration
HCVS Pneumatic Supply Pressure	ISO9001 / IEEE 344-2004 / Demonstration
HCVS Electrical Power Supply Availability	ISO9001 / IEEE 344-2004 / Demonstration

* The specific qualification method used for each required HCVS instrument will be reported in future 6 month status reports. *[include the specific qualification method used for each instrument if available]*

Monitoring of HCVS

The {site name} wetwell HCVS will be capable of being manually operated during sustained operations from a control panel located in the main control room (MCR) and will meet the requirements of Order element 1.2.4. The MCR is a readily accessible location with no further evaluation required. Control Room dose associated with HCVS operation conforms to GDC 19/Alternate Source Term (AST). Additionally, to meet the intent for a secondary control location of section 1.2.5 of the Order, a readily accessible Remote Operating Station (ROS) will also be incorporated into the HCVS design as described in NEI 13-02 section 4.2.2.1.2.1. The controls and indications at the ROS location will be accessible and functional under a range of plant conditions, including severe accident conditions with due consideration to source term and dose impact on operator exposure, extended loss of AC power (ELAP), and inadequate containment cooling. An evaluation will be performed to determine accessibility to the location, habitability, staffing sufficiency, and communication capability with Vent-use decision makers.

The wetwell HCVS will include means to monitor the status of the vent system in both the MCR and the ROS. {Included in the current design of the reliable hardened vent (RHV) are control switches in the MCR with valve position indication. The existing RHV controls currently meet the environmental and seismic requirements of the Order for the plant severe accident and will be upgraded to address ELAP. The ability to open/close these valves

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multiple times during the event's first 24 hours will be provided by air accumulator tanks and station service batteries, supplemented by installed backup battery power sources.} Beyond the first 24 hours, the ability to maintain these valves open or closed will be provided with {replaceable nitrogen bottles and FLEX generators.}

The wetwell HCVS will include indications for vent pipe pressure, temperature, and effluent radiation levels at {both the MCR and ROS}. Other important information on the status of supporting systems, {such as power source status and pneumatic supply pressure, will also be included in the design and located to support HCVS operation.} The wetwell HCVS includes existing containment pressure and wetwell level indication in the MCR to monitor vent operation. This monitoring instrumentation provides the indication from the MCR as per Requirement 1.2.4 and will be designed for sustained operation during an ELAP event.

Component reliable and rugged performance

The HCVS downstream of the second containment isolation valve, including piping and supports, electrical power supply, valve actuator pneumatic supply, and instrumentation (local and remote) components, [has been / will be] designed/analyzed to conform to the requirements consistent with the applicable design codes (e.g., Non-safety, Cat 1, SS and 300# ASME or B31.1, NEMA 4, etc.) for the plant and to ensure functionality following a design basis earthquake.

Additional modifications required to meet the Order will be reliably functional at the temperature, pressure, and radiation levels consistent with the vent pipe conditions for sustained operations. The instrumentation/power supplies/cables/connections (components) will be qualified for temperature, pressure, radiation level, total integrated dose radiation for the Effluent Vent Pipe {and HCVS ROS Location.}

Conduit design will be installed to Seismic Class 1 criteria. Both existing and new barriers will be used to provide a level of protection from missiles when equipment is located outside of seismically qualified structures. Augmented quality requirements, will be applied to the components installed in response to this Order.

If the instruments are purchased as commercial-grade equipment, they will be qualified to operate under severe accident environment as required by NRC Order EA-13-109 and the guidance of NEI 13-02. {The equipment will be qualified seismically (IEEE 344), environmentally (IEEE 323), and EMC (per RG 1.180).} These qualifications will be bounding conditions for {site name}.

For the instruments required after a potential seismic event, the following methods will be used to verify that the design and installation is reliable / rugged and thus capable of ensuring HCVS functionality following a seismic event. Applicable instruments are rated by the manufacturer (or otherwise tested) for seismic impact at levels commensurate with those of postulated severe accident event conditions in the area of instrument component use using one or more of the following methods:

- demonstration of seismic motion will be consistent with that of existing design basis

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loads at the installed location; • substantial history of operational reliability in environments with significant vibration with a design envelope inclusive of the effects of seismic motion imparted to the instruments proposed at the location; • adequacy of seismic design and installation is demonstrated based on the guidance in Sections 7, 8, 9, and 10 of IEEE Standard 344-2004, *IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations*, (Reference xxx) or a substantially similar industrial standard; • demonstration that proposed devices are substantially similar in design to models that have been previously tested for seismic effects in excess of the plant design basis at the location where the instrument is to be installed (g-levels and frequency ranges); or • seismic qualification using seismic motion consistent with that of existing design basis loading at the installation location.

Part 2 Boundary Conditions for WW Vent: **BDBEE Venting**

Determine venting capability for BDBEE Venting, such as may be used in an ELAP scenario to mitigate core damage.

Ref: EA-13-109 Section 1.1.4 / NEI 13-02 Section 2.2

First 24 Hour Coping Detail

Provide a general description of the venting actions for first 24 hours using installed equipment including station modifications that are proposed.

Ref: EA-13-109 Section 1.2.6 / NEI 13-02 Section 2.5, 4.2.2

The operation of the HCVS *[has been / will be]* designed to minimize the reliance on operator actions for response to a ELAP and BDBEE hazards identified in part 1 of this OIP. Immediate operator actions can be completed by Operators from the HCVS control station(s) and include remote-manual initiation. The operator actions required to open a vent path are as described in table 2-1.

Remote-manual is defined in this report as a non-automatic power operation of a component and does not require the operator to be at or in close proximity to the component. No other operator actions are required to initiate venting under the guiding procedural protocol.

The HCVS {has been / will be} designed to allow initiation, control, and monitoring of venting from {the Main Control Room (MCR) / or specify the alternate location}. This location minimizes plant operators' exposure to adverse temperature and radiological conditions and is protected from hazards assumed in Part 1 of this report.

Permanently installed power and motive air/gas capability will be available to support operation and monitoring of the HCVS for {24 / x} hours. Permanently installed equipment will supply air and power to HCVS for 24 hours.

System control:

i. Active: {Control valves and/or PCIVs} are operated in accordance with EOPs/SOPs to control containment pressure. The HCVS {will be / is} designed for {#} open/close cycles under ELAP conditions over the first 24 hours following an ELAP. Controlled venting will be permitted in the revised EPGs and associated implementing EOPs*. {add specific site details if available}* {e.g., jumpers will be used to override the containment isolation circuit on the PCIVs needed to vent containment.}

ii. Passive: Inadvertent actuation protection is provided by *[describe the feature credited for protection of inadvertent actuation]*

{Rupture disk(s) are provided in the vent line downstream of the CIVs. Rupture disks can be intentionally breached from the [Main Control Room / alternate control location] as directed by applicable procedures. The CIVs must be open to permit vent flow. State what rupture disk burst pressure is based on (PSP, PCPL, design pressure, or other)

Part 2 Boundary Conditions for WW Vent: **BDBEE Venting**
- OR –   Key lock switches located in the [Main Control Room / alternate control location] as directed by applicable procedures.   - *OR* –   Other}
Greater Than 24 Hour Coping Detail   *Provide a general description of the venting actions for greater than 24 hours using portable and installed equipment including station modifications that are proposed.*   **Ref: EA-13-109 Section 1.2.4, 1.2.8 / NEI 13-02 Section 4.2.2**
After {24 / x} hours, available personnel will be able to connect supplemental motive air/gas to the HCVS. Connections for supplementing electrical power and motive air/gas required for HCVS {will be / are} located in accessible areas with reasonable protection per NEI 12-06 that minimize personnel exposure to adverse conditions for HCVS initiation and operation. Connections {will be / are} pre-engineered quick disconnects to minimize manpower resources. *[State if you are crediting FLEX to sustain power for a BDBEE ELAP. If so, state that the response to NRC EA-12-049 will demonstrate the capability for FLEX efforts to maintain the power source.]*   These actions provide long term support for HCVS operation for the period beyond 24 hrs. to 7 days (sustained operation time period) because on-site and off-site personnel and resources will have access to the unit(s) to provide needed action and supplies.
Details:
Provide a brief description of Procedures / Guidelines: *Confirm that procedure/guidance exists or will be developed to support implementation.*
Primary Containment Control Flowchart exists to direct operations in protection and control of containment integrity, {including use of the existing Hardened Vent System}. Other site procedures for venting containment using the HCVS include: {31EO-TSG-001-0, Technical Support Guidelines; 31EO-EOP-101-1/2, Emergency Containment Venting; 31EO-EOP-104-1/2, Primary Containment Venting for Hydrogen and Oxygen Control.}
Identify modifications: *List modifications and describe how they support the HCVS Actions.*
EA-12-049 Modifications   • DCPs SNC467474 and SNC476661 will provide the Inverters that will convert station battery DC power into AC power for use by the end-users needed for HCVS operation.   • DCPs SNC440278 and SNC539300 will provide both the air accumulators and the

Part 2 Boundary Conditions for WW Vent: **BDBEE Venting**

nitrogen bottles needed for pneumatic support of the HCVS air actuators for the first 72 hours following an ELAP event. It will install the means to manually burst the rupture disk in the HCVS header to allow for flow.

- DCP SNC469007 will provide forced ventilation to MCR for operator habitability and HCVS equipment controls and instrumentation functionality.

EA-13-109 Modifications

- A modification will be required to install the dedicated batteries and the disconnect switches needed to supply power to HCVS for the second 12 hours following the ELAP event once station batteries have been depleted.
- A modification will be required to install a Remote Operation Station for both units.
- A modification will be required to install a HCVS Rad Monitor and power supply on each unit.
- A modification will be required for installation of required HCVS instrumentation and controls in the MCR and ROS for both units. Some of this will be completed under FLEX DCPs SNC440278 and SNC539300.
- Additional modifications may be required to system isolation valves, rupture disk/assembly, and existing HCVS piping.

Key Venting Parameters:

List instrumentation credited for this venting actions. Clearly indicate which of those already exist in the plant and what others will be newly installed (to comply with the vent order)

Initiation, operation and monitoring of the HCVS venting will rely on the following key parameters and indicators:

Key Parameter	**Component Identifier**	**Indication Location**
HCVS Effluent temperature	TBD	MCR/ROS
HCVS Pneumatic supply pressure	TBD	MCR/ROS
HCVS valve position indication	TBD	MCR/ROS
HCVS system pressure indication	TBD	MCR/ROS
Rupture Disc Pressure	1T48-N030/2T48-N030)	Reactor Building

Part 2 Boundary Conditions for WW Vent: **BDBEE Venting**

Initiation, operation and monitoring of the HCVS system will rely on several existing Main Control Room key parameters and indicators which are qualified or evaluated to Reg Guide 1.97 per the existing plant design:

Key Parameter	**Component Identifier**	**Indication Location**
Drywell pressure	1/2T48-N023A/B	MCR
Torus pressure		MCR
Torus water temperature		MCR
Torus level	1/2T48-N021A/B	MCR
Reactor pressure		MCR
Drywell radiation		MCR

HCVS indications for HCVS valve position indication, HCVS pneumatic supply pressure, HCVS effluent temperature, and HCVS system pressure will be installed in the MCR to comply with EA-13-109. {All of the indications listed above will be installed at the Remote Operating Station.}

Notes:

Part 2 Boundary Conditions for WW Vent: **Severe Accident Venting**

Determine venting capability for Severe Accident Venting, such as may be used in an ELAP scenario to mitigate core damage.

Ref: EA-13-109 Section 1.2.10 / NEI 13-02 Section 2.3

First 24 Hour Coping Detail

Provide a general description of the venting actions for first 24 hours using installed equipment including station modifications that are proposed.

Ref: EA-13-109 Section 1.2.6 / NEI 13-02 Section 2.5, 4.2.2

The operation of the HCVS will be designed to minimize the reliance on operator actions for response to an ELAP and severe accident events. Severe accident event assumes that specific core cooling actions from the FLEX strategies identified in the response to Order EA-12-049 were not successfully initiated. Access to the reactor building will be restricted as determined by the RPV water level and core damage conditions. Immediate actions will be completed by Operators in the Main Control Room (MCR) or at the HCVS Remote Operating Station (ROS) and will include remote-manual actions {from a local gas cylinder station}. The operator actions required to open a vent path were previously listed in the BDBEE Venting Part 2 section of this report (Table 2-1).

Permanently installed power and motive air/gas capable will be available to support operation and monitoring of the HCVS for 24 hours. Specifics are the same as for BDBEE Venting Part 2.

System control:

i. Active: Same as for BDBEE Venting Part 2.

ii. Passive: Same as for BDBEE Venting Part 2, except {the rupture disk has a burst set pressure which has been determined to be above the maximum inlet header pressure expected during a design basis event. In a severe accident scenario, the pressure from the wet well will be able to burst the rupture disk unassisted, as it will be above the pressure expected during the worst case design basis event.}

Greater Than 24 Hour Coping Detail

Provide a general description of the venting actions for greater than 24 hours using portable and installed equipment including station modifications that are proposed.

Ref: EA-13-109 Section 1.2.4, 1.2.8 / NEI 13-02 Section 4.2.2

Specifics are the same as for BDBEE Venting Part 2 except {the location and refueling actions for the FLEX DG and replacement Nitrogen Bottles} will be evaluated for SA environmental conditions resulting from the proposed damaged Reactor Core and resultant HCVS vent pathway.

{[OPEN ITEM]: Perform SA Evaluation for FLEX DG use for post 24 hour actions}

Part 2 Boundary Conditions for WW Vent: **Severe Accident Venting**
These actions provide long term support for HCVS operation for the period beyond 24 hrs. to 7 days (sustained operation time period) because on-site and off-site personnel and resources will have access to the unit(s) to provide needed action and supplies.
Details:
Provide a brief description of Procedures / Guidelines: *Confirm that procedure/guidance exists or will be developed to support implementation.*
The operation of the HCVS is governed the same for SA conditions as for BDBEE conditions. Existing guidance in the SAMGs directs the plant staff to consider changing radiological conditions in a severe accident.
Identify modifications*:* *List modifications and describe how they support the HCVS Actions.*
The same as for BDBEE Venting Part 2 {except ….}
Key Venting Parameters: *List instrumentation credited for the HCVS Actions. Clearly indicate which of those already exist in the plant and what others will be newly installed (to comply with the vent order)*
The same as for BDBEE Venting Part 2 {except ….}
Notes:

Part 2 Boundary Conditions for WW Vent: **HCVS Support Equipment Functions**
Determine venting capability support functions needed **Ref: EA-13-109 Section 1.2.8, 1.2.9 / NEI 13-02 Section 2.5, 4.2.4, 6.1.2**
BDBEE Venting *Provide a general description of the BDBEE Venting actions support functions. Identify methods and strategy(ies) utilized to achieve venting results.* **Ref: EA-13-109 Section 1.2.9 / NEI 13-02 Section 2.5, 4.2.2, 4.2.4, 6.1.2**
Containment integrity is initially maintained by permanently installed equipment. All containment venting functions will be performed from the MCR or ROS {except for breaching of the rupture disc for anticipatory venting.} Venting will require support from DC power as well as instrument air systems as detailed in the response to Order EA-12-049. Existing safety related station batteries will provide sufficient electrical power for HCVS operation for greater than {XX} hours. Before station batteries are depleted, portable FLEX diesel generators, as detailed in the response to Order EA-12-049, will be credited to charge the station batteries and maintain DC bus voltage after {XX} hours. Newly installed accumulator tanks with back-up portable N2 bottles will provide sufficient motive force for all HCVS valve operation and will provide for multiple operations of the {1/2T48-F082} vent valve.
Severe Accident Venting *Provide a general description of the Severe Accident Venting actions support functions. Identify methods and strategy(ies) utilized to achieve venting results.* **Ref: EA-13-109 Section 1.2.8, 1.2.9 / NEI 13-02 Section 2.5, 4.2.2, 4.2.4, 6.1.2**
The same support functions that are used in the BDBEE scenario would be used for severe accident venting. {To ensure power for the 12 to 24 hours, a set of dedicated HCVS batteries will be available to feed HCVS loads via a manual transfer switch.} At 24 hours, power will be {switched back to the station service batteries, which at that point will be backed up by FLEX generators evaluated for SA capability. Nitrogen bottles that will be located outside of the reactor building and in the immediate area of the ROS} will be available to tie-in supplemental pneumatic sources.
Details:
Provide a brief description of Procedures / Guidelines: *Confirm that procedure/guidance exists or will be developed to support implementation.*
Most of the equipment used in the HCVS is permanently installed. The key portable items are the {SA Capable/FLEX DGs, argon bottles needed to burst the rupture disk and the nitrogen bottles} needed to supplement the air supply to the AOVs after 24 hours. These will be staged

Part 2 Boundary Conditions for WW Vent**: HCVS Support Equipment Functions**
in position for the duration of the event.
Identify modifications*:* *List modifications and describe how they support the HCVS Actions.*
Flex modifications applicable to HCVS operation: {main control room vestibule to provide air flow pathway to main control rooms for operator habitability; add connection points and cabling at the control building wall and turbine building (SW Corner) to connect FLEX 600VAC diesel generators to the 600 VAC Bus C and Bus D to provide power to the battery chargers and critical AC components after 24 hours.} HCVS modification: {add piping and connection points at a suitable location in the control building or outside to connect portable N2 bottles for motive force to HCVS components after 24 hours.}HCVS connections required for portable equipment will be protected from all applicable screened-in hazards and located such that operator exposure to radiation and occupational hazards will be minimized. Structures to provide protection of the HCVS connections will be constructed to meet the requirements identified in NEI-12-06 section 11 for screened in hazards.
Key Support Equipment Parameters: *List instrumentation credited for the support equipment utilized in the venting operation. Clearly indicate which of those already exist in the plant and what others will be newly installed (to comply with the vent order)*
Local control features of the FLEX DG electrical load and fuel supply. Pressure gauge on supplemental Nitrogen bottles.
Notes:

Part 2 Boundary Conditions for WW Vent**: HCVS Venting Portable Equipment Deployment**		
Provide a general description of the venting actions using portable equipment including modifications that are proposed to maintain and/or support safety functions. **Ref: EA-13-109 Section 3.1 / NEI 13-02 Section 6.1.2, D.1.3.1**		
Deployment pathways for compliance with Order EA-12-049 are acceptable without further evaluation needed except in areas around the Reactor Building or in the vicinity of the HCVS piping. Deployment in the areas around the Reactor Building or in the vicinity of the HCVS piping will allow access, operation and replenishment of consumables with the consideration that there is potential Reactor Core Damage and HCVS operation.		
Details:		
Provide a brief description of Procedures / Guidelines: *Confirm that procedure/guidance exists or will be developed to support implementation.*		
Operation of the portable equipment is the same as for compliance with Order EA-12-049 thus they are acceptable without further evaluation		
HCVS Actions	**Modifications**	**Protection of connections**
Identify Actions including how the equipment will be deployed to the point of use.	*Identify modifications*	*Identify how the connection is protected*
Per compliance with Order EA-12-049 (FLEX)	N/A	Per compliance with Order EA-12-049 (FLEX)
Notes:		

Part 3: Boundary Conditions for Dry Well Vent

Provide a sequence of events and identify any time constraint required for success including the basis for the time constraint.

HCVS Actions that have a time constraint to be successful should be identified with a technical basis and a justification provided that the time can reasonably be met (for example, a walk-through of deployment).

Describe in detail in this section the technical basis for the time constraint identified on the sequence of events timeline Attachment 2B

See attached sequence of events timeline (Attachment 2B).

Ref: EA-13-109 Section X.X.X / NEI 13-02 Section X.X.x

Severe Accident Venting

Determine venting capability for Severe Accident Venting, such as may be used in an ELAP scenario to mitigate core damage.

Ref: EA-13-109 Section X.X.X / NEI 13-02 Section X.X.x

First 24 Hour Coping Detail

Provide a general description of the venting actions for first 24 hours using installed equipment including station modifications that are proposed.

Ref: EA-13-109 Section X.X.X / NEI 13-02 Section X.X.x

Greater Than 24 Hour Coping Detail

Provide a general description of the venting actions for greater than 24 hours using portable and installed equipment including station modifications that are proposed.

Ref: EA-13-109 Section X.X.X / NEI 13-02 Section X.X.x

Details:

Provide a brief description of Procedures / Guidelines:

Confirm that procedure/guidance exists or will be developed to support implementation.

Identify modifications*:*

List modifications and describe how they support the HCVS Actions.

Part 3: Boundary Conditions for Dry Well Vent
Key Venting Parameters: *List instrumentation credited for the venting HCVS Actions.*
Notes:

Part 4: Programmatic Controls, Training, Drills and Maintenance

Identify how the programmatic controls will be met.

Provide a description of the programmatic controls equipment protection, storage and deployment and equipment quality addressing the impact of temperature and environment

Ref: EA-13-109 Section 3.1, 3.2 / NEI 13-02 Section 6.1.2, 6.1.3, 6.2

Program Controls:

The HCVS venting actions will include:

- Site procedures and programs are being developed in accordance with NEI 13-02 to address use and storage of portable equipment relative to the Severe Accident defined in NRC Order EA-13-109 and the hazards applicable to the site per Part 1 of this OIP.
- Routes for transporting portable equipment from storage location(s) to deployment areas will be developed as the response details are identified and finalized. The identified paths and deployment areas will be accessible during all modes of operation and during Severe Accidents.

Procedures:

Procedures will be established for system operations when normal and backup power is available, and during ELAP conditions.

The HCVS procedures will be developed and implemented following the plants process for initiating or revising procedures and contain the following details:

- appropriate conditions and criteria for use of the HCVS
- when and how to place the HCVS 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 of portable equipment

[If the plant utilizes CAP for ECCS pump NPSH] {The procedures should state that "use of the vent may impact NPSH."}

Licensees will establish provisions for out-of-service requirements of the HCVS and compensatory measures. The following provisions will be documented in the *{Site Specific*

Part 4: Programmatic Controls, Training, Drills and Maintenance

control document}:

The provisions for out-of-service requirements for HCVS functionality are applicable in Modes 1, 2 and 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 are non-functional, no compensatory actions are necessary.
- If the out of service times exceed 30 or 90 days as described above, the following actions will be performed:
  - The condition will entered into the corrective action system,
  - The HCVS functionality will be restored in a manner consistent with plant procedures,
  - A cause assessment will be performed to prevent future loss of function for similar causes.
  - Initiate action to implement appropriate compensatory actions

Describe training plan

List training plans for affected organizations or describe the plan for training development

Ref: EA-13-109 Section 3.2 / NEI 13-02 Section 6.1.3

Personnel expected to perform direct execution of the HVCS will receive 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. Training content and frequency will be established using the Systematic Approach to Training (SAT) process.

In addition, (reference NEI 12-06) all personnel on-site will be available to supplement trained personnel.

Identify how the drills and exercise parameters will be met.

Alignment with NEI 13-06 and 14-01as codified in NTTF Recommendation 8 and 9 rulemaking

The Licensee should demonstrate use of the HCVS system in drills, tabletops, or exercises as follows:

- Hardened containment vent operation on normal power sources (no ELAP).
- During FLEX demonstrations (as required by EA-12-049: Hardened containment vent

Part 4: Programmatic Controls, Training, Drills and Maintenance

operation on backup power and from primary or alternate location during conditions of ELAP/loss of UHS with no core damage. System use is for containment heat removal AND containment pressure control.

- HCVS operation on backup power and from primary or alternate location during conditions of ELAP/loss of UHS with core damage. System use is for containment heat removal AND containment pressure control with potential for combustible gases (Demonstration may be in conjunction with SAG change).

Ref: EA-13-109 Section 3.1 / NEI 13-02 Section 6.1.3

The site will utilize the guidance provided in NEI 13-06 and 14-01 for guidance related to drills, tabletops, or exercises for HCVS operation. In addition, the site will integrate these requirements with compliance to any rulemaking resulting from the NTTF Recommendations 8 and 9.

Describe maintenance plan:

- The HCVS maintenance program should ensure that the HCVS equipment reliability is being achieved in a manner similar to that required for FLEX equipment. Standard industry templates (e.g., EPRI) and associated bases may be developed to define specific maintenance and testing.
  - Periodic testing and frequency should be determined based on equipment type, expected use and manufacturer's recommendations (further details are provided in Section 6 of this document).
  - Testing should be done to verify design requirements and/or basis. The basis should be documented and deviations from vendor recommendations and applicable standards should be justified.
  - Preventive maintenance should be determined based on equipment type and expected use. The basis should be documented and deviations from vendor recommendations and applicable standards should be justified.
  - Existing work control processes may be used to control maintenance and testing.
- HCVS permanent installed equipment should be maintained in a manner that is consistent with assuring that it performs its function when required.
  - HCVS permanently installed equipment should be subject to maintenance and testing guidance provided to verify proper function.
- HCVS non-installed equipment should be stored and maintained in a manner that is consistent with assuring that it does not degrade over long periods of storage and that it is accessible for periodic maintenance and testing.

Ref: EA-13-109 Section 1.2.13 / NEI 13-02 Section 5.4, 6.2

Part 4: Programmatic Controls, Training, Drills and Maintenance

The site will utilize the standard EPRI industry PM process (Similar to the Preventive Maintenance Basis Database) for establishing the maintenance calibration and testing actions for HCVS components. The control program will include maintenance guidance, testing procedures and frequencies established based on type of equipment and considerations made within the EPRI guidelines.

{Site Name} will implement the following operation, testing and inspection requirements for the HCVS to ensure reliable operation of the system.

Table 4-1: Testing and Inspection Requirements

Description	Frequency
Cycle the HCVS valves and the interfacing system valves not used to maintain containment integrity during operations.	Once per operating cycle
Perform visual inspections and a walk down of HCVS components	Once per operating cycle
Test and calibrate the HCVS radiation monitors.	Once per operating cycle
Leak test the HCVS.	(1) Prior to first declaring the system functional; (2) Once every three operating cycles thereafter; and (3) After restoration of any breach of system boundary within the buildings
Validate the HCVS operating procedures by conducting an open/close test of the HCVS control logic from its control panel and ensuring that all interfacing system valves move to their proper (intended) positions.	Once per every other operating cycle

Notes:

Part 5: Milestone Schedule

Provide a milestone schedule. This schedule should include:

- **Modifications timeline**
- **Procedure guidance development complete**
  - **HCVS Actions**
  - **Maintenance**
- **Storage plan (reasonable protection)**
- **Staffing analysis completion**
- **Long term use equipment acquisition timeline**
- **Training completion for the HCVS Actions**

The dates specifically required by the order are obligated or committed dates. Other dates are planned dates subject to change. Updates will be provided in the periodic (six month) status reports.

Ref: EA-13-109 Section D.1, D.3 / NEI 13-02 Section 7.2.1

The following milestone schedule is provided. The dates are planning dates subject to change as design and implementation details are developed. Any changes to the following target dates will be reflected in the subsequent 6 month status reports.

Milestone	Target Completion Date	Activity Status	Comments *{Include date changes in this column}*
Hold preliminary/conceptual design meeting	Jun, 2014	Complete	
Submit Overall Integrated Implementation Plan	Jun 2014	Complete	
Submit 6 Month Status Report	Dec. 2014		
Submit 6 Month Status Report	Jun. 2015		
Submit 6 Month Status Report	Dec. 2015		Simultaneous with Phase 2 OIP
U2 Design Engineering On-site/Complete	Mar, 2016		
Submit 6 Month Status Report	Jun. 2016		
Operations Procedure Changes Developed	Dec, 2016		
Site Specific Maintenance Procedure Developed	Dec, 2016		

Part 4: Programmatic Controls, Training, Drills and Maintenance

Submit 6 Month Status Report	Dec. 2016		
Training Complete	Dec, 2016		
U2 Implementation Outage	Feb, 2017		
Procedure Changes Active	Mar, 2017		
U2 Walk Through Demonstration/Functional Test	Mar, 2017		
U1 Design Engineering On-site/Complete	Mar, 2017		
Submit 6 Month Status Report	Jun. 2017		
Submit 6 Month Status Report	Dec. 2017		
U1 Implementation Outage	Feb, 2018		
U1 Walk Through Demonstration/Functional Test	Mar, 2018		
Submit Completion Report	May, 2018		

Attachment 1: HCVS Portable Equipment

List portable equipment	*BDBEE Venting*	*Severe Accident Venting*	*Performance Criteria*	*Maintenance / PM requirements*
Argon Cylinders	**X**		**N/A**	**Check periodically for pressure, replace or replenish as needed**
Nitrogen Cylinders	**X**	**X**	**TBD**	**Check periodically for pressure, replace or replenish as needed**
FLEX DG	**X**	**X**	**TBD**	**Per Response to EA-12-049**

Attachment 2: Sequence of Events Timeline

{insert site specific time line to support submittal}

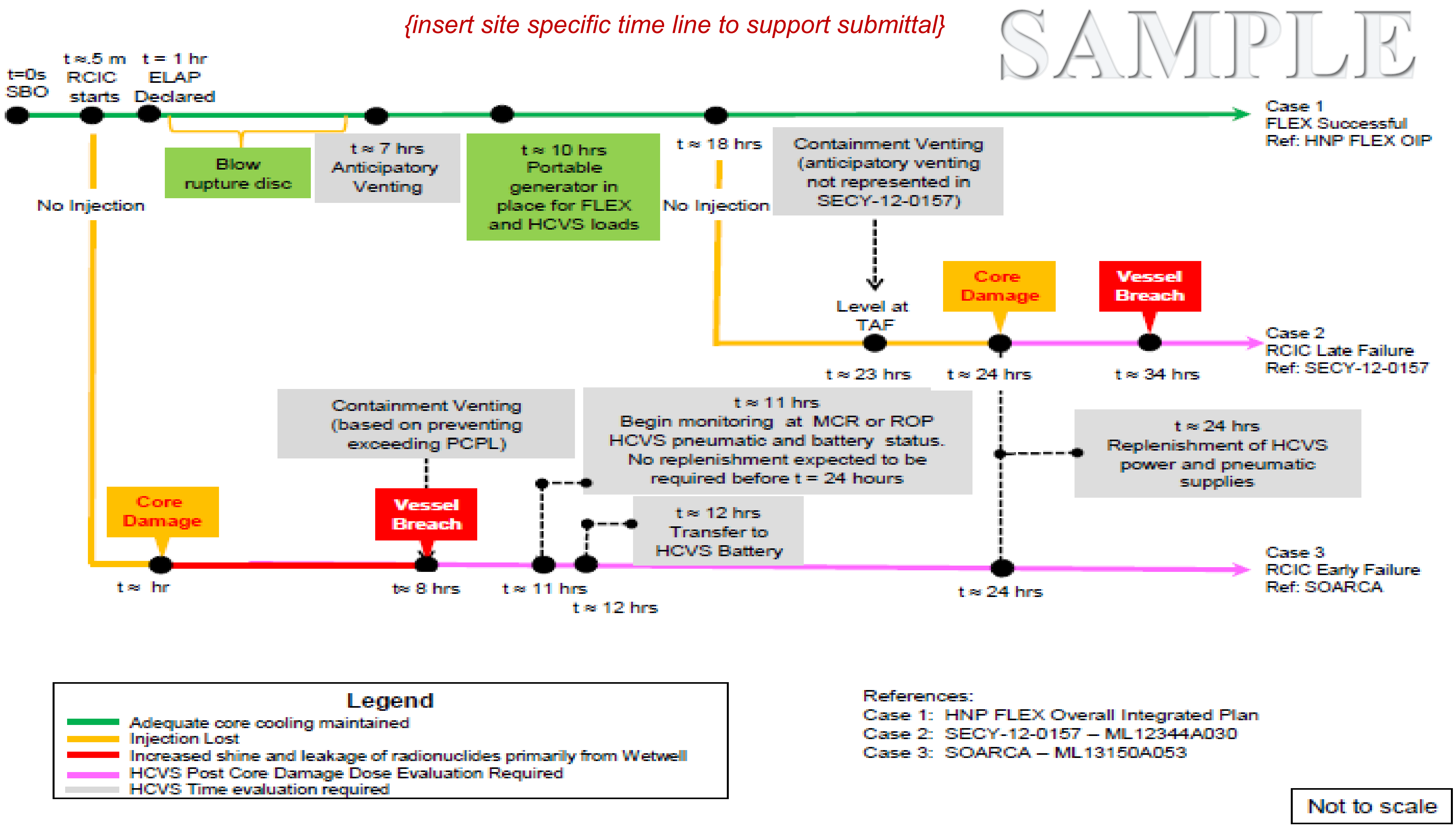


Table 2A: Wet Well HCVS Timeline

Attachment 3: Conceptual Sketches

(Conceptual sketches, as necessary to indicate equipment which is installed or equipment hookups necessary for the HCVS Actions)

- Plant layout with egress and ingress pathways
- Piping routing for vent path
- Instrumentation Process Flow
- Electrical Connections
- Include a piping and instrumentation diagram of the vent system. Demarcate the valves (in the vent piping) between the currently existing and new ones.

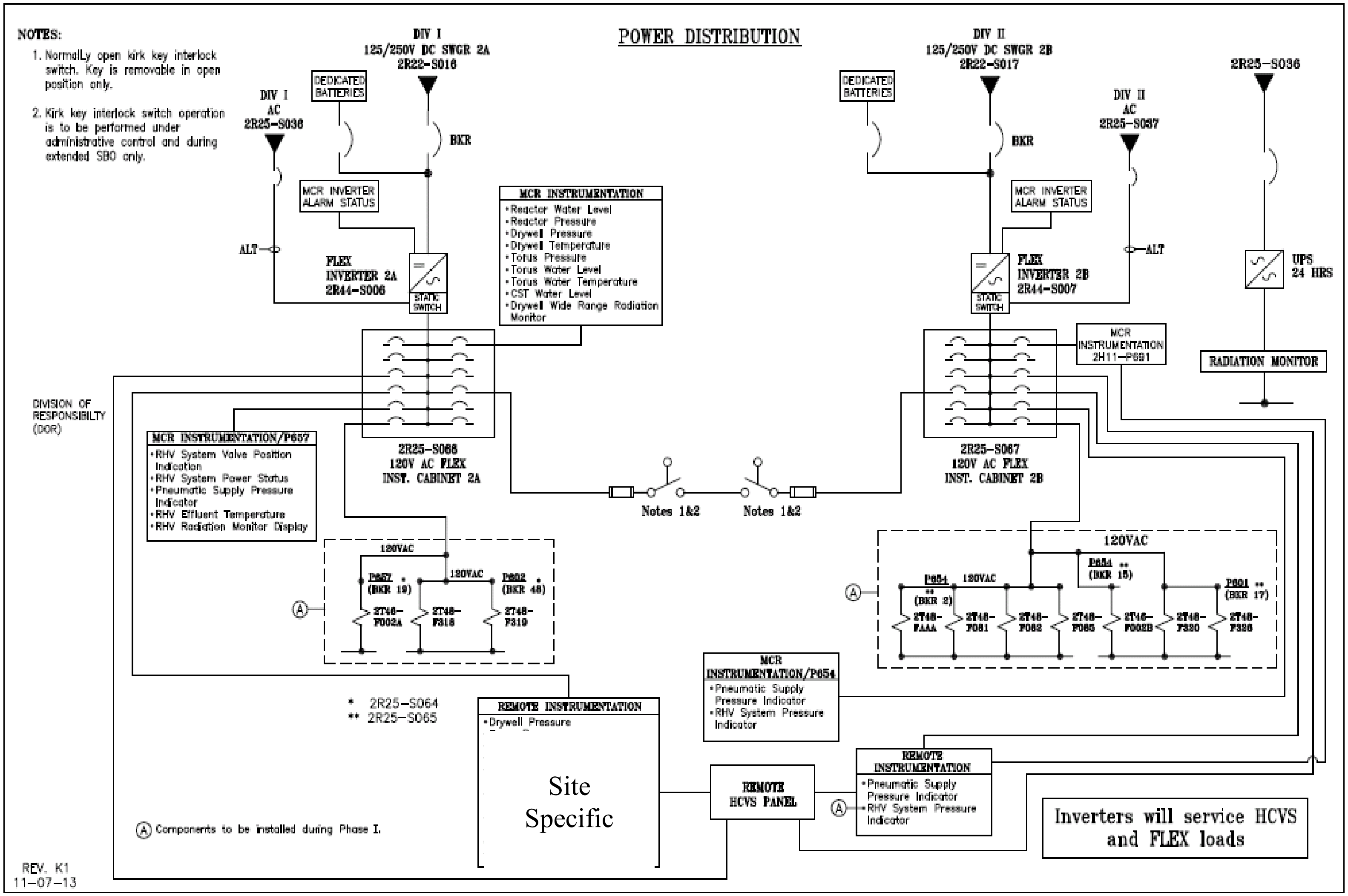
Sketch 1: Electrical Layout of System *(preliminary)*

Sketch 2: P&ID Layout of HCVS *(preliminary)*

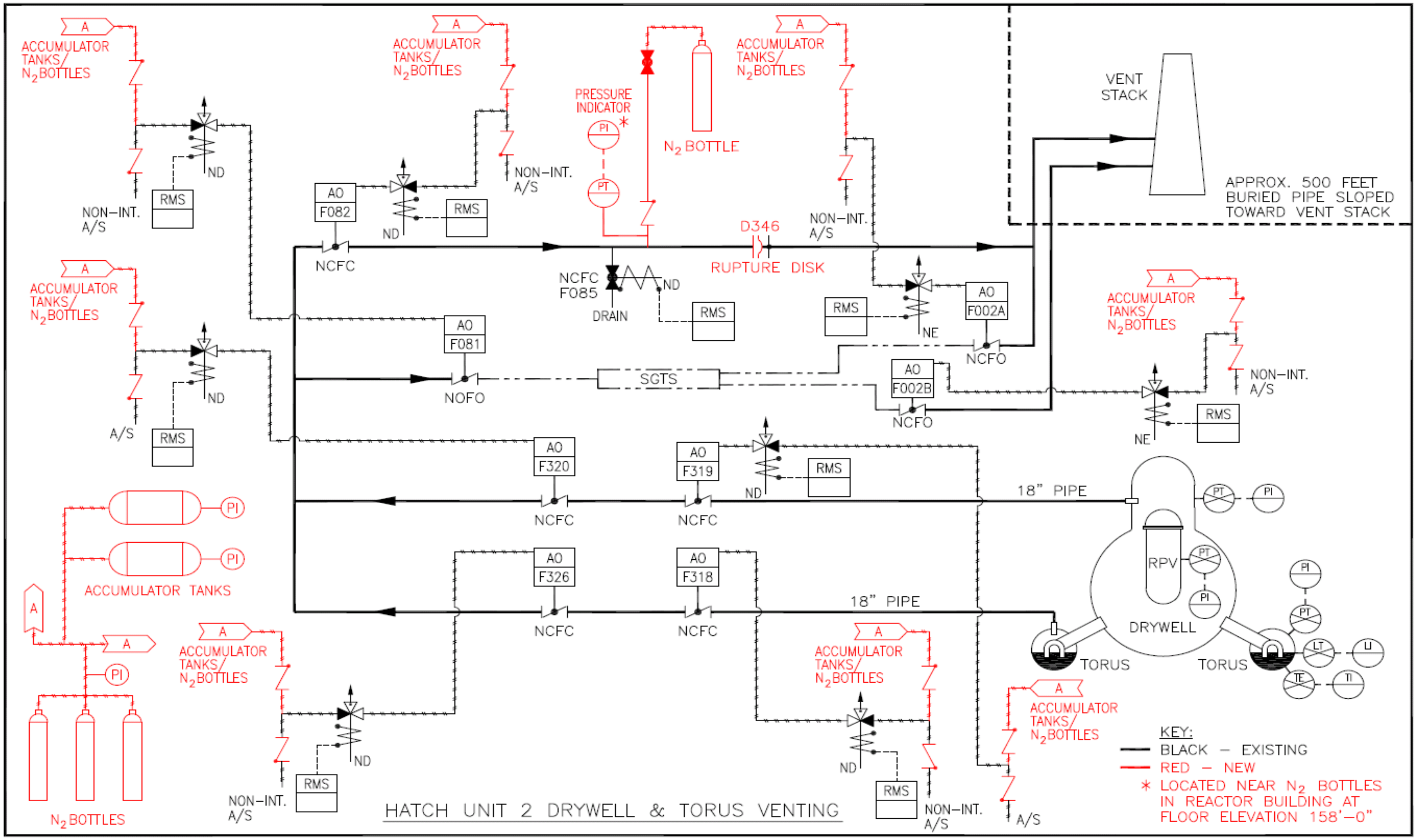
- **Piping routing for vent path**
- **Demarcate the valves (in the vent piping) between the currently existing and new ones**
- **HCVS Instrumentation Process Flow Diagram**

Sketch 3: Plant Layout *(later)*

- **Egress and Ingress Pathways to ROS, Battery Transfer Switch, DG Connections and Deployment location**
- **Site layout sketch to show location/routing of HCVS piping and associated components. This should include relative locations both horizontally and vertically**



Sketch 1: Electrical Layout of System (Unit 2, Unit 1 similar)



Sketch 2: Layout of current HCVS, Unit 2 (Unit 1 similar)

Attachment 4: Failure Evaluation Table

Table 4A: Wet Well HCVS Failure Evaluation Table

Functional Failure Mode	Failure Cause	Alternate Action	Failure with Alternate Action Impact on Containment Venting?
Failure of Vent to Open on Demand	Valves fail to open/close due to loss of normal AC power	No action needed, power is already tied into station service battery via inverter for minimum 12 hours	No
Failure of Vent to Open on Demand	Valves fail to open/close due to loss of alternate AC power (long term)	Connect dedicated batteries to inverter via transfer switch for minimum 12 hours	No
Failure of Vent to Open on Demand	Valves fail to open/close due to complete loss of batteries (long term)	Recharge station service batteries with FLEX provided generators, considering severe accident conditions	No
Failure of Vent to Open on Demand	Valves fail to open/close due to loss of normal pneumatic air supply	No action needed, air can be supplied by accumulator tanks, which is sufficient for at least 12 cycles of F082 valve over first 24 hours.	No
Failure of Vent to Open on Demand	Valves fail to open/close due to loss of alternate pneumatic air supply (long term)	Tie-in nitrogen cylinders to air system supporting HCVS valves, replace bottles as needed.	No
Failure of Vent to Open on Demand	Valves fail to open/close due to SOV failure	Heroic action needed	Yes

Attachment 5: References

1. Generic Letter 89-16, Installation of a Hardened Wetwell Vent, dated September 1, 1989
2. Order EA-12-049, Mitigation Strategies for Beyond-Design-Basis External Events, dated March 12, 2012
3. Order EA-12-050, Reliable Hardened Containment Vents, dated March 12, 2012
4. Order EA-12-051, Reliable SFP Level Instrumentation, dated March 12, 2012
5. Order EA-13-109, Severe Accident Reliable Hardened Containment Vents, dated June 6, 2013
6. JLD-ISG-2012-01, Compliance with Order EA-12-049, Mitigation Strategies for Beyond-Design-Basis External Events, dated August 29, 2012
7. JLD-ISG-2012-02, Compliance with Order EA-12-050, Reliable Hardened Containment Vents, dated August 29, 2012
8. JLD-ISG-2013-02, Compliance with Order EA-13-109, Severe Accident Reliable Hardened Containment Vents, dated November 14, 2013
9. NRC Responses to Public Comments, Japan Lessons-Learned Project Directorate Interim Staff Guidance JLD-ISG-2012-02: Compliance with Order EA-12-050, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents, ADAMS Accession No. ML12229A477, dated August 29, 2012
10. NEI 12-06, Diverse and Flexible Coping Strategies (FLEX) Implementation Guide, Revision 1, dated August 2012
11. NEI 13-02, Industry Guidance for Compliance with Order EA–13–109, Revision 0, Dated November 2013
12. NEI 13-06, Enhancements to Emergency Response Capabilities for Beyond Design Basis Accidents and Events, Revision 0, dated March 2014
13. NEI 14-01, Emergency Response Procedures and Guidelines for Extreme Events and Severe Accidents, Revision 0, dated March 2014
14. NEI FAQ HCVS-01, HCVS Primary Controls and Alternate Controls and Monitoring Locations
15. NEI FAQ HCVS-02, HCVS Dedicated Equipment
16. NEI FAQ HCVS-03, HCVS Alternate Control Operating Mechanisms
17. NEI FAQ HCVS-04, HCVS Release Point
18. NEI FAQ HCVS-05, HCVS Control and ‘Boundary Valves’
19. NEI FAQ HCVS-06, FLEX Assumptions/HCVS Generic Assumptions
20. NEI FAQ HCVS-07, Consideration of Release from Spent Fuel Pool Anomalies

21. NEI FAQ HCVS-08, HCVS Instrument Qualifications
22. NEI FAQ HCVS-09, Use of Toolbox Actions for Personnel
23. NEI White Paper HCVS-WP-01, HCVS Dedicated Power and Motive Force
24. NEI White Paper HCVS-WP-02, HCVS Cyclic Operations Approach
25. NEI White Paper HCVS-WP-03, Hydrogen/CO Control Measures
26. NEI White Paper HCVS-WP-04, FLEX/HCVS Interactions
27. IEEE Standard 344-2004, IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power *Generating Stations*,
28. {Plant Site} EA-12-049 (FLEX) Overall Integrated Implementation Plan, Rev 0, February 2013
29. {Plant Site} EA-12-050 (HCVS) Overall Integrated Implementation Plan, Rev 0, February 2013
30. {Plant Site} EA-12-051 (SFP LI) Overall Integrated Implementation Plan, Rev 0, February 2013

Attachment 6: Changes/Updates to this Overall Integrated Implementation Plan

Any significant changes to this plan will be communicated to the NRC staff in the 6 Month Status Reports

Attachment 7: List of Overall Integrated Plan Open Items

Open Item	Action	Comment
1	Confirm suppression pool heat capacity	
2	Evaluate location of Portable DG for accessibility under Severe Accident HCVS use	Confirmatory action

APPENDIX L – SIX MONTH UPDATE TEMPLATE

[Throughout this template, both instructions and fields for licensee specific information are presented in brackets.

- Green brackets designate fields to fill in
- Blue brackets designate instructions
- All bracketed text should be removed prior to submission
- It is recommended that non-bracketed text not be removed]

[Attachment or Enclosure]

[Licensee]'s [First or sequential number] Six Month Status Report for the Implementation of Order EA-13-109, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions"

1 Introduction

[Licensee] developed an Overall Integrated Plan (Reference 1 in Section 8), documenting the installation of a Hardened Containment Vent System (HCVS) that provides a reliable hardened venting capability for pre-core damage and under severe accident conditions, including those involving a breach of the reactor vessel by molten core debris, in response to Reference 2. This attachment provides an update of milestone accomplishments since submittal of the Phase 1 [&2] Overall Integrated Plan [for future status reports, this will read "the last status report"], including any changes to the compliance method, schedule, or need for relief/relaxation and the basis, if any.

2 Milestone Accomplishments [required by NEI 13-02 Section 7.3.1.2]

[Milestone accomplishments are completion of items included in Attachment 2 of the Overall Integrated Plan.]

The following milestone(s) have been completed since the development of the Overall Integrated Plan (Reference 1), and are current as of [site specific closure date to permit internal submittal review, for example July 30, 2013 for the first status report].

[Subsequent reports: "The following milestone(s) have been completed since [site specific date provided in previous status report], and are current as of [site specific closure date to permit internal submittal review]."]

- [A brief statement summarizing accomplishment]
- [A brief statement summarizing accomplishment]
- [A brief statement summarizing accomplishment]

[OR]

None

3 Milestone Schedule Status [required by NEI 13-02 Section 7.3.1.1]

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

[If the licensee has received target completion dates related to RAIs, RAI response should be included in the milestone schedule.]

[If there are changes to target completion dates, use one of the following statements to explain the impact of these changes.]

The revised milestone target completion dates to not impact the order implementation date.

[OR]

The revised target completion dates impact the order implementation date. An explanation of the impact of these changes is provided in Section 5 of this [attachment or enclosure].

[Include an update to Attachment 2 of the Overall Integrated Plan or a table representative of Attachment 2. Dates provided in the Overall Integrated Plan or last status report should be given as "Target Completion Date" and any changes to these dates should be provided in "Revised Target Completion Date." Suggested activity statuses are not started, started, and complete. The following table provides an example, but other methods to present the information are acceptable.]

Milestone	Target Completion Date	Activity Status	Comments {Include date changes in this column}
Phase 1 HCVS Milestone Table			
Submit Overall Integrated Plan	**Jun 2014**	Complete	
Submit 6 Month Updates:			
Update 1	**Dec. 2014**	Complete	
Update 2	**Jun. 2015**	Not Started	
Update 3 [Simultaneous with Phase 2	**Dec. 2015**	Not Started	

Milestone	Target Completion Date	Activity Status	Comments {Include date changes in this column}
Phase 1 HCVS Milestone Table			
OIP]			
Update 4	Month - Year	Not Started	
Update 5	Month - Year	Not Started	
Update 6	Month - Year	Not Started	
Update 7	Month - Year	Not Started	
Modifications:			
Hold preliminary/conceptual design meeting	Date	Status	
Modifications Evaluation	Date	Status	
Unit 1 Design Engineering On-site/Complete	Date	Status	
Unit 1 Implementation Outage	Date	Status	
Unit 1 Walk Through Demonstration/Functional Test	Date	Status	
Unit 2 Design Engineering On-site/Complete	Date	Status	
Unit 2 Walk Through Demonstration/Functional Test	Date	Status	
Unit 2 Implementation Outage	Date	Status	
Procedure Changes Active			
Operations Procedure Changes Developed	Date	Status	
Site Specific Maintenance Procedure Developed	Date	Status	
Procedure Changes Active	Date	Status	
Training:			

Milestone	Target Completion Date	Activity Status	Comments {Include date changes in this column}
Phase 1 HCVS Milestone Table			
Training Complete	Date	Status	
Completion			
Unit 1 HCVS Implementation	Date	Status	
Unit 2 HCVS Implementation	Date	Status	
Full Site HCVS Implementation	Date	Status	
Submit Completion Report [60 days after full site compliance]	Date	Status	

4 Changes to Compliance Method [required by NEI 13-02 Section 7.3.1.3]

[This section is intended to document any changes to the compliance method with NEI 13-02 and any exceptions identified in the Licensee's Overall Integrated Plan.]

[If there are changes to the compliance method that meet NEI 13-02, but are changes to the information provided in the Licensee's Overall Integrated Plan, describe the changes.]

[Describe changes and justification.]

[If there are changes to the compliance method that are alternatives to NEI 13-02 but still meet order EA-13-109, describe the changes. The justification for these alternatives should be communicated to the NRC under separate cover on an expedited basis. The changes may also be communicated in the six month updates if the updates communicate the information in a timely manner.]

[Describe changes and justification.]

[If there are no changes, the following text should be used.]

There are no changes to the compliance method as documented in the Phase 1 [&2] Overall Integrated Plan (Reference 1).

5 Need for Relief/Relaxation and Basis for the Relief/Relaxation [required by NEI 13-02 Section 7.3.1.4]

[This section is intended to document any need for relief/relaxation from order EA-13-109.]

[If there is not a required need for relief/relaxation use the following words.]

[Licensee] expects to comply with the order implementation date and no relief/relaxation is required at this time.

[If relief/relaxation is required, documentation should be provided to the NRC describing the need for relief/relaxation under separate cover and then summarized in this section.]

[Describe the needed relief/relaxation and the basis for this relief/relaxation.]

This section provides a summary of needed relief/relaxation only. The specific details [will be or have been] submitted in a separate document, [site specific reference].

6 Open Items from Overall Integrated Plan and Interim Staff Evaluation [required by NEI 13-02 Section 7.3.1.5]

[Provide an update on the progress made on any open items provided in the Overall Integrated Plan and open items included in the I SE. Each included open item should have a status such as not started, started or complete, where complete means that Licensee actions are complete. At the time an open item is determined to be complete, a summary (including a level of detail appropriate to the item, e.g., the level of detail that would have been used had the open item been closed in the Overall Integrated Plan) of the results used to close the item should be included.]

[If open items were provided in the Overall Integrated Plan or have been received as a part of the ISE, use the following text.]

The following tables provide a summary of the open items documented in the Phase 1 Overall Integrated Plan or the Interim Staff Evaluation (ISE) and the status of each item.

Overall Integrated Plan Phase 1 [& 2] Open Item	Status
[Open item number and text]	[Status on progress toward completion of open item]

Interim Staff Evaluation Open Item	Status
[Open item number and text]	[Status on progress toward completion of open item]

[If open items were not provided in the Overall Integrated Plan or have not been received as a part of the ISE, use the following text.]

None.

7 Interim Staff Evaluation Impacts

[Provide a summary of the updates described above that impact a specific portion of the Phase 1 ISE and consider providing suggested wording for the SE. Continuity should be present between this section and Sections 4, 5 and 6.]

[If the ISE has not been received or if no impacts have been identified, use the following text.]

There are no potential impacts to the Interim Staff Evaluation identified at this time.

8 References

The following references support the updates to the Phase 1 [& 2] Overall Integrated Plan described in this [attachment or enclosure].

1. [Licensee]'s Overall Integrated Plan in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated [Licensee specific date].
2. NRC Order Number EA-13-109, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions" dated June 6, 2013.
3. NEI 13-02, "Industry Guidance for Compliance with NRC Order EA-13-109, 'To Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions," Revision 0, dated November 2013.
4. NRC Interim Staff Guidance JLD-ISG-2013-02, "Compliance with Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions," Revision 0, dated November 2013 (Accession No. ML13304B836).
5. NRC Endorsement of industry "Hardened Containment Venting System (HCVS) Phase 1 Overall Integrated Plan Template (EA-13-109) Rev 0" (Accession No. ML14128A219).

6. [Additional references to support the progress made on implementation of HCVS as summarized in this attachment. Examples include documentation to support closure of open items and information to support the basis for relief/relaxation.]