DRAFT

U. S. NUCLEAR REGULATORY COMMISSION

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

Interim Staff Guidance
Revision 0

Draft for Public Comment
March 2015

March 2015 ML15051A143

DRAFT

U. S. NUCLEAR REGULATORY COMMISSION

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

Interim Staff Guidance

Revision 0

Draft for Public Comment
March 2015

ADAMS Accession No.: ML15051A143

*Concurrence via e-mail

OFFICE	NRR/JLD/JPSB	NRR/JLD/JHMB	Tech Editor*	NRR/DSS/SCVB*
NAME	RAuluck	SLent	CHsu	RDennig
DATE	02/23/15	02/20/15	02/23/15	02/24/15
OFFICE	NRR/JLD/PSB	NRR/JLD/JCBB	OGC*	NRR/JLD/TSD
NAME	GBowman	SBailey	HBenowitz	JMcHale
DATE	02/23/15	02/23/15	02/27/15	02/23/15
OFFICE	NRR/JLD			
NAME	JDavis			
DATE	03/02/15			

OFFICIAL RECORD COPY

DRAFT

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

JLD-ISG-2015-01

PURPOSE

The U.S. Nuclear Regulatory Commission (NRC) staff is providing this Japan Lessons-Learned Division (JLD) interim staff guidance (ISG) to assist nuclear power reactor licensees with the identification of methods needed to comply with the requirements of Phase 2 of Order EA-13-109, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Performing under Severe Accident Conditions" (Ref. 1). This order requires licensees of boilng-water reactors (BWRs) with Mark I and Mark II containments to have either a vent path from the containment drywell or a strategy that makes it unlikely that venting would be needed from the drywell before alternate reliable containment heat removal and pressure control is reestablished. This ISG endorses, with exceptions and clarifications, the methods described in the industry guidance document Nuclear Energy Institute (NEI) 13-02, "Industry Guidance for Compliance with Order EA-13-109," Rev. 0E2 (Ref. 2). This ISG provides one acceptable approach for satisfying Phase 2 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

The accident at the Fukushima Dai-ichi nuclear power station reinforced the importance of reliable operation of containment vents for BWR plants with Mark I and Mark II containments. In response to the accident, the NRC issued Order EA-12-050, "Issuance of Order to Modify Licenses with Regard to Reliable hardened Containment Vent." dated March 12, 2012 (Ref. 3), which required BWR licensees with Mark I and Mark II containments to upgrade or install a reliable hardened containment venting system. The EA-12-050 requirements were intended to increase the reliability of BWR Mark I and II containment venting systems to support decay heat removal from the reactor core and to provide protection against over-pressurization of the primary containments. While developing the requirements for Order EA-12-050, the NRC acknowledged that questions remained about maintaining containment integrity and limiting the release of radioactive materials if licensees used the venting systems during severe accident conditions.

The staff presented options to address these issues for Commission consideration in SECY-12-0157, "Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments," dated November 26, 2012 (Ref. 4). The options presented in SECY-12-0157 included: (1) continuing with the implementation of Order EA-12-050 for reliable hardened vents; (2) requiring licensees to upgrade or replace the reliable hardened vents required by EA-12-050 with a containment venting system designed and installed to remain functional during severe accident conditions;

(3) requiring licensees with BWR Mark I and Mark II containments to install an engineered filtered containment venting system intended to prevent the release of significant amounts of radioactive material following the dominant severe accident sequences; and (4) pursuing development of requirements and technical acceptance criteria for performance-based confinement strategies. The staff provided an evaluation considering various quantitative analyses and qualitative factors related to the four options and recommended that the Commission approve Option 3 to require the installation of an engineered filtering system.

In the staff requirements memorandum (SRM) for SECY-12-0157, dated March 19, 2013 (Ref. 5), the Commission directed the staff to: (1) issue a modification to Order EA-12-050 to require BWR licensees with Mark I and 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; and (2) develop a technical basis and rulemaking for filtering strategies with drywell filtration and severe accident management for BWRs with Mark I and II containments. After the SRM was issued, the NRC staff held a series of public meetings to solicit stakeholder input on adding requirements related to severe accident conditions to the existing requirements in Order EA-12-50. The resultant Order EA-13-109 was issued on June 6, 2013. This order requires installation of reliable hardened wetwell vents that not only will assist in preventing core damage when containment heat-removal capability is lost, but also will function in severe accident conditions (i.e., when core damage has occurred). Severe accident conditions include: the elevated temperatures, pressures, radiation levels, and concentrations of combustible gases 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. This order also requires licensees with Mark I and Mark II containments to either install a severe-accident-capable drywell venting system or 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.

In recognition of the relative effectiveness for retention of radioactive material when comparing venting from the wetwell and drywell, a phased approach to implementation is being used to minimize delays in implementing the requirements that Order EA-12-050 originally imposed. Phase 1 involves upgrading the capabilities for venting 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. Phase 2 involves providing additional protection for severe accident conditions through either installation of a reliable, severe-accident-capable drywell vent capability that allows for flooding of the wetwell 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. The revised order contains two distinct schedules for implementation. For Phase 1, all licensees are required to implement the requirements no later than startup from the second refueling outage that begins after June 30, 2014, or June 30, 2018, whichever comes first. For Phase 2, all licensees are required to implement the requirements no later than startup from the first refueling outage that begins after June 30, 2017, or June 30, 2019, whichever comes first.

Phase 1 Guidance

Since the issuance of the revised order, the NRC staff issued JLD-ISG-2013-02, Rev. 0, for Phase 1 of Order EA-13-109 on November 14, 2013 (Ref. 6). JLD-ISG-2013-02, Rev. 0, endorses, with exceptions and clarifications, the methodologies described in NEI 13-02, Rev. 0, "Industry Guidance for Compliance with Order EA-13-109" (Ref. 7). All applicable licensees submitted an overall integrated plan (OIP) for NRC review on or before June 30, 2014, which included a description of how compliance with Phase 1 requirements will be achieved. The staff is currently reviewing the Phase 1 OIPs and conducting audits of licensee progress towards compliance with Phase 1 of Order EA-13-109. By June 30, 2015, the staff plans to issue interim staff evaluations (ISEs) to all applicable licensees documenting open items associated with implementation of the Phase 1 OIPs.

Phase 2 Guidance

The focus of this ISG is to provide guidance for implementing Phase 2 requirements of the order. The Phase 2 portion of Order EA-13-109 builds on the Phase 1 activities, and is intended to be consistent with the expected outcome of the development of a regulatory basis for the Containment Protection and Release Reduction (CPRR) rulemaking. Specifically, the industry described a containment venting approach that includes severe accident water addition (SAWA) and severe accident water management (SAWM) strategies that would preserve the use of a wetwell vent path, in addition to providing other benefits. Evaluations performed in support of the CPRR rulemaking confirmed significant benefits to including SAWA as part of a severe accident management strategy. Similar to the process used for developing guidance for Phase 1 requirements, the industry working group developed proposed guidance for implementation of Phase 2 requirements of Order EA-13-109. The NRC staff held several public meetings and provided its own comments on the proposed guidance. Although not addressed by this ISG, licensees may propose and request NRC approval of alternative methods for complying with the requirements in Order EA-13-109. An example could be the installation of a drywell vent with or without an engineered filter along with a severe accident water addition capability as an alternate to the current requirements in Phase 1 and Phase 2 of Order EA-13-109.

On December 10, 2014, on behalf of the industry, NEI submitted for NRC staff review and endorsement a revised industry document NEI 13-02, Rev. 0E2, "Industry Guidance for Compliance with Order EA-13-109, Rev. 0E2." The NRC staff has reviewed the guidance document and has endorsed the methodology, with exceptions and clarifications, as noted in Attachment 1.

RATIONALE

1. Order EA-13-109 provides a two-phased approach to implement requirements identified in the order. Under Phase 1, licensees of BWR facilities with Mark I and Mark II containment designs shall install a wetwell venting system that remains functional during severe accident conditions. Under Phase 2, licensees of BWR facilities with Mark I and Mark II containment designs shall either install a severe-accident-capable drywell venting system or develop and implement a reliable containment venting strategy that makes it unlikely that a licensee would need to vent from the containment drywell during

a severe accident. The installed venting system must meet prescribed quality standards. Generally, the system must be of a "seismically rugged design" and meet the plant's design basis.

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

APPLICABILITY

This ISG 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 BWR licensees with Mark I and Mark II containment designs. The NRC staff considers that the design, development, implementation, and testing of severe-accident-capable hardened containment venting systems (HCVS) as described in NEI 13-02, Rev. 0E2 are acceptable means of meeting the Phase 2 requirements of Order EA-13-109. However, NRC endorsement of NEI 13-02, Rev. 0E2 does not imply NRC endorsement of references listed in NEI 13-02, Rev. 0E2.

IMPLEMENTATION

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 to evaluate licensee compliance as presented in submittals required in Order EA-13-109.

BACKFITTING DISCUSSION

Licensees may use the guidance in this document to demonstrate compliance with Order EA-13-109. Accordingly, the NRC staff issuance of this ISG is not considered backfitting, as defined in 10 CFR 50.109(a)(1), nor is it deemed to be in conflict with any of the issue finality provisions in 10 CFR Part 52, "Licenses, Certifications, and Approvals for Nuclear Power Plants."

FINAL RESOLUTION

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

ATTACHMENT

1. Guidance for Developing, Implementing, and Maintaining Reliable Hardened Containment Venting Systems at Boiling-Water Reactor Facilities with Mark I and Mark II Containment Designs for Phase 2 of Order EA-13-109.

REFERENCES

1. U.S. Nuclear Regulatory Commission, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions," Order EA-13-109, June 6, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13130A067).

2. Nuclear Energy Institute 13-02, "Industry Guidance for Compliance with Order EA-13-109," Rev. 0E2, December 10, 2014, (ADAMS Accession No. ML14345B045).

3. U.S. Nuclear Regulatory Commission, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents," Order EA-12-050, March 12, 2012 (ADAMS Accession No. ML12054A694).

4. U.S. Nuclear Regulatory Commission, "Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments," SECY-12-0157, November 26, 2012 (ADAMS Accession No. ML12325A704).

5. U.S. Nuclear Regulatory Commission, "SRM - SECY-12-0157 – Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments," SRM-SECY-12-0157, March 19, 2013 (ADAMS Accession No. ML13078A017).

6. U.S. Nuclear Regulatory Commission, "Interim Staff Guidance JLD-ISG-2013-02, " Compliance with Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Vents Capable of Operation under Severe Accident Conditions," November 14, 2013 (ADAMS Accession No. ML13304B836).

7. Nuclear Energy Institute 13-02, "Industry Guidance for Compliance with Order EA-13-109," Rev. 0, November 12, 2013 (ADAMS Accession No. ML13316A853).

DRAFT

Guidance for Developing, Implementing, and Maintaining Reliable Hardened Containment Venting Systems at Boiling-Water Reactor Facilities with Mark I and Mark II Containment Designs for Phase 2 of Order EA-13-109

1.0 Phased Approach

Order EA-13-109 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13130A067) requires boiling-water reactors (BWRs) with Mark I and Mark II containments to have a reliable, severe-accident-capable hardened containment venting system (HCVS). The order allows implementation of these requirements in two phases. In Phase 1, the subject licensees are required to design and install a venting system that provides venting capability from the wetwell during severe accident conditions. In Phase 2, licensees for BWRs with Mark I and Mark II containments are required to either install a system for venting from the drywell under severe accident conditions or develop and implement a reliable containment venting strategy that makes it unlikely that a licensee would need to vent from the drywell during severe accident conditions.

The timeline for issuing the interim staff guidance (ISG) and for complying with Order EA-13-109 are different for Phase 1 and Phase 2. Specifically, the order allows Phase 2 implementation approximately 1 year later than Phase 1 implementation. The U.S. Nuclear Regulatory Commission (NRC) staff issued the ISG for Phase 1 of Order EA-13-109 on November 14, 2013 (ADAMS Accession No. ML13304B836). The purpose for having a phased approach was in part, to avoid inconsistency with the studies related to the development of a regulatory basis for the Containment Protection and Release Reduction (CPRR) rulemaking. Since issuance of Order EA-13-109, a significant work has been done on the CPRR rulemaking and the NRC staff is developing an information paper to inform the Commission of the findings and staff's path forward. On December 10, 2014, Nuclear Energy Institute (NEI) submitted NEI 13-02, "Industry Guidance for Compliance with Order EA-13-109, Revision 0E2," for NRC review and endorsement. The submitted document contains implementation guidance for the entire order, both Phases 1 and 2. This ISG addresses the Phase 2 portion of the guidance contained in NEI 13-02.

2.0 Order Requirements and Applicable Guidance

The requirements in Order EA-13-109 and the corresponding sections in NEI 13-02, that contain the applicable guidance for both Phases 1 and 2, are listed in Table B-1 of Appendix B, "Road Map of Order Requirements" to NEI 13-02.

Staff Position: NEI 13-02 provides acceptable method(s) for satisfying the order requirements with exceptions and clarifications as noted in Section 4 of this ISG.

3.0 Phase 2 Compliance Methods in NEI 13-02

Phase 2 of Order EA-13-109 requires licensees of BWRs with Mark I and Mark II containments to design and install a reliable venting capability from the drywell under severe accident conditions as described by order requirements B(1) and Section B.1 or alternatively, 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 before alternate reliable heat removal and pressure control is reestablished as described in order requirements B(2) and Section B.2.

NEI 13-02, Rev. 0E2 provides guidance to licensees for three different methods of complying with Phase 2 of Order EA-13-02, The first method corresponds with order requirements B(1) and Section B.1, and the other methods correspond to order requirements B(2) and Section B.2.

The first method would provide a severe accident capable drywell vent without additional capabilities for water addition during severe accident conditions. An inability to add water to the containment during the accident calls into question the 545 degrees Fahrenheit (°F) design temperature boundary condition within Mark I and Mark II containments established by the supporting analyses for the guidance. Therefore, NEI 13-02, Rev. 0E2 states that if this method of compliance is to be selected, licensees would need to submit plant-specific analysis relative to the design temperature boundary condition for NRC approval because the existing generic plant analysis shows drywell temperatures significantly exceeding 545°F during a severe accident with reactor vessel breach by core debris without water addition to the reactor pressure vessel or drywell.

The second and third methods of compliance rely on water addition to the containment to achieve the 545°F design temperature boundary condition for a drywell vent or as part of a strategy making it unlikely that a drywell vent would be needed. The second method involves a hybrid approach to the order where licensees would develop a strategy that includes severe accident water addition (SAWA), but also install a severe accident capable drywell vent that complies with the order requirements B(1) and Section B.1. Under that method, SAWA supports the 545°F design temperature boundary condition for the drywell vent. The third method, referred to as severe accident water management (SAWM), includes SAWA and provisions for controlling the rate of water addition. By SAWA with SAWM, the capability to vent from the severe accident capable wetwell vent could be preserved for an extended period of time, until an alternate means of reliable containment heat removal and pressure control could be established. Thus, the third method could be a reliable containment venting strategy, meeting the requirements of B(2) and B.2 of Order EA-13-109, and obviating the need for a drywell vent.

First Method of Compliance:

NEI 13-02, Rev. 0E2 states that the severe accident drywell vent (SADV) installed under this method will comply with the order requirements, the guidance and the supporting appendices developed under Phase 1 of the Order, with the exception of design temperature boundary condition. See the discussion in Section 4.0 “Staff Clarifications and Exceptions to NEI 13-02, Rev. 0E2” for further details. NEI 13-02, Rev. 0E2 states that licensees will need to submit

plant-specific analysis relative to the design temperature boundary condition for the NRC's approval.

Second Method of Compliance

This method will provide a strategy for SAWA along with a SADV that complies with the order requirements B(1) and Section B.1. The temperature boundary condition is achieved by SAWA. The wetwell vent will be used for as long as it is available and when SAWA floods the wetwell vent, the drywell vent will perform the venting function until alternate reliable decay heat removal and pressure control is established. The SADV will comply with the order requirements and the guidance that was developed during Phase 1, including extending the vent design temperature of 545°F developed during that phase to the remaining portions of the drywell vent system. NEI 13-02 describes this method as a strategy addressed by the provisions of B(2) in Order EA-13-109 that includes using a Section B.1-compliant drywell vent until alternate reliable heat removal and pressure control can be established. This hybrid-type approach and description is acceptable. The staff finds the functional requirements defined for the venting system addressed by Section B.1 provides a logical starting point for addressing the functional requirements of equipment used in proposed strategies and enables development of alternatives that provide comparable improvements.

The SAWA guidance was provided in Appendix I of the NEI 13-02, Revision 0E2. The SAWA point will be located in a place that is accessible under severe accident conditions. In the example provided in the appendix, the water addition point can be common for Order EA-12-049 (FLEX) injection and SAWA supporting Order EA-13-109. The water addition source was validated as 500 gallons per minute (gpm) by the Electric Power Research Institute (EPRI) Technical Report (Ref. 27 of NEI 13-02) for the analyzed plant. The time to establish the water addition capability and avoid containment compromise is less than 8 hours from the onset of the loss of all injection sources, based on the worst case scenario presented in NUREG/CR7110, Volume 1, for a short-term station blackout without reactor core isolation cooling (RCIC) black start. Portable pumps used to satisfy the requirements of Order EA-12-049, "Order Modifying Licenses with Regard to Requirements for Mitigating Strategies for Beyond-Design-Basis External Events," can be credited as a SAWA source. All actions necessary to deploy and sustain the equipment will be shown capable of being performed under the temperature and radiological conditions that could exist during a severe accident as defined by Order EA-13-109.

The overall method, conceptually, is acceptable to the NRC staff. However, there are elements of the guidance for SAWA (Appendix I of the draft revision of NEI 13-02) that require further discussions with the industry as to compliance with the order. Those items are discussed in Section 4.0, "Staff Clarifications and Exceptions to NEI 13-02," and relate primarily to providing additional detail on the functional requirements for installed or portable equipment including instrumentation, or providing the basis for why such equipment and instrumentation is not needed.

Third Method of Compliance

This method controls the water addition in SAWA using SAWM and extends the capability to vent from the wetwell for a longer period of time until alternate decay heat removal and pressure control can be established. The guidance states that this method qualifies as a reliable containment venting strategy meeting the order requirements in B(2) and Section B.2. Conceptually, this method is acceptable to the NRC staff. However, some aspects of this method remain under discussion between the industry and NRC staff. These issues are discussed in Section 4.0, "Staff Clarifications and Exceptions to NEI 13-02."

4.0 Staff Clarifications and Exceptions to NEI 13-02

The NRC staff's endorsement of NEI 13-02, "Industry Guidance for Compliance with Order EA-13-109," Draft Revision 0E2, is subject to the following exceptions and clarifications.

4.1 First Method of Compliance

The order requires consideration of accidents involving extensive core damage, including accidents involving molten core debris breaching the reactor vessel. The potential for extremely high temperatures in the drywell, possibly exceeding 1,000°F, with core debris on the drywell floor has been known for some time. The structural integrity of containment and the performance of drywell head seals and other penetrations would likely be compromised when the drywell reaches such high temperatures. While a drywell vent may provide overpressure protection under such conditions, it is likely that releases into the reactor building would take place simultaneously through compromised drywell head seals and other penetrations. Under such conditions, there is an increased potential for not being able to restore the containment function after the vent is closed in scenarios with insufficient water addition. During the development of Order EA-13-109, there was a general assumption on the part of industry participants and the NRC staff that water addition would likely be included as a possible requirement in the Containment Protection and Release Reduction (CPRR) rulemaking. During the Phase 1 guidance development, substantial discussions took place regarding an acceptable design temperature for a drywell vent. A temperature of 545°F for drywell vent boundary condition was established and included in NEI 13-02. The value is considered reasonable, because it was thought likely to be within the capability of containment boundary components and a readily achievable design parameter for a containment at the existing Mark I and Mark II plants provided there is water addition. In addition, it is expected to provide protection from gross leakage from drywell head seals and other penetrations. Industry and NRC staff analyses have confirmed that drywell temperatures are not likely to exceed 545°F for a majority of accident sequences that include severe accident water addition.

The guidance states that if this method, which does not include SAWA, is to be selected, the licensees would need to submit the plant-specific analysis used to establish the design temperature for the drywell vent for NRC review and approval. The NRC staff would review these plant-specific analyses, including the applicability of other elements of Section B.1, prior to approving implementation of this method. However, as discussed above and in the letter from NEI dated September 10, 2014 (ADAMS accession No. ML14266A270) and related NRC response dated December 10, 2014 (ADAMS Accession No. ML14343A818), there are potential

longer-term issues related to the CPRR rulemaking should a licensee decide to pursue this option.

4.2 Second Method of Compliance

Under this hybrid approach, the temperature boundary condition for the drywell vent and for prevention of gross leakage through drywell head seals and other penetrations is achieved by SAWA. The wetwell vent would be used for as long as it is available, and when SAWA floods the wetwell vent, the drywell vent would perform the venting function until alternate reliable decay heat removal and pressure control is established. Appendix I, "Severe Accident Water Addition (SAWA)" to NEI 13-02 provides the guidance for SAWA. Although developed as a strategy under Provision B(2) and Section B.2 of Order EA-13-109, this method (Option 1 in NEI-13-02) includes a drywell vent that meets the functional requirements of B(1), with a design temperature established at 545°F for the vent due to the beneficial effects of water addition. Other aspects of the strategy, primarily SAWA as described in Appendix I, are compared against the B(2) provisions of the order. The staff finds that the functional requirements defined in Section B.1 provide a logical starting point for addressing functional requirements for equipment used in proposed SAWA strategies. It would be useful for the guidance and the subsequent template for aiding licensees preparing overall integrated plans for Phase 2 of Order EA-13-109 to use the guidance prepared for Section B.1, including the identification of areas of applicability or inapplicability, to help define the functional requirements of SAWA-related equipment.

Appendix I of NEI 13-02 discusses reactor pressure vessel pressure control in the realm of Emergency Procedure Guidelines (EPGs) and Severe Accident Guidelines (SAGs). This discussion is informational on how the equipment would be used but has no direct bearing on the implementation of Phase 2 of Order EA-13-109. Therefore, the NRC did not review and is not endorsing this discussion.

The proposed strategy that includes a drywell vent designed to the requirements of B(1) and a SAWA provision developed in accordance with B(2) is an area requiring further discussion to ensure the guidance can be readily implemented For example, Section 2.5.2 of the guidance states that the requirement defining a 24-hour capability for dedicated and permanently installed equipment in the venting system does not apply to non-HCVS equipment (e.g., SAWA pumps, valves, and instrumentation) needed to support strategies implemented for Section B.2 of the order using SAWA and/or SAWM. At Fukushima Dai-ichi, limitations in time and unpredictable conditions associated with the accident significantly hindered the operator's attempts to prevent core damage and containment failure. Notably, operators could not successfully operate the containment venting system when needed. The problems with venting the containments under the challenging conditions following the tsunami, contributed to the progression of the accident and ultimately to containment failure. The broad set of requirements in Order EA-13-109 is intended to provide a higher probability of successful venting when normal means of transferring reactor decay heat out of containment are not functioning, including conditions associated with a severe accident having progressed to core debris being on the drywell floor. Requirement 1.2.6 of Attachment 2 of Order EA-13-109, which discusses requirements associated with 24-hour

capability for dedicated and permanently installed equipment, is a major part of the order to ensure a vent path can be achieved with minimal operator actions.

The NRC staff recognizes that the guidance in NEI 13-02 is not taking any exceptions to the order requirement as it applies to the HCVS part of the strategy defined in the second method (or Option 1 in NEI 13-02). The NRC also recognizes that capabilities associated with Order EA-12-049 may be credited for powering SAWA 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 temperature and radiological conditions associated with a severe accident. However, there is also a reference to permanently installed instrumentation (e.g. wetwell level) with no guidance on how power to the instrument is ensured during the first 24 hours or an alternate time associated with the implementation of the strategy (Section B.2.3 of Order EA-13-109). In the absence of an implementation strategy or guidance for defining functional requirements for the SAWA-related installed and portable equipment (including instrumentation) associated with the second method, the industry position that the 24-hour capability for dedicated and permanently installed equipment from B(1) does not apply to any non-HCVS equipment requires further discussion between the staff and the industry.

4.3 Third Method of Compliance

4.3.1 Wetwell Vent Preservation

This method involves a strategy that controls the water addition in SAWA using SAWM and extends the capability to vent from the wetwell for a longer period of time. As an alternative to installing a severe accident capable drywell vent, Order requirement B(2) allows licensees to:

> …. develop and implement 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." Section B.2 of the order provides additional requirements for the containment venting strategy.

The guidance related to determining that 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 is an area that requires continued discussion between the industry and NRC staff. The industry has proposed in NEI 13-02 a performance criterion using a coping time concept in which venting capability from the drywell is not required if it can be shown that it is not needed within a defined time from the onset of the accident (e.g., 72 hours). That duration is stated to be long enough for emergency response organization (ERO) and offsite support to be established and to develop and implement plans for alternate means of containment heat removal and pressure control. Some parts of the guidance in Appendix C more fully describe how licensees would meet B(2) requirements of the order, while in other areas, the guidance mentions specific coping times of ≥ 48 hours and 72 hours as being an acceptable duration metric for preservation of the wetwell vent. The guidance does not specifically discuss the procedures and functional requirements associated with the establishment of alternate means of

containment heat removal. As such, the NRC staff is unable to conclude that 48 or 72 hours duration is sufficient.

The order also states:

> [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 sequences that result in the loss of active containment heat removal capability or extended loss of alternating current (ac) power.

The order does not establish any limiting metric for the duration of the loss of ac power just as Order EA-12-049 does not. However, in Phase 1 guidance development, the NRC staff and the industry agreed that the HCVS could be considered capable of sustained operations if it could remain functional for at least 7 days, because 7 days was thought to be a reasonably conservative period of time. There was no discussion during the development of the Phase 1 guidance about how a licensee would provide reliable alternate containment heat removal methods or justify a period for sustained operations of less than 7 days. An acceptable approach for Phase 2 could be for licensees to develop procedures and functional requirements for installed and portable equipment, including instrumentation, supporting SAWM and venting from the wetwell for the same 7-day period previously agreed upon for Phase 1.

If the industry desires to reduce the 7 day sustained operation concept, the guidance could direct licensees to submit for staff review, their potential success paths to establish an alternate heat removal system in the desired time period. The OIPs should discuss the development of procedures and the identification and availability of equipment that could be used during severe accident conditions and/or any permanent modifications required to enable a successful strategy during a severe accident. The proposed success path(s) will be reviewed by staff, and if accepted, will be included as a staff audit item under Order EA-13-109. The staff acknowledges that emergency response organizations and offsite resources can support the development and implementation of ad hoc alternate heat removal capabilities. However, if the wetwell vent preservation time is less than the 7-day period, the NRC staff acceptance may be based on licensees showing a success path(s) to establish an alternate heat removal system within the desired compressed time. This issue remains an open item and will be the topic of ongoing discussions on the completion of the guidance for Phase 2 of Order EA-13-109.

4.3.2 Alternate Containment Pressure Control

Another open item relates to the longer term or alternate control of containment conditions during the recovery from a severe accident. NEI 13-02 discusses the potential need for alternate pressure control in the following statements:

> “Use of a drywell vent path that is not EA-13-109 severe accident capable is acceptable provided combustible gases have been mitigated (e.g., purged and diluted) such that a combustible gas mixture no longer exists in the drywell.” (Section 1, Page 4)

> "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" (Appendix C, Item C-2)

Indicating that a drywell vent is not required is the statement:

> "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." (Appendix C, Item C-2).

Appendix C, Section C.7.1.4.4.1 states:

> "Due to the variability of the progression of a severe accident, it is not possible to identify specific actions for the transition from Severe Accident Coping to alternate reliable containment heat removal and pressure control. The emergency response organization (ERO) will determine the actions needed based on the status of the plant and the equipment available at that time."

The guidance should instruct licensees to identify and include in their OIPs possible means of providing the alternative pressure control. The staff expects to consider such alternate pressure control measures needed for longer-term plant recovery similar to its treatment of secondary or alternative containment protection features included in licensee plans for Order EA-12-049. The issue of longer-term actions remains an open item and will be the topic of ongoing discussions on the completion of the guidance for Phase 2 of Order EA-13-109.

As stated above, operators at Fukushima Dal-chi were challenged in operating the HCVS at those plants. One of the objectives of Order EA-13-109 is to provide assurance that operators will be able to control containment pressure throughout the accident management and accident recovery phases. Longer term or alternate drywell vent requirements can assume additional time and actions to implement and therefore need not address the order requirements addressing accident management functions. For example, NEI 13-02 states that combustible gases are not a concern for an alternate drywell vent because the wetwell vent would have vented out a significantly large portion of the gases. Also, the vent capacity could be much lower when the vent is needed and the requirement to establish motive power for the vent flow path comes much later.

If the licensees determine that drywell venting would be a necessary accident management function after the wetwell vent is flooded and within 7 days of the onset of the accident, licensees should submit for the staff review, one or more possible success paths to establish an alternate containment pressure control as discussed above in Section 4.3.1. The discussion should address the equipment required and any permanent modifications required to enable drywell vent system operation during a severe accident. The proposed success path(s) will be reviewed by staff, and if accepted, will be included in staff audits under Order EA-13-109. The issue of an acceptable coping time for SAWM remains an open item and will be the topic of ongoing discussions on the completion of the guidance for Phase 2 of Order EA-13-109.

4.3.3 Instruments Required for Implementation of SAWM

NEI 13-2, Rev. 0E2 should include guidance regarding functional requirements such as how power to the required instruments is ensured during the first 24 hours following onset of the accident. The industry believes that requirements associated with 24-hour capability for dedicated and permanently installed equipment does not apply to non-HCVS vent line flow path equipment. This issue requires further discussion between the NRC staff, the industry, and other stakeholders. The purpose of the order is to ensure that HCVS is available under severe accident conditions, needing only minimal operator actions under the demanding conditions that would exist during a severe accident. The NRC staff finds the functional requirements defined for the venting systems addressed by Section B.1 provide a logical starting point for addressing the functional requirements of the equipment used in proposed strategies and enable development of alternatives that provide comparable improvements. NEI 13-02, Rev. 0E2 should provide guidance as to what needs to be submitted in the licensee's OIPs, including information on how water addition rate is reduced, by portable components or permanent components, in transitioning from SAWA to SAWM.

4.4 Reference 27 to NEI 13-02, EPRI Technical Report 3002003301, Technical Basis for Severe-Accident Mitigating Strategies

Much of the supporting analyses for SAWA and SAWM were performed by the industry and the NRC staff using generic assumptions or models for reference plants that were shared and discussed in public meetings during development of the guidance. The analyses are appropriately reflected in the guidance and will be further documented in reports to be published by the industry (reference 27) and the NRC in a NUREG report. However, it is not clear how and to what extent plant-specific configurations might differ from the analyzed plant. The guidance should provide direction to licensees as to what is expected of them to support the applicability of the discussion in NEI 13-02, Rev. 0E2 to their individual plants, including plant-specific analysis that might be required.

4.5 Emergency Operating Procedures, Severe Accident Management Guidelines, and Emergency Preparedness Procedures.

NEI 13-02, Rev. 0E2 contains references to the Boiling-Water Reactor Owners Group (BWROG) generic EPGs/SAGs and plant-specific Emergency Operation Procedures (EOPs), Severe Accident Management Guidelines (SAMGs), and Emergency Preparedness procedures. The discussion in this section extends beyond the scope of Order EA-13-109 and the staff's endorsement of the technical and quality requirements of severe-accident-capable vents. The discussion pertains to using a drywell vent when plant-specific EPGs/SAMGs are revised to incorporate post-Fukushima revisions recommended by the BWROG EPGs/SAGs. This discussion is informational and the NRC staff is not providing a general endorsement for the contents, including but not limited to the BWROG generic EPGs/SAGs or plant-specific EOPs/SAMGs. The staff will review the procedural requirements on the operation and use of the drywell portion of the HCVS during review of licensee submittals of OIPs related to Phase 2.

4.6 Appendix E - Interface with the Requirements of Generic Letter 89-16, "Installation of a Hardened Wetwell Vent"

The stated purpose of Appendix E to NEI 13-02, Rev. 0E2 is to provide a clear understanding of the interface between Generic Letter (GL) 89-16, "Installation of a Hardened Wetwell Vent," and Order EA-13-109, "Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions." Appendix E also clarifies administrative housekeeping, in that it provides a basis for the licensee use of changing commitments to GL 89-16 in accordance with NEI 99-04, "Guidelines for Managing NRC Commitment Changes" (ADAMS Accession No. ML003680088). The appendix contains no information on the guidance related to the design and implementation of the HCVS required by Order EA-13-109. Therefore, the staff did not review Appendix E of NEI 13-02, Rev. 0E2 and it is not within the scope of this ISG.

4.7 Instrumentation Design Features

NEI 13-02, Rev. 0E2 provides several different references to instrumentation being used for monitoring the protection of personnel, the surveillance of environmental conditions to maintain leak-tight conditions, and the main operations of the HCVS system. The instrumentation and controls require design features that, as stated in Item 1.2.10 of Order EA-13-109 can withstand and remain functional during a severe accident, which could include the dynamic loading of combustible gas deflagration and detonation. Item 1.2.13 states that the HCVS shall include features and provisions for operation, testing, inspection and maintenance adequate to ensure that reliable function and capability are maintained during a severe accident.

The licensees should show that the instrumentation has continued functionality during severe accidents including environmental effects from the vibration, shock, temperature, humidity, radiation and pressure associated with the accident along with initiating event conditions. The instrumentation history for reliability and the operating performance of the HCVS should be described.

With the abnormal conditions during a severe accident, and to have confidence in the safety, function and reliability of the HCVS instrumentation and controls, the guidance should include a sufficient discussion of or reference to existing design/operating documents regarding:

- an intrinsically safe system;
- flame-proof or explosion-proof features for hazardous locations;
- seismic effects, and vibration and shock performance during several open and close cycles, when the instrumentation and its mounting are under dynamic severe accident load;
- training, procedure development, and surveillance routines for testing and calibration.

4.8 References in NEI 13-02, Rev. 0E2

NEI 13-02, Rev. 0E2 and its appendices cite a number of other documents. The references are generally acceptable to the NRC staff when they are the source document for the information provided in NEI 13-02, Rev. 0E2. However, in some cases these references also provide

alternate methods and choices for designing the HCVS. The NRC staff is not providing a blanket endorsement of the references when they are intended to support methods for implementing the HCVS under Order EA-13-109. The staff will conduct such a review only if the licensee's submittals provide details on the specific application and methods identified in the references that the licensee is relying on for its implementation of Order EA-13-109.

4.9 Appendix A – Glossary of Terms

In Appendix A to NEI 13-02, Rev. 0E2, the NEI provided definitions for a number of key terms used in the guidance. To avoid causing conflicts and confusion with definitions in other documents in the regulatory infrastructure, such as Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.2, "Definitions," the NRC staff is not endorsing these definitions. The staff emphasizes that the definitions in Appendix A to NEI 13-02, Rev. 0E2 are intended only for use within NEI-13-02, Rev. 0E2 and acknowledges that some terms, including "stable state," are used in other contexts (such as NRC regulation 10 CFR 50.54(w)(4)(i)) with a different meaning than in NEI 13-02, Rev. 0E2. To the degree that the definitions are critical to some of the issues identified above (e.g., coping time and alternate pressure control), the definitions are the subject of continued discussions between the NRC staff and industry.