DRAFT INTERIM STAFF GUIDANCE
COMPLIANCE WITH ORDER EA-12-050, ORDER MODIFYING LICENSES WITH REGARD TO RELIABLE HARDENED CONTAINMENT VENTS
NRR ISG XXX

Purpose

The U.S. Nuclear Regulatory Commission (NRC) staff is providing this interim staff guidance (ISG) to assist nuclear power reactor applicants and licensees with the identification of measures needed to comply with requirements to mitigate challenges to key safety functions. These requirements are contained in Order EA-12-050, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents." This ISG is applicable to all operating Boiling Water Reactor (BWR) licensees with Mark I And Mark II containments issued under Title 10 of the *Code of Federal Regulations*, Part 50 (10 CFR Part 50), "Domestic Licensing of Production and Utilization Facilities." This ISG provides an acceptable method for satisfying those requirements. Licensees may propose other methods for satisfying these requirements. The NRC staff will review such methods and determine their acceptability on a case by case basis.

Background

On March 11, 2011, a magnitude 9.0 earthquake struck off the coast of the Japanese island of Honshu. The earthquake resulted in a large tsunami, estimated to have exceeded 14 meters (45 feet) in height, which inundated the Fukushima Dai-ichi nuclear power plant site. The earthquake and tsunami produced widespread devastation across northeastern Japan, and significantly affected the infrastructure and industry in the northeastern coastal areas of Japan. When the earthquake occurred, Fukushima Dai-ichi Units 1, 2, and 3 were in operation and Units 4, 5, and 6 were shut down for routine refueling and maintenance activities. The Unit 4 reactor fuel was offloaded to the Unit 4 spent fuel pool. Following the earthquake, the three operating units automatically shut down and offsite power was lost to the entire facility. The emergency diesel generators (EDGs) started at all six units providing alternating current (ac) electrical power to critical systems at each unit. The facility response to the earthquake appears to have been normal.

Approximately 40 minutes following the earthquake and shutdown of the operating units, the first large tsunami wave inundated the site, followed by additional waves. The tsunami caused extensive damage to site facilities and resulted in a complete loss of all ac electrical power at Units 1 through 5, a condition known as station blackout (SBO). In addition, all direct current electrical power was lost early in the event on Units 1 and 2, and for some period of time at the other units. Unit 6 retained the function of one air-cooled EDG. Despite their actions, the operators lost the ability to cool the fuel in the Unit 1 reactor after several hours, in the Unit 2 reactor after about 70 hours, and in the Unit 3 reactor after about 36 hours, resulting in damage to the nuclear fuel shortly after the loss of cooling capabilities.

Operators first considered using the facility's hardened vent to control pressure in the containment within an hour following the loss of all ac power at Unit 1. The Emergency Response Center began reviewing accident management procedures and checking containment venting procedures to determine how to open the containment vent valves without power. Ultimately, without adequate core and containment cooling, primary containment (drywell) pressure and temperature in Units 1, 2, and 3 substantially exceeded the design values for the containments. When the operators attempted to vent the containments, they were significantly challenged in opening the hardened wetwell (suppression chamber) vents because of complications from the prolonged SBO, and high radiation fields that impeded access.

At Fukushima Dai-ichi Units 1, 2, 3, and 4, venting the wetwell involved opening motor- and air-operated valves. Similar features are used in many hardened vent systems that were installed in U.S. BWR Mark I containment plants following issuance of Generic Letter (GL) 89-16, "Installation of a Hardened Wetwell Vent." In the prolonged SBO situation that occurred at Fukushima, operator actions were not possible from the control room because of the loss of power, and the loss of pneumatic supply pressure to the air-operated valves. The resultant delay in venting the containment precluded early low-pressure injection of coolant into the reactor vessels. The lack of coolant, in turn, resulted in extensive core damage, high radiation levels, hydrogen production and containment failure. The leakage of hydrogen gas into the reactor buildings resulted in explosions in the secondary containment buildings of Units 1, 3, and 4, and the ensuing damage to the facility contributed to the uncontrolled release of radioactive material to the environment and great delay in achieving cold shutdown conditions.

Fukushima Dai-ichi Units 1, 2, 3, and 4 use the Mark I containment design; however, because Mark II containment designs are only slightly larger in volume than Mark I containment designs and use wetwell pressure suppression, it can reasonably be inferred that a Mark II under similar circumstances may have suffered similar consequences.

Following the events at the Fukushima Dai-ichi nuclear power plant, the NRC established a senior-level agency task force referred to as the Near-Term Task Force (NTTF). The NTTF was tasked with conducting a systematic and methodical review of the NRC regulations and processes and determining if the agency should make additional improvements to these programs in light of the events at Fukushima Dai-ichi. As a result of this review, the NTTF developed a comprehensive set of recommendations, documented in SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," dated July 12, 2011 [reference 1]. These recommendations were enhanced by the NRC staff following interactions with stakeholders. Documentation of the staff's efforts is contained in SECY-11-0124, "Recommended Actions To Be Taken Without Delay From the Near-Term Task Force Report," dated September 9, 2011 [reference 2], and SECY-11-0137, "Prioritization of Recommended Actions To Be Taken in Response to Fukushima Lessons Learned," dated October 3, 2011[reference 3] .

As directed by the Staff Requirements Memorandum (SRM) for SECY-11-0093 [reference 4], the NRC staff reviewed the NTTF recommendations within the context of the NRC's existing regulatory framework and considered the various regulatory vehicles available to the NRC to implement the recommendations. SECY-11-0124 and SECY-11-0137 established the staff's prioritization of the recommendations based upon the potential safety enhancements.

The importance of reliable operation of hardened vents during conditions involving loss of containment heat removal capability was already well established and this understanding has been reinforced by the clear lessons of Fukushima. Hardened vents have been in place in U.S. plants with BWR Mark I containments for many years but a wide variance exists with regard to the reliability of the vents. Additionally, hardened vents are not required on plants with BWR Mark II containments although as discussed above, Mark II containments are only slightly larger than Mark I. Therefore, reliable hardened venting systems in BWR facilities with Mark I and

Mark II containments are needed to ensure that adequate protection of public health and safety is maintained.
In SRM-SECY 11 0137, the Commission directed the NRC staff to take certain actions and provided further guidance including directing the staff to consider filtered vents. The NRC staff plans to submit a Policy Paper to the Commission in July 2012.

On February 17, 2012, the NRC staff submitted SECY-12-0025, "Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami" [reference 8] to the Commission, including the order to implement requirements relating to reliable hardened venting systems at BWR facilities with Mark I and Mark II containment designs. As directed by SRM-SECY-12-0025 [reference 9], the NRC staff issued Order EA-12-050, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents" [reference 10].

Rationale

1. Order EA-12-050 requires that licensees of BWR facilities with Mark I and Mark II containment designs shall ensure that these facilities have a containment venting system that meets certain requirements relating to reliable and dependable operation in order to be able to implement strategies relating to the prevention of core damage.

2. The installed venting system must meet prescribed quality standards. Generally, the system must be of a "seismically rugged design" and meet the plant's existing design basis if more stringent requirements are necessary to meet the licensee's existing design basis.

3. The order requires that licensees develop the necessary procedures and conduct appropriate training of personnel who may be required to operate the system.

Applicability

This ISG shall be implemented on the day following its approval. It shall remain in effect until it has been superseded, withdrawn, or incorporated into a regulatory guide or the Standard Review Plan (SRP).

Proposed Guidance

As discussed above, this ISG is applicable to all operating Boiling Water Reactor (BWR) licensees with Mark I and Mark II containment designs. The NRC staff considers that the implementation of the methods described in Attachment 1 to this ISG is an acceptable means of meeting the requirements of Order EA-12-050.

Final Resolution

The contents of this ISG may subsequently be incorporated into the SRP, and/or other guidance documents, as appropriate.

Attachment

1. Guidance for Reliable Hardened Containment Venting Systems at Boiling Water Reactor (BWR) Facilities with Mark I and Mark II Containment Designs

References

1. SECY-11-0093, “Recommendations for Enhancing Reactor Safety in the 21st Century, the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident,” July 12, 2011 (NRC’s Agencywide Documents Access and Management System (ADAMS) Accession No. ML11186A950).

2. SECY-11-0124, “Recommended Actions to be Taken without Delay from the Near-Term Task Force Report,” September 9, 2011 (ADAMS Accession No. ML11245A158).

3. SECY-11-0137, “Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned,” October 3, 2011 (ADAMS Accession No. ML11272A111).

4. SRM-SECY-11-0093, “Staff Requirements – SECY-11-0093 – Near-Term Report and Recommendations for Agency Actions following the Events in Japan,” August 19, 2011 (ADAMS Accession No. ML112310021).

5. SRM-SECY-11-0124, “Staff Requirements – SECY-11-0124 – Recommended Actions to be Take without Delay from the Near-Term Task Force Report,” October 18, 2011 (ADAMS Accession No. ML112911571).

6. SRM-SECY-11-0137, “Staff Requirements – SECY-11-0137- Prioritization of Recommended Actions to be Taken in Response to Fukushima Lessons Learned,” December 15, 2011 (ADAMS Accession No. ML113490055).

7. Letter from Adrian Heymer (NEI) to David L. Skeen (NRC), “An Integrated, Safety-Focused Approach to Expediting Implementation of Fukushima Daiichi Lessons Learned,” December 16, 2011.

8. SECY-12-0025, “Proposed Orders and Requests for Information in Response to Lessons Learned from Japan’s March 11, 2011, Great Tohoku Earthquake and Tsunami,” February 17, 2012 (ADAMS Accession No. ML12039A103).

9. SRM- SECY-12-0025, “Staff Requirements – SECY-12-0025 - Proposed Orders and Requests for Information in Response to Lessons Learned from Japan’s March 11, 2011, Great Tohoku Earthquake and Tsunami,” March 9, 2012 (ADAMS Accession No. ML120690347).

10. Order EA-12-050, “Order Modifying Licenses with Regard to Reliable Hardened Containment Vents,” March 9, 2012 (ADAMS Accession No. ML12054A696).

Draft Guidance for Reliable Hardened Containment Venting Systems at Boiling Water Reactor (BWR) Facilities with Mark I and Mark II Containment Designs

1.0 Introduction

Order EA-12-050 requires that all Boiling-Water Reactor (BWR) Mark I and Mark II containments shall have a reliable hardened vent to remove decay heat and maintain control of containment pressure within acceptable limits following events that result in the loss of active containment heat removal capability or prolonged Station Blackout (SBO). The hardened vent system shall be capable of reliable operation under a range of plant conditions, including a prolonged SBO and inadequate containment cooling. The following guidance provides the NRC staff's technical position on the requirements outlined in EA-12-050. The requirements in the order address the potential usage of the HCVS for prevention of core damage. The HCVS has no requirements for severe accident service. The references to radiological consequences, airborne radioactivity leakage, and hydrogen leakage in this guidance document convey the challenges that the operators could face in taking actions subsequent to the onset of core damage such as closing the HCVS vent valves.

Definitions

"Seismically rugged design" – A term often used to describe the design of components beyond the second containment isolation barrier to ensure HCVS functionality following a design basis seismic event. While the design and construction must meet the plant's seismic requirements, licensees are not required to qualify piping, supports and other related components in accordance with NRC requirements for safety related SSCs, including Appendix B, "Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants."

"Reliable Hardened Containment Vent System (HCVS)": A term used to describe a containment vent system that can be initiated and operated with a high degree of certainty during a prolonged SBO event. The HCVS shall be designed to be placed in operation from switches or push buttons on readily accessible control panels and shall be capable of operating in this mode with no additional operator actions until such time additional help becomes available. The NRC staff's determination if a licensee has a reliable hardened vent will be based on conformance to the requirements of order EA-12-050, as further defined and elaborated in this ISG.

2.0 Administrative Requirements

Section IV.A.	Licensees shall promptly start implementation of the requirements in Attachment 2 to the Order and shall complete full implementation no later than two (2) refueling cycles following the submittal of the overall integrated plan, as required in Condition C.1. (due no later than February 28, 2013), or December 31, 2016, whichever comes first.
Staff Position:	The implementation schedule specified in the Orders conforms to Commission direction to the staff to implement the lessons learned from Fukushima within five years. Additionally, the schedule incorporated feedback received from stakeholders, including the nuclear industry, during several public meetings. Specifically, the industry stated that at least two maintenance periods would be required during regularly

scheduled refueling outages to perform necessary inspections, measurements and implementation of hardware changes. Therefore, in accordance with Commission direction, and with appropriate consideration of stakeholder feedback, the proper interpretation of “two refueling cycles” is that full implementation shall be completed prior to commencement of plant start-up (control rod withdrawal) from the second scheduled refueling outage after submittal of the overall integrated plan required by the Orders. Under this schedule, all operating BWRs with Mark I and Mark II containments are expected to complete full implementation prior to December 31, 2016. For example, a reactor on an 18-month operating cycle and for whom its first scheduled refueling outage after February 28, 2013, occurs in the spring of 2013, will be required to achieve full implementation prior to commencing control rod withdrawal following its scheduled fall of 2014 refueling outage. This affords that licensee two full refueling cycles to plan and implement the necessary plant modifications.

Should a licensee encounter significant hardship in meeting the schedule required by any of the Orders, it may, with demonstration of good cause, request relief from that specific Order. Each such request will be reviewed by the staff on a case-by-case basis.

3.0 Hardened Containment Venting System (HCVS) Requirements

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

Staff Position: During events that significantly challenge plant operations, individual operators are more prone to human error. In addition, the plant operations staff may be required to implement strategies and/or take many concurrent actions that further places a burden on its personnel. During the prolonged SBO condition at the Fukushima Dai-ichi units, operators faced many significant challenges while attempting to restore numerous plant systems that were necessary to cool the reactor core, including the containment venting systems. The difficulties faced by the operators related to the location of the HCVS 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 NRC staff recognizes that operator actions will be needed to operate the HCVS valves; however, the licensees shall 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 ISG.

The HCVS shall be designed to be started from a control panel located in the main control room or a remote but readily accessible location. The HCVS shall 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 additional on-site or off-site personnel and portable equipment become available. The HCVS shall be capable of operating in this mode for at least 24 hours during the prolonged SBO, unless a shorter period is substantiated by the licensees. The HCVS operation in this mode depends on a variety of conditions, such as the cause for the SBO (e.g. seismic event, flood, tornado, high winds), severity of the event, and time for additional help to reach the plant, move portable equipment into place and make connections to HCVS. The reference to 24 hours of operation is a tentative recommendation at this time and it could change depending on adequate supporting information from the licensees.

Requirement 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.

Staff Position: During a prolonged SBO, the drywell, wetwell (torus) and nearby areas in the plant where HVCS components are expected to be located will likely experience an excursion in 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 design basis accidents when locating valves, instrument air supplies, and other components that will be required to safely operate the system. Components required for manual operation should be placed in areas that are readily accessible to plant operators, and not require additional actions, such as ladders, temporary scaffolding, to operate the system.

When developing a design strategy, the NRC staff expects licensees to analyze potential plant conditions and use its acquired knowledge of these areas, in terms of how temperatures would react to extended SBO conditions and the lighting that would be available. This knowledge also provides an input to system operating procedures, the choice of protective clothing, required tools and equipment, and flash lights that would be kept in nearby storage locations.

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

Staff Position: The design of the HCVS should take into consideration the radiological consequences resulting from the event that could negatively impact event response. During the Fukushima event, personnel actions to manually operate the vent valves were impeded due to the location of the valves in the torus rooms. The HCVS shall be designed to be placed in operation by operator actions at a control panel, located in the main control room or in a remote location. The system shall be deigned to function in this mode with permanently installed equipment providing electrical power (e.g. DC power batteries) and valve motive force (N_2/air cylinders). The system shall be designed to function in this mode for a minimum duration of 24 hours with no operator actions required or credited, other than the system initiating actions at the control panel. To ensure continued operation of the HCVS beyond this duration, licensees are allowed to credit manual actions, such as moving portable equipment to supplement electrical power and valve motive power sources. In response to GL 89-16, a number of facilities with Mark I containments installed vent valves in the torus room, near drywell, or both. Licensees in this circumstance will need to justify continued use of these locations, and demonstrate that reliable operator actions are possible. In addition, leakage from the HCVS within the plant and the location of the external release from the HCVS could also 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:

1. Licensees shall provide permanent radiation shielding where necessary to facilitate personnel access to valves and allow manual operation of the valve locally. Licensee may use alternatives such as providing features to facilitate manual operation of valves from remote locations, as discussed further in this guidance under Requirement 1.2.2 or relocate the vent valves to areas that are significantly less challenging to operator access/actions.

2. In accordance with Requirement 1.2.8, the HCVS shall be designed for pressures that are consistent with maximum containment design pressures as well as dynamic loading resulting from system actuation. In addition, the system shall be leak-tight. As such, ventilation duct work (i.e., sheet metal) shall 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.

3. The HCVS release to outside atmosphere shall be at an elevation higher than adjacent plant structures. Release through existing plant stacks is considered acceptable, provided the guidance under Requirement 1.2.6 is satisfied. If the release from HCVS is through a vent stack different than the plant stack, the elevation of the stack should be higher than the nearest building or structure.

Requirement 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.

Staff Position: Beyond design basis external events such as a prolonged SBO could result in the loss of active containment heat removal capability. The primary design objective of the HCVS is to provide sufficient venting capacity to prevent a long-term overpressure failure of the containment. The NRC staff has determined that a 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 primary containment pressure limit is sufficient to prevent the containment pressure from increasing any further. This determination is based on studies that have shown that the torus suppression capacity is sufficient to remove decay heat generated during the first 3 hours following the shutdown of the reactor, that decay heat is typically less than 1 percent of rated thermal power 3 hours following shutdown of the reactor, and continues to decrease to well under 1 percent thereafter. Licensees shall have an auditable engineering basis that provides reasonable assurance that the HCVS will have sufficient venting capacity under such conditions. Licensees may also use a venting capacity sized under conditions of constant heat input at a rate lower than 1 percent of thermal power if it can be justified by analysis that containment design pressure would not be exceeded. In cases where plants were granted, have applied, or plan to apply for EPU, the licensees shall use 1 percent thermal power corresponding to the EPU thermal power.

Requirement 1.2.2 The HCVS shall be accessible to plant operators and be capable of remote operation and control, or manual operation, during sustained operations.

Staff Position: 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, provided the licensees take into consideration the following:

1. Sustained operations mean the ability to open/close the valves multiple times during the event.

2. An assessment of temperature and radiological conditions that operating personnel may encounter both in transit and locally at the controls. Licensee may use alternatives such as providing features to facilitate manual operation of valves from remote locations or relocating/reorienting the valves.

3. All permanently installed HCVS equipment, including any connections required to supplement the HCVS operation during a prolonged SBO (electric power, N_2/air) shall be located above the maximum flood level that could potentially occur at the plant concurrent with the prolonged SBO.

4. During a prolonged SBO, manual operation/action may also 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. 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 by means such as reach rods, chain links, hand

wheels, and portable equipment to provide motive force (e.g., air/N2 bottles, diesel powered compressors, and DC batteries). The connections between the valves and portable equipment should be designed for quick deployment. If a portable motive force (e.g., air or N_2 bottles, DC power supplies) is used in the design strategy, licensees shall provide reasonable protection of that equipment from external events (e.g. seismic, flood, tornado) at readily accessible storage locations.

5. The design shall preclude the need for operators to move temporary ladders or operate from atop scaffolding to access the valves or remote operating locations.

Requirement 1.2.3 The HCVS shall include a means to prevent inadvertent actuation.

Staff Position: The design of the HCVS shall incorporate features, such as control panel key-locked switches, locking systems or methods to prevent the inadvertent use of hand operated valves, rupture discs, and administrative controls. The system shall be designed to preclude inadvertent actuation of the HCVS due to any single active failure. The design should consider general guidelines such as single point vulnerability and spurious operations of any plant installed equipment associated with HCVS.

The objective of the HCVS is to provide sufficient venting of containment and prevent long term overpressure failure of containment following active containment heat removal capability or prolonged SBO. However, an inadvertent actuation of HCVS due to a design error, equipment malfunction, or operator error during a design basis loss-of-coolant accident (DBLOCA) could potentially have an opposite effect. The emergency core cooling system (ECCS) pumps start on a DBLOCA and operate at a high flow rate, providing core injection. A number of Mark I and Mark II plants rely on containment accident pressure (CAP) to provide adequate NPSH to the ECCS pumps during the first few hours after a DBLOCA. The HCVS has no function during a DBLOCA. The vent should not be open during a DBLOCA; however, if it were to be open, the CAP would be compromised thus leading to a potential failure of the ECCS pumps due to inadequate NPSH. Therefore, prevention of inadvertent actuation is an important issue for all plants but extremely more important for plants relying on CAP. The licensee submittals on HCVS shall specifically include details on how this issue will be addressed on their individual plants.

Requirement 1.2.4 The HCVS shall include a means to monitor the status of the vent system (e.g., valve position indication) from the control room or other location(s). The monitoring system shall be designed for sustained operation during a prolonged SBO.

Staff Position: Plant operators must be able to readily monitor the status of the HVCS at all times, including being able to understand whether or not valves are open or closed, system pressure and effluent temperature. Other important information includes the status of supporting systems, such as instrument air (or N_2, if used) valve position indication and pressure. The means to monitor system status shall support sustained operations during a prolonged SBO.

Requirement 1.2.5 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 in the control room or other location(s), and shall be designed for sustained operation during a prolonged SBO.

Staff Position: Licensees shall provide a means to monitor radioactivity that may be released from the HCVS discharge. A gross monitoring system for the overall activity in the release providing indication that effluent from the reactor are passing by the monitor is acceptable. The monitoring system shall be provided with indication in control room or a remote location for the first 24 hours after the initiation of the HCVS with electric power provided by permanent DC battery sources, supplemented by portable power sources for sustained operations. The remote indicating location should be in the close proximity to other operator actions required for sustained operation of the HCVS, such as manual connections to the portable motive force (N_2 or air bottles, air compressor) and electric power for the system. Monitoring is required only during the events that necessitate operation of the HCVS.

Requirement 1.2.6 The HCVS shall include design features to minimize unintended cross flow of vented fluids within a unit and between units on the site.

Staff Position: At Fukushima, an explosion also occurred in Unit 4, which was in a shutdown at the time of the event. Although the facts have not been fully established, a likely cause of the explosion is that hydrogen leaked from Unit 3 to Unit 4 through a common venting system. System cross-connections present a potential for steam, hydrogen, and airborne radioactivity leakage to other areas of the plant and to an adjacent plant at multi-unit sites if the units are equipped with common vent piping. In this context, the most preferable method is to have a vent system configuration with short piping run to a dedicated vent release point for each plant with no cross-connections. If this is determined to be not feasible, licensees shall provide design features to prevent the cross flow of vented fluids to migrate to other areas within the plant or to an adjacent plant at multi-unit sites. The current design of the hardened vent at many plants the U.S. includes a tie in with the Standby Gas Treatment System (SGTS), which contains sheet metal ducts which are not as leak tight as hard pipes. In addition, dual unit plant sites are often equipped with a common plant stack. Licensees shall provide design features to eliminate or minimize the unintended cross flow from the HCVS to other areas within the plant or to another plant on the site. Acceptable means for prevention of cross flow is by valves, leak-tight dampers, and check valves, which shall be designed to automatically close upon the initiation of the HCVS and shall remain closed for as long as the HCVS is in operation. If power is required for the interfacing valves to fail in the isolation position, it shall be from the same power sources as the vent valves. Leak tightness of any such barriers shall be periodically verified by testing.

Requirement 1.2.7 The HCVS shall include features and provision for the operation, testing, inspection and maintenance adequate to ensure that reliable function and capability are maintained.

Staff Position: The HCVS piping run shall be designed to eliminate the potential for condensation accumulation, as subsequent water hammer could complicate system operation during intermittent venting or to withstand the potential for water hammer without compromising the functionality of the system. Licensees shall provide a means (e.g., drain valves, pressure and temperature gauge connections, etc.) to periodically test system components, including the periodic exercise (opening and closing) of the vent valve(s).

The HCVS valves and the interfacing system valves shall be cycled every operating cycle. System visual inspections and walkdowns shall be conducted every operating cycle. The venting procedure shall be validated every other operating cycle.

Requirement 1.2.8 The HCVS shall be designed for pressures that are consistent with maximum containment design pressures as well as dynamic loading resulting from system actuation.

Staff Position: The vent system shall be designed for the higher of the primary containment pressure limit or 100 psig, and a temperature of 600° F. The piping, valves and the valve actuators shall be designed to withstand the dynamic loading resulting from the actuation of the system, including piping reaction loads from valve opening and potential for water hammer from accumulation of steam condensation during multiple venting cycles.

Requirement 1.2.9 The HCVS shall discharge the effluent to a release point above main plant structures.

Staff Position: The HCVS release to outside atmosphere shall be at an elevation higher than adjacent plant structures. Release through existing plant stacks is considered acceptable, provided the guidance under Requirement 1.2.6 is satisfied. If the release from HCVS is through a stack different than the plant stack, the elevation of the stack should be higher than the nearest building or structure. The release point should be situated away from ventilation system intake and exhaust openings or emergency response facilities. The release stack or structure exposed to outside shall be designed or protected to withstand missiles that could be generated by the external events causing the prolonged SBO (e.g. tornadoes, high winds).

Requirement 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.

Staff Position: The design out to and including the second containment isolation barrier shall meet safety related requirements consistent with the design basis of the plant, including General Design Criteria (GDC) 54 "Piping systems penetrating containment" and GDC 56 "Primary containment isolation." The piping and piping supports shall be designed to meet Seismic Category I requirements. The staff notes that in response to GL 89-16, in many cases, the HCVS vent line connections were made to existing systems. In some cases, the connection was made in between two existing containment isolation valves and in others to the vacuum breaker line. A design that is free of physical and control interfaces with other systems offers the potential outcome for a highly reliable vent system. The licensees are encouraged to design the HCVS with a dedicated penetration and dedicated vent valves that would be kept closed at all conditions except for periodic testing and when the HCVS is called into operation with a short run of piping leading to the vent release point. If this were determined to be not feasible, the existing containment isolation valves and the vent valve also become part of the containment isolation barrier. The HCVS system design shall not preclude the containment isolation valves, including the vent valve from performing their intended containment isolation function consistent with the design basis for the plant. The design shall include all necessary overrides of containment isolation signals and other interface system signals to enable the vent valves to open upon initiation of the HCVS from its control panel.

Requirement 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.

Staff Position: All components of the HCVS beyond the second containment isolation barrier shall be designed to ensure HCVS functionality following the plant's design basis seismic event. These components include, in addition to the hardened vent pipe, electric power supply, pneumatic supply and instrumentation. The design of power and pneumatic supply lines between the HCVS valves and remote locations (if portable sources were to be employed) shall also be designed to ensure HCVS functionality. Licensees shall ensure that the HCVS will not impact other safety related structures and components and that the HCVS will not be impacted by other non-seismic components. The HCVS components, including the piping run, shall not be located in non-seismic structures. The hardened vent shall be designed to conform to the requirements of the applicable American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (ASME Code) and the applicable Specifications, Codes and Standards of the American Institute of Steel Construction (AISC).

Requirement 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 SBO conditions.

Staff Position: Procedures shall be developed about when and how to place the HCVS in operation, time constraints, location of system components, discussion of 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 equipment. The procedures shall be written in a clear, concise and easy to understand manner given the time constraints, and circumstances the operators are dealing with during a prolonged SBO. The procedures shall clearly state the nexus between CAP and ECCS pumps during a DBLOCA and how an inadvertent opening of the vent valve could have an adverse impact on this nexus.

The licensee shall establish provisions for out-of-service requirements of the HCVS and compensatory measures. The system shall not be out-of-service for longer than 7 days during modes 1, 2, and 3.

Requirement 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 SBO conditions.

Staff Position: All personnel expected to operate the HVCS shall receive training in the use of plant procedures developed for system operations when normal and backup power is available, and during SBO conditions consistent with the plants systematic approach to training. The training shall be refreshed on a periodic basis and as any changes occur to the HCVS.

4.0 Reporting Requirements

Section IV.C. 1. All Licensees shall, by February 28, 2013, submit to the Commission for review an overall integrated plan including a description of how compliance with the requirements described in Attachment 2 will be achieved.

Staff Position: The February 28, 2013, submittal shall contain information with the necessary detail to demonstrate compliance with the requirements described in Attachment 2 of EA-12-050. Licensees shall provide a complete description of the system, 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). In addition, the staff expects the Licensee's submittal will provide the following information:

- A description of how the design objectives contained in Attachment 2, Requirements 1.1.1, 1.1.2, and 1.1.3 are met.
- Description of major system components, including applicable quality requirements.
- Operational characteristics and a description of how each of the order's technical requirements are being met.
- A piping and instrumentation diagram (P&ID)

The February 28, 2013, submittal shall also include an update of implementation schedule milestones.

Section IV.C.2. All Licensees shall provide an initial status report sixty (60) days following issuance of the final ISG, and at six (6)-month intervals following submittal of the overall integrated plan, as required in Condition C.1, which delineates progress made in implementing the requirements of this Order.

Staff Position: TBD. Awaiting stakeholder input.

Section IV.C.3 All Licensees shall report to the Commission when full compliance with the requirements described in Attachment 2 is achieved.

Staff Position: TBD. Awaiting stakeholder input.