UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

May 7, 2019

Mr. John Dent, Jr.
Vice President-Nuclear and CNO
Nebraska Public Power District
Cooper Nuclear Station
72676 648A Avenue
P.O. Box 98
Brownville, NE 68321

SUBJECT: COOPER NUCLEAR STATION – SAFETY EVALUATION REGARDING IMPLEMENTATION OF HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS RELATED TO ORDER EA-13-109 (CAC NO. MF4384; EPID NO. L-2014-JLD-0046)

Dear Mr. Dent:

On June 6, 2013 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13143A334), the U.S. Nuclear Regulatory Commission (NRC) issued Order EA-13-109, "Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions," to all Boiling Water Reactor (BWR) licensees with Mark I and Mark II primary containments. The order requirements are provided in Attachment 2 to the order and are divided into two parts to allow for a phased approach to implementation. The order required each licensee to submit an Overall Integrated Plan (OIP) for review that describes how compliance with the requirements for both phases of Order EA-13-109 would be achieved.

By letter dated June 30, 2014 (ADAMS Accession No. ML14189A415), Nebraska Public Power District (NPPD, the licensee) submitted its Phase 1 OIP for Cooper Nuclear Station (Cooper) in response to Order EA-13-109. At 6-month intervals following the submittal of the Phase 1 OIP, the licensee submitted status reports on its progress in complying with Order EA-13-109 at Cooper, including the combined Phase 1 and Phase 2 OIP in its letter dated December 21, 2015 (ADAMS Accession No. ML15364A011). These status reports were required by the order, and are listed in the enclosed safety evaluation. By letters dated May 27, 2014 (ADAMS Accession No. ML14126A545), and August 10, 2017 (ADAMS Accession No. ML17220A328), the NRC notified all BWR Mark I and Mark II licensees that the staff will be conducting audits of their implementation of Order EA-13-109 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" (ADAMS Accession No. ML082900195). By letters dated February 11, 2015 (Phase 1) (ADAMS Accession No. ML15006A234), September 29, 2016 (Phase 2) (ADAMS Accession No. ML16266A066), and March 29, 2018 (ADAMS Accession No. ML18081A870), the NRC issued Interim Staff Evaluations and an audit report, respectively, on the licensee's progress. By letter dated January 14, 2019 (ADAMS Accession No. ML19022A365), as supplemented by letter dated April 16, 2019 (ADAMS Accession No. ML19127A022), the licensee reported that Cooper is in full compliance with the requirements of Order EA-13-109, and submitted a Final Integrated Plan for Cooper.

The enclosed safety evaluation provides the results of the NRC staff's review of Cooper's hardened containment vent design and water management strategy for Cooper. The intent of the safety evaluation is to inform Cooper on whether or not its integrated plans, if implemented as described, appear to adequately address the requirements of Order EA-13-109. The staff will evaluate implementation of the plans through inspection, using Temporary Instruction 2515-193, "Inspection of the Implementation of EA-13-109: Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions" (ADAMS Accession No. ML17249A105). This inspection will be conducted in accordance with the NRC's inspection schedule for the plant.

If you have any questions, please contact Dr. Rajender Auluck, Senior Project Manager, Beyond-Design-Basis Engineering Branch, at 301-415-1025, or by e-mail at Rajender.Auluck@nrc.gov.

Sincerely,

Brett Titus

Brett Titus, Acting Chief
Beyond-Design-Basis Engineering Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Docket No. 50-298

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

TABLE OF CONTENTS

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO ORDER EA-13-109

NEBRASKA PUBLIC POWER DISTRICT

COOPER NUCLEAR STATION

DOCKET NO. 50-298

1.0 INTRODUCTION

The earthquake and tsunami at the Fukushima Dai-ichi nuclear power plant in March 2011 highlighted the possibility that extreme natural phenomena could challenge the prevention, mitigation and emergency preparedness defense-in-depth layers already in place in nuclear power plants in the United States. At Fukushima, limitations in time and unpredictable conditions associated with the accident significantly challenged attempts by the responders to preclude core damage and containment failure. During the events at Fukushima, the challenges faced by the operators were beyond any faced previously at a commercial nuclear reactor and beyond the anticipated design basis of the plants. The U.S. Nuclear Regulatory Commission (NRC) determined that additional requirements needed to be imposed at U.S. commercial power reactors to mitigate such beyond-design-basis external events (BDBEEs) during applicable severe accident conditions.

On June 6, 2013 [Reference 1], the NRC issued Order EA-13-109, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions". This order requires licensees to implement its requirements in two phases. In Phase 1, licensees of boiling-water reactors (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. 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.

By letter dated June 30, 2014 [Reference 2], Nebraska Public Power District (NPPD, the licensee) submitted its Phase 1 Overall Integrated Plan (OIP) for Cooper Nuclear Station (CNS, Cooper) in response to Order EA-13-109. By letters dated December 19, 2014 [Reference 3], June 30, 2015 [Reference 4], December 21, 2015 (which included the combined Phase 1 and Phase 2 OIP) [Reference 5], June 30, 2016 [Reference 6], December 28, 2016 [Reference 7], June 19, 2017 [Reference 8], December 21, 2017 [Reference 9], June 26, 2018 [Reference 10], and December 4, 2018 [Reference 11], the licensee submitted 6-month updates to its OIP. By letters dated May 27, 2014 [Reference 12], and August 10, 2017 [Reference 13], the NRC notified all BWR Mark I and Mark II licensees that the staff will be conducting audits of their implementation of Order EA-13-109 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" [Reference 14]. By letters dated February 11, 2015 (Phase 1) [Reference 15], September 29, 2016 (Phase 2) [Reference 16], and March 29, 2018 [Reference 17], the NRC issued Interim Staff Evaluations (ISEs) and an audit report, respectively, on the licensee's progress. By letter dated January 14, 2019 [Reference 18], as supplemented by letter dated April 16, 2019 [Reference 38], the licensee reported that full compliance with the requirements of Order EA-13-109 was achieved and submitted its Final Integrated Plan (FIP).

2.0 REGULATORY EVALUATION

Following the events at the Fukushima Dai-ichi nuclear power plant on March 11, 2011, 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 improvements to these programs in light of the events at Fukushima Dai-ichi. As a result of this review, the NTTF developed a 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 19]. Following interactions with stakeholders, these recommendations were enhanced by the NRC staff and presented to the Commission.

On February 17, 2012 [Reference 20], the NRC staff provided 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", to the Commission. This paper included a proposal to order licensees to implement the installation of a reliable hardened containment venting system (HCVS) for Mark I and Mark II containments. As directed by the Commission in staff requirements memorandum (SRM)-SECY-12-0025 [Reference 21], the NRC staff issued Order EA-12-050, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents" [Reference 22], which required licensees to install a reliable HCVS for Mark I and Mark II 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 the venting systems were used during severe accident conditions. The NRC 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" [Reference 23]. In the SRM for SECY-12-0157 [Reference 24], the Commission directed the staff to issue a modification to Order EA-12-050, requiring 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." The NRC staff held a series of public meetings following issuance of SRM SECY-12-0157 to engage stakeholders on revising the order. Accordingly, as directed by the Commission in SRM-SECY-12-0157, on June 6, 2013, the NRC staff issued Order EA-13-109.

Order EA-13-109 requires that BWRs with Mark I and Mark II containments have a reliable, severe-accident capable HCVS. Attachment 2 of the order provides specific requirements for implementation of the order. The order shall be implemented in two phases.

2.1 Order EA-13-109, Phase 1

For Phase 1, licensees of BWRs with Mark I and Mark II containments are required to 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.

The NRC staff held several public meetings to provide additional clarifications on the order's requirements and comments on the proposed draft guidance prepared by the Nuclear Energy Institute (NEI) working group. On November 12, 2013 [Reference 25], NEI issued NEI 13-02, "Industry Guidance for Compliance with Order EA-13-109," Revision 0, to provide guidance to assist nuclear power reactor licensees with the identification of measures needed to comply with the requirements of Phase 1 of Order EA-13-109. The NRC staff reviewed NEI 13-02, Revision 0, and on November 14, 2013 [Reference 26], issued Japan Lessons-Learned Project Directorate (JLD) interim staff guidance (ISG) JLD-ISG-2013-02, "Compliance with Order EA-13-109, 'Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Performing under Severe Accident Conditions'", endorsing, in part, NEI 13-02, Revision 0, as an acceptable means of meeting the requirements of Phase 1 of Order EA-13-109, and on November 25, 2013, published a notice of its availability in the *Federal Register* (78 FR 70356).

2.2 Order EA-13-109, Phase 2

For Phase 2, licensees of BWRs with Mark I and Mark II containments are required to design and install a venting system that provides venting capability from the drywell under severe accident conditions, or, alternatively, to 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.

The NRC staff, following a similar process, held several meetings with the public and stakeholders to review and provide comments on the proposed drafts prepared by the NEI working group to comply with the Phase 2 requirements of the order. On April 23, 2015 [Reference 27], NEI issued NEI 13-02, "Industry Guidance for Compliance with Order EA-13-109," Revision 1, to provide guidance to assist nuclear power reactor licensees with the identification of measures needed to comply with the requirements of Phase 2 of Order EA-13-109. The NRC staff reviewed NEI 13-02, Revision 1, and on April 29, 2015 [Reference 28], the NRC staff issued 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 Performing under Severe Accident Conditions'", endorsing, in part, NEI 13-02, Revision 1, as an acceptable means of meeting the requirements of Phase 2 of Order EA-13-109, and on April 7, 2015, published a notice of its availability in the *Federal Register* (80 FR 26303).

3.0 TECHNICAL EVALUATION OF ORDER EA-13-109, PHASE 1

Cooper is a single unit General Electric BWR site with a Mark I primary containment system. To implement Phase 1 requirements of Order EA-13-109, the licensee uses a nominal 12-inch diameter pipe connected to the existing 24" primary containment vent and purge piping. It is routed through the torus area and the reactor building, exits through the reactor building roof, and discharges to the atmosphere. The HCVS is initiated via manual action from the main control room (MCR) or the mechanical remote operating station (MROS) at the appropriate time based on procedural guidance in response to plant conditions from observed or derived symptoms.

The vent utilizes containment parameters of pressure and level from the MCR instrumentation to monitor effectiveness of the venting actions. The vent operation is monitored by HCVS valve position, HCVS vent line temperature, and effluent radiation levels. The HCVS motive force is monitored and has 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 at least 7 days.

The operation of the HCVS is designed to minimize the reliance on operator actions in response to external hazards. The screened in external hazards for CNS are seismic, extreme cold, high winds, and extreme high temperature. Initial operator actions are completed by plant personnel and include the capability for remote-manual initiation from the MROS. Attachment 2 of the FIP, contains a one-line diagram of the HCVS vent flow path.

3.1 HCVS Functional Requirements

3.1.1 Performance Objectives

Order EA-13-109 requires that the design and operation of the HCVS shall satisfy specific performance objectives including minimizing the reliance on operator actions and plant operators' exposure to occupational hazards such as extreme heat stress and radiological conditions, and accessibility and functionality of HCVS controls and indications under a broad range of plant conditions. Below is the staff's assessment of how the licensee's HCVS meets the performance objectives required by Order EA-13-109.

3.1.1.1 Operator Actions

Order EA-13-109, Attachment 2, Section 1.1.1 requires that the HCVS be designed to minimize the reliance on operator actions. Relevant guidance is found in NEI 13-02, Section 4.2.6 and HCVS-FAQ [Frequently Asked Questions]-01.

In its FIP, the licensee stated that the operation of the HCVS was designed to minimize the reliance on operator actions in response to hazards identified in NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide", Revision 2 [Reference 29], which are applicable to the plant site. Operator actions to initiate venting through the HCVS vent path can be completed by plant personnel, and the system includes the capability for remote-manual initiation from the MROS. A list of the remote manual actions performed by plant personnel to open the HCVS vent path are listed in Table 3-1, "HCVS Operator Actions," of the FIP. An HCVS extended loss of alternating current (ac) power (ELAP) Failure Evaluation Table (FIP Table 3-2), which shows alternate actions that can be performed, is also provided in the FIP.

The licensee also stated that permanently-installed electrical power and pneumatic supplies are available to support operation and monitoring of the HCVS for a minimum of 24 hours. No large portable equipment needs to be moved in the first 24 hours to operate the HCVS. After 24 hours, available personnel will be able to connect supplemental electric power and pneumatic supplies for sustained operation of the HCVS for a minimum of 7 days.

The FLEX generators and replacement nitrogen bottles provide this motive force. In all likelihood, these actions will be completed in less than 24 hours. However, the HCVS can be operated for at least 24 hours without any supplementation.

The NRC staff reviewed the HCVS Operator Actions Table, compared it with the information contained in NEI 13-02, and determined that these actions should minimize the reliance on operator actions. These actions are consistent with the type of actions described in NEI 13-02, Revision 1, as endorsed, in part, by JLD-ISG-2013-02 and JLD-ISG-2015-01, as an acceptable means for implementing applicable requirements of Order EA-13-109. The NRC staff also reviewed the HCVS Failure Evaluation Table and determined that the actions described adequately address all the failure modes listed in NEI 13-02, Revision 1, which include: loss of normal ac power, long-term loss of batteries, loss of normal pneumatic supply, loss of alternate pneumatic supply, and solenoid operated valve failure.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design should minimize the reliance on operator actions, and, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.1.2 Personnel Habitability – Environmental

Order EA-13-109, Attachment 2, Section 1.1.2 requires that the HCVS be designed to minimize plant operators' exposure to occupational hazards, such as extreme heat stress, while operating the HCVS. Relevant guidance is found in: NEI 13-02, Sections 4.2.5 and 6.1.1; NEI 13-02, Appendix I; and HCVS-FAQ-01.

In its FIP, the licensee stated that primary control of the HCVS is accomplished from the MCR. Alternate control of the HCVS is accomplished from the MROS, which is located at the south exterior wall of the reactor building. FLEX actions that may be taken to maintain the habitability of the MCR and MROS were developed in response to NRC Order EA-12-049. These actions include:

1. Ventilating the MCR by opening MCR doors to the outside, and operating a portable generator and fan to move air out of the MCR per the guidance provided in FSG 5.10FLEX.19, "Alternate Ventilation FLEX Operations."
2. Opening doors and a roof hatch in the reactor building to establish natural circulation air flow in the reactor building per the guidance provided in FSG 5.10FLEX.18, "Alternate Reactor Building Ventilation FLEX Operations."

In the FIP, Table 2 contains a thermal evaluation of all the operator actions that may be required to support HCVS operation. The relevant ventilation calculations demonstrate that the final design meets the order requirements to minimize the plant operators' exposure to occupational hazards.

The NRC staff audited the temperature response for the MCR under Order EA-12-049 compliance and documented in the NRC staff's safety evaluation [Reference 37] that the licensee has developed a plan that, if implemented appropriately, should maintain or restore equipment and personnel habitability conditions in the MCR following a BDBEE.

The licensee did not provide or discuss that any habitability evaluations of environmental conditions were performed for the MROS. During the audit the licensee indicated that the

MROS is open to the atmosphere and the temperature of the MROS will be ambient conditions. Therefore, heat from electrical loads and piping will not affect the MROS temperature. The licensee indicated they have cold weather gear available for operators, if needed, to permit operator use of the MROS during cold weather.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design, with respect to personnel habitability during severe accident conditions, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.1.3 Personnel Habitability – Radiological

Order EA-13-109, Attachment 2, Section 1.1.3 requires that the HCVS be designed to account for radiological conditions that would impede personnel actions needed for event response. Relevant guidance is found in: NEI 13-02, Sections 4.2.5 and 6.1.1; NEI 13-02, Appendices D, F, G and I; HCVS-FAQ-01, -07, -09 and -12; and HCVS-WP [White Paper]-02.

The licensee performed its review and acceptance in calculation NEDC 15-024, Owner Acceptance of TetraTech Calculation CNS001-194-4933-005, "Radiological Conditions Resulting from the Operation of the HCVS," which documents the dose assessment for designated areas inside the CNS reactor building (outside of containment) and outside the CNS reactor building caused by the sustained operation of the HCVS under severe accident conditions. The licensee stated that the TetraTech calculation was performed using NRC-endorsed HCVS-WP-02 [Reference 30] and HCVS-FAQ-12 [Reference 31] methodologies. Consistent with the definition of sustained operations in NEI 13-02, Revision 1, the integrated whole-body gamma dose equivalent[1] due to HCVS operation over a 7-day period as determined in the licensee's dose calculation should not exceed 10 Roentgen equivalent man (rem)[2]. The calculated 7-day dose due to HCVS operation is a conservative, maximum integrated radiation dose over a 7-day period with an ELAP and fuel failure starting at reactor shutdown. For the sources considered and the methodology used in the calculation, the timing of the HCVS vent operation or cycling of the vent will not create higher doses at personnel habitability and equipment locations (i.e., maximum doses determined in the calculation bound operational considerations for HCVS vent operation).

The licensee determined the expected dose rates, under the severe accident conditions of the order, in all locations requiring personnel access. The licensee's evaluation indicates that for the areas requiring access in the early stages of the event, the expected dose rates would not be a limiting consideration. For those areas where expected dose rates would be elevated at later stages of the event, the licensee has determined that the expected stay times would ensure that operations could be accomplished without exceeding the emergency response organization emergency worker dose guidelines.

[1] For the purposes of calculating the personnel whole-body gamma dose equivalent (rem), it is assumed that the radiation units of Roentgen (R), radiation absorbed dose (rad), and Roentgen equivalent man (rem) are equivalent. The conversion from exposure in R to absorbed dose on in rad is 0.874 in air and < 1 in soft tissue. For photons, 1 rad is equal to 1 rem. Therefore, it is conservative to report radiation exposure in units of R and to assume that 1 R 1 rad 1 rem.

[2] Although radiation may cause cancer at high doses and high dose rates, public health data do not absolutely establish the occurrence of cancer following exposure to low doses and dose rates below about 10,000 mrem (100 mSv). https://www.nrc.gov/about-nrc/radialion/health-effects/rad-exposure-cancer.html.

The licensee evaluated the maximum dose rates and 7-day integrated whole-body gamma dose equivalents for the MCR, which is the primary control location, and the MROS. In its FIP, the licensee states that the MROS is located external to the reactor building in a low dose area during normal operation. The licensee further states that during an accident, the distance and shielding combined with the short duration of actions required at the MROS show the MROS to be an acceptable location for alternate control. The evaluation (as documented in NEDC 15-024) demonstrates that the integrated whole-body gamma dose equivalent to personnel occupying defined habitability locations (resulting from HCVS operation under beyond-design-basis severe accident conditions) should not exceed 10 rem.

The NRC staff notes that there are no explicit regulatory dose acceptance criteria for personnel performing emergency response actions during a beyond-design-basis severe accident. The Environmental Protection Agency (EPA) Protective Action Guides (PAG) Manual, EPA-400/R- 16/001, "Protective Action Guides and Planning Guidance for Radiological Incidents," provides emergency worker dose guidelines. Table 3.1 of EPA-400/R-16/001 specifies a guideline of 10 rem for the protection of critical infrastructure necessary for public welfare, such as a power plant, and a value of 25 rem for lifesaving or for the protection of large populations. The NRC staff further notes that during an emergency response, areas requiring access will be actively monitored by health physics personnel to ensure that personnel doses are maintained as low as reasonably achievable.

The NRC staff audited the licensee's calculation of the expected radiological conditions to ensure that operating personnel can safely access and operate controls and support equipment. Based on the expected integrated whole-body dose equivalent in the MCR and MROS during the sustained operating period, the NRC staff agrees that the mission doses associated with actions taken to protect the public under beyond-design-basis severe accident conditions will not subject plant personnel to an undue risk from radiation exposure.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design, with respect to personnel habitability during severe accident conditions, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.1.4 HCVS Controls and Indications

Order EA-13-109, Attachment 2, Section 1.1.4 requires that the HCVS controls and indications be accessible and functional under a range of plant conditions, including severe accident conditions, ELAP, and inadequate containment cooling. Relevant guidance is found in: NEI 13-02, Sections 4.1.3, 4.2.2, 4.2.3, 4.2.4, 4.2.5, and 6.1.1; NEI 13-02, Appendices F, G and I; and HCVS-FAQs-01 and -02.

Accessibility of the controls and indications for the environmental and radiological conditions are addressed in Sections 3.1.1.2 and 3.1.1.3 of this safety evaluation, respectively.

In its FIP, the licensee stated that primary control of the HCVS is accomplished from the MCR and that under the postulated scenarios of Order EA-13-109, the MCR is adequately protected from excessive radiation dose and no further evaluation of its use is required (HCVS-FAQ-06).

The licensee also stated that alternate control of the HCVS is accomplished from the MROS located against the south wall of the reactor building on the exterior side. The licensee stated that the MROS location is in an area evaluated to be accessible before and during a severe accident. The licensee also provided, in Table 1 of the FIP, a list of the controls and indications that are or may be required to operate the HCVS during a severe accident, including the locations, anticipated environmental conditions, and the environmental conditions (temperature and radiation) to which each component is qualified.

The NRC staff reviewed the FIP including the response in Section 1.1.4 of the FIP and examined the information provided in Table 1. The NRC staff determined that the controls and indications appear to be consistent with the NEI 13-02 guidance. The NRC staff also confirmed the environmental qualification information in Table 1 of the FIP, as well as the seismic qualification of the controls and indications equipment through audit reviews of NPPD document CED 6036742, "Reliable Hardened Containment Venting System." The NRC staff noted that the Regulatory Guide (R.G.) 1.97 instruments for drywell pressure and wetwell level did not have qualification information listed in Table 1, but are considered acceptable, in accordance with the NEI 13-02 guidance, based on their design basis qualifications.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design, with respect to accessibility and functionality of the HCVS controls and indications during severe accident conditions, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.2 Design Features

Order EA-13-109 requires that the HCVS shall include specific design features, including specifications of the vent characteristics, vent path and discharge, control panel, power and pneumatic supply sources, inadvertent actuation prevention, HCVS monitoring, equipment operability, and hydrogen control. Below is the staff's assessment of how the licensee's HCVS meets the performance objectives required by Order EA-13-109.

3.1.2.1 Vent Characteristics

Order EA-13-109, Attachment 2, Section 1.2.1 requires that the HCVS has the capacity to vent the steam/energy equivalent of one 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. Relevant guidance is found in NEI 13-02, Section 4.1.1.

The licensee stated that the HCVS wetwell path is designed for venting steam/energy at a nominal capacity of 1 percent of licensed thermal power and is able to maintain containment pressure below the primary containment design pressure.

The licensee performed calculation NEDC 15-020, Owner Acceptance of TetraTech Calculation CNS001-194-4933-001, "Calculation of HCVS Flow Rate and Vent Size," which provides verification of 1 percent power flow capacity at the primary containment pressure limit (PCPL) (62.7 pounds per square gauge (psig)). This calculation models all the piping elbows, valves, and other components using industry standard flow coefficients to determine an equivalent length of piping. Since the piping consists of 24" and 12" sections, both are modeled. The minimum flow at design pressure to pass 1 percent rated thermal power was calculated to be equivalent to 75,500 pounds mass per hour (lbm/hr). Calculation NEDC 15-020 verifies that the piping can pass greater than 1 percent flow.

The licensee's calculation NEDC 14-026, documents its review of ERIN Calculation C122140001-11622, "MAAP Analysis to support Cooper FLEX Strategy," and its applicability and acceptability to CNS. This ERIN calculation of containment response demonstrates the decay heat absorbing capacity of the suppression pool and the selection of the venting pressure were made such that the HCVS will have sufficient capacity to maintain containment pressure at or below the containment design pressure (56 psig), which is lower than the PCPL.

The NRC staff audited the licensee's evaluations and agrees that the mass flow rate required to vent 1 percent of rated thermal power of 2419 megawatts thermal (MWt) is 75,500 lbm/hr. The calculations further demonstrate that a 12" diameter pipe will vent the equivalent of 1 percent of the rated thermal power flow rate at 20.3 psig and will have 105,000 lbm/hr margin at 56 psig. Based on the evaluations, the HCVS vent design appears to have the capacity to vent 1 percent of rated thermal power during ELAP and severe accident conditions with margin.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design characteristics, if implemented appropriately, appear to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.2.2 Vent Path and Discharge

Order EA-13-109, Attachment 2, Section 1.2.2 requires that the HCVS discharge the effluent to a release point above main plant structures. Relevant guidance is found in: NEI 13-02, Section 4.1.5; NEI 13-02, Appendix H; and HCVS-FAQ-04.

The NRC staff evaluated the HCVS vent path and the location of the discharge. The torus penetration is a 20" piping penetration located at the top of the torus in a vent pipe bay. The piping enlarges to a 24" pipe beyond the penetration. This pipe contains two butterfly primary containment isolation valves (PCIVs), PC-MOV-233MV and PC-AOV-237AV. Downstream, the 24" pipe changes to a 24" thin-walled pipe. This thin-walled piping has been evaluated in calculation NEDC 92-054, "Analysis of 24" Torus Purge-Vent Duct for Hard Pipe Vent Locations," and was determined to meet the design requirements of the HCVS. The HCVS path T's off from the existing torus vent piping downstream of PC-MOV-233MV and PC-AOV-237AV as a new 12" line and a new 12" control valve has been installed in the new 12" line in the torus room area. The pipe travels along the south wall of the reactor building, across the southwest corner room, into the A2 staircase, up through the floor slab, and exits the top of the stairwell structure (9' above elevation 1001') on the refuel floor. The vent line then follows the west wall and exits vertically through the reactor building roof to the release point 3' above the roof parapet. The NRC staff's review indicates that this appears to be consistent with the guidance provided in HCVS-FAQ-04.

Part of the HCVS-FAQ-O4 guidance is designed to ensure that vented fluids are not drawn immediately back into any emergency ventilation intakes. Such ventilation intakes should be below the level of the HCVS discharge pipe by 1 foot for every 5 horizontal feet of separation. Ventilation intake and exhaust pathways of concern are the control building essential heating, ventilation, and air-conditioning (HVAC), and control room emergency filter (CREF) system HVAC. The control building essential HVAC intake and exhaust is approximately 200 feet from the HCVS vent pipe (farther than the CREF system HVAC intake and exhaust), which would require the intake and exhaust to be approximately 40 feet below the HCVS vent pipe. The control building essential HVAC intake and exhaust and the CREF system HVAC intake and exhaust are both located at elevation 950', which is approximately 60 feet below the HCVS pipe outlet. Therefore, the vent pipe discharge point appears to be consistent with the guidance of HCVS-FAQ-04 for stack discharge relative to the ELAP air intake. Although the distance between the HCVS exhaust and the normal building HVAC is not subject to any specific requirements, the reactor building HVAC intake is located a horizontal distance of 140 feet and a vertical distance of 100 feet from the HCVS release point and thus adheres to the reasonable assurance guidance.

Guidance document NEI 13-02, states that the HCVS 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. There is an existing reactor building HVAC exhaust duct on the northeast end of the reactor building roof, as well as the refuel floor hatch. These are potential natural circulation discharge points during a BDBEE. Although the zone of influence criteria do not apply in this case, both points are situated approximately 170' away from the HCVS release point.

Guidance document NEI 13-02, Section 5.1.1.6, provides guidance that missile impacts are to be considered for portions of the HCVS. The NRC-endorsed NEI white paper, HCVS-WP-04, "Tornado Missile Evaluation for HCVS Components 30 Feet Above Grade," Revision 0 [Reference 32], provides a risk-informed approach to evaluate the threat posed to exposed portions of the HCVS by wind-borne missiles. The white paper concludes that the HCVS is unlikely to be damaged in a manner that prevents containment venting by wind-generated missiles coincident with an ELAP or loss of normal access to the ultimate heat sink (UHS) for plants that are enveloped by the assumptions in the white paper.

The licensee evaluated the vent pipe robustness with respect to wind-borne missiles against the assumptions contained in HCVS-WP-04. This evaluation demonstrated that the pipe was robust with respect to external missiles per HCVS-WP-04 in that:

1. No portion of the HCVS vent piping is exposed below 30' above grade. The HCVS vent piping exits the reactor building at elevation 1049' (146'above grade).

2. The exposed piping greater than 30' above grade has the following characteristics:
    a. The total vent pipe exposed strike area is less than 10 square feet which is less than the 300 square feet.
    b. The pipe is made of schedule 40 carbon steel and is not plastic and the pipe components have no small tubing susceptible to missiles.
    c. There are no obvious sources of missiles located in the proximity of the exposed HCVS components.

3. Per the BWR Owners Group (BWROG) guidance found in BWROG-TP-15-005, the HCVS pipe is required to be seismically rugged but not missile protected if the exposed piping is at an elevation over 30' from the nominal ground elevation. The section of pipe above the reactor building roof has been evaluated using the guidance in NEI 12-06, Section 7.3.1, to determine if reasonable protection is provided against high winds and wind generated missiles. By its nature, it is not practical to locate the HCVS vent pipe in diverse locations (as there is only one); however, based on the location of the pipe within the reactor building, the reactor building will provide reasonable protection from any wind generated missiles originating from the ground up to the roof line of the reactor building.

Due to the elevation of the reactor building roof in relation to the other structures onsite, it is much less likely that a wind generated missile will be originated above the elevation of the reactor building. Since the HCVS piping above the reactor building roof is more than 30' above nominal ground elevation and there is no obvious source of tornado missiles that could potentially strike the HCVS piping on top of the reactor building roof, the licensee concluded that no additional missile shielding, nor a cutting tool are needed.

4. CNS is not screened in for hurricanes

The licensee's evaluation, NEDC 15-028, Revision 1, documents its review of TetraTech Calculation CNS001-194-4933-009 "Analysis of the HCVS Piping for the Hardened Containment Vent System Project," Revision 0, for applicability and acceptability to CNS. The TetraTech calculation performed a pipe stress analysis, including the seismic and tornado wind design analysis, for the HCVS pipe. The evaluation classified the HCVS as Seismic Class II/I piping and analyzed it using safe shutdown earthquake forces and operating basis earthquake allowable stress limits. The licensee's evaluation determined that the HCVS pipe is adequately protected from the tornado missile assumptions identified in HCVS-WP-04. The NRC staff audited the information provided and agrees that supplementary protection is not required for the HCVS piping and components.

Based on the evaluation above, the NRC staff concludes that the licensee's location and design of the HCVS vent path and discharge, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.2.3 Unintended Cross Flow of Vented Fluids

Order EA-13-109, Attachment 2, Section 1.2.3 requires that the HCVS include design features to minimize unintended cross flow of vented fluids within a unit and between units on the site. Relevant guidance is found in: NEI 13-02, Sections 4.1.2, 4.1.4, and 4.1.6; and HCVS-FAQ-05.

In its FIP, the licensee stated that the wetwell vent utilizes primary containment system inboard and outboard PCIVs for containment isolation. Primary containment system boundary valves PC-AOV-235AV and PC-AOV-239AV are the only functional boundary valves between the HCVS and the downstream vent and purge system. These valves do not have a safety-related function during a design basis accident but are tested for leakage using the guidance of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Appendix J, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors", Program [Reference 33]. The downstream primary containment valves serve the function of isolating the HCVS flow path from the standby gas treatment (SGT) system. These valves are tested, and will continue to be tested, for leakage using the guidance of 10 CFR Part 50, Appendix J Program as part of the containment boundary in accordance with HCVS-FAQ-05 "HCVS Control and Boundary Valves."

As part of the audit, the NRC staff requested information regarding the potential for unintended flow through the 20" diameter pipe which branches off the 24" HCVS line upstream of PCIV PC-MO-233MV. This path splits into two branches with each path having an air-operated valve (AOV) and a check valve in series. These valve combinations are AO-243/PC-13CV and AO-244/PC-14CV. The AOVs are shown as normally-closed/fail-open. The licensee responded that PC-AOV-243AV/PC-CV-13CV and PC-AOV-244AV/PC-CV-14CV provide suppression pool vacuum relief. These valves are considered primary containment boundary valves at CNS and are tested in accordance with the CNS Appendix J Program per Procedure 6.PC.522, "Standby Nitrogen Injection and PC Purge and Vent System Local Leak Rate Tests." As such, valves PC-CV-13CV and PC-CV-14CV will prevent unintended flow of the vented fluid into the reactor building. The AOVs (PC-AOV-243AV & PC-AOV-244AV) fail to their open positions upon a loss of electrical power and a loss of motive air. The NRC staff audited the information provided and agrees that the use of primary containment isolation valves appears to be acceptable for prevention of inadvertent cross-flow of vented fluids and consistent with the guidance provided in HCVS-FAQ-05.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design limits the potential for unintended cross flow of vented fluids and, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.2.4 Control Panels

Order EA-13-109, Attachment 2, Section 1.2.4 requires that the HCVS 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. Relevant guidance is found in NEI 13-02, Sections 4.2.2, 4.2.4, 4.2.5, 5.1, and 6.1; NEI 13-02, Appendices A and H; and HCVS-FAQs-01 and -08.

In its FIP, the licensee stated that the wetwell vent will be initiated and then monitored and operated from a control panel in the MCR. The licensee also stated, that prior to initiating HCVS operation, operators must access reactor building elevation 958' to align alternate power to valve PC-MOV-233MV by means of a transfer switch. Table 1 of the FIP contains a list of the HCVS instrumentation and controls components including their location and qualification information. The NRC staff reviewed Section III.B.1.2.4 and confirmed these statements by comparing the instrumentation and controls component locations provided in Table 1 of the FIP.

Based on the evaluation above, the NRC staff concludes that the licensee's location and design of the HCVS control panels, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.2.5 Manual Operation

Order EA-13-109, Attachment 2, Section 1.2.5 requires that the HCVS, in addition to meeting the requirements of Section 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. Relevant guidance is found in NEI 13-02, Section 4.2.3 and in HCVS-FAQs-01, -03, -08, and -09.

In its FIP, the licensee stated that to meet the requirement for an alternate means of operation, a readily accessible alternate location, called the MROS was added. After opening PC-MOV-233MV from a control panel located in the MCR. Operators can manually operate the HCVS from the MROS. The MROS contains manually operated valves that supply pneumatics to the HCVS flow path valve actuators so that these valves may be opened without power to the valve actuator solenoids and regardless of any containment isolation signals. This provides a diverse method of valve operation and improves system reliability.

The MROS is located on the exterior south wall of the reactor building. The MROS is a missile shielded structure. An entry door has been installed to allow operator access and to move additional nitrogen bottles into the MROS to supply pneumatic motive force beyond the initial 24 hours of the event. The exterior and interior walls forming the door entrance have been constructed in order to protect the equipment in the MROS from tornado missiles. Therefore, the door does not need to be designed for missile protection itself. The sketch provided in Attachment 8 of the FIP shows the site layout for the HCVS. The controls available at the MROS location are accessible and functional under a range of plant conditions, including severe accident conditions with due consideration to source term and dose impact on operator exposure, ELAP, inadequate containment cooling, and loss of Reactor Building ventilation.

Table 1 of the FIP contains an evaluation of the required controls and instruments that are required for severe accident response and demonstrates that these controls and instruments will be functional during a loss of ac power and severe accident. Table 2 of the FIP contains a summary of thermal and radiological evaluations of the operator actions that may be required to support HCVS operation during a loss of ac power and severe accident. The licensee's evaluations conclude that these actions will be possible without undue hazard to the operators. These evaluations demonstrate that the design meets the requirement to be manually operated from a remote but readily accessible location during sustained operation. The NRC staff audited the pertinent plant drawings and evaluation documents. The NRC staff's audit confirmed that the actions appear to be consistent with the guidance.

During the audit, the NRC staff requested additional information regarding PC-MOV-233MV. The licensee responded that PC-MOV-233MV is geared such that if fails "as-is" on a loss of power. Manual operation of PC-MOV-233MV as discussed within the FIP consists of manually aligning the alternate power source (PC-233MV UPS) to the valve. Upon an ELAP condition, the plant's normal AC power supply to PC-MOV-233MV is lost. As such, to electrically be able to open this valve, an uninterruptible power supply (UPS) is aligned to the valve. The switch (EE-SW-233MV) for aligning this alternate power source is located within the reactor building on elevation 958'. Procedure 5.3SBO, "Station Blackout," directs the opening of PC-MOV-233MV within the first 3 hours of the ELAP/SBO condition such that access to the reactor building is not restricted (due to high temperature) to be able to switch the power supplies. There is also guidance in Procedure 5.3SBO that if the ELAP/SBO without injection occurs, that the opening of PC-MOV-233MV will be performed "as soon as possible" due to imminent fuel failure. The performance guidance for aligning the alternate power source and then using the control switches within the MCR is contained within Procedure 5.10FLEX.30, "Hardened Containment Vent System FLEX Operations." Only one electrical power source (EE-UPS-233MV) is provided to operate this valve following an ELAP/SBO condition. The guidance also removes power from PC-MOV-233MV after opening to prevent inadvertent operation. If the UPS fails, then the valve will have to be manually opened using its local hand wheel.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design allows for manual operation, and, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.2.6 Power and Pneumatic Supply Sources

Order EA-13-109, Attachment 2, Section 1.2.6 requires that the HCVS be capable of operating with dedicated and permanently installed equipment for at least 24 hours following the loss of normal power or loss of normal pneumatic supplies to air operated components during an

ELAP. Relevant guidance is found in: NEI 13-02, Sections 2.5, 4.2.2, 4.2.4, 4.2.6, and 6.1; NEI 13-02, Appendix A; HCVS-FAQ-02; and HCVS-WPs-01 and -02.

Pneumatic Sources Analysis

For the first 24 hours following the event, a combination of existing and newly installed instrument air accumulators will supply the motive force for the AOVs with an additional backup supply from nitrogen gas bottles that will be pre-installed and available at the MROS. The accumulators have been sized such that they can provide motive force for up to eight venting cycles, which includes opening the PCIV (PC-AOV-237AV) and the downstream isolation valve (PC-AOV-AO32). In its FIP, the licensee stated that, based on its evaluation, only 8 venting cycles are needed in the first 24 hours. The nitrogen bottles have been designed to open PC-AOV-237AV 6 times and PC-AOV-AO32 48 times after the initial 24-hour duration up to 7 days.

The licensee determined the required pneumatic supply storage volume and supply pressure set point required to operate the HCVS AOVs for 24 hours following a loss of normal pneumatic supplies during an ELAP in calculation NEDC 92-073, "Accumulator Sizing and Recharge Time," Revision 1. The licensee's calculation determined that an accumulator volume of 90 gallons will provide sufficient motive force to open PC-AOV-237AV and a 240-gallon accumulator will open PC-AOV-AO32 8 times. The licensee's calculation determined that 2 accumulators filled to a pressure of 90 psig each can provide sufficient capacity for operation of the HCVS valves for 24 hours following an ELAP and that a low-pressure alarm setpoint of 75 psig will provide operators with an indication of when two cycles of capacity remain for PC-AOV-A032. This pressure includes an allowance for leakage. The licensee repurposed the three 30 gallon accumulators and re-designated them IA-ACC-237A(1), IA-ACC-237A(2), and IA-ACC-237A(3), to increase the total accumulator(s) capacity for PC-AOV-237AV to 90 gallons. Furthermore, the licensee installed a 240-gallon accumulator, designated IA-ACC-AO32, to operate PC-AOV-AO32 the required number of cycles.

The licensee also calculated the required pneumatic supply storage volume and supply pressure set point required to operate the HCVS AOVs for after the initial 24 hours for 7 days in calculation NEDC 15-026, "Mechanical ROS Nitrogen Calculation," Revision 1. AOVs PC-AOV-237AV and PC-AOV-AO32A need a nitrogen pressure greater than 70 psig of nitrogen to actuate. The licensee's calculation determined that 9 bottles at an initial pressure of 2640 psig will provide sufficient motive force to cycle PC-AOV-237AV and PC-AOV-AO32 the required number of times discussed above. The licensee installed a 9-bottle rack to supply nitrogen.

The NRC staff audited the calculation and confirmed that there should be sufficient pneumatic supply available to provide motive force to operate the HCVS AOVs for 24 hours and the subsequent 7-day period following a loss of normal pneumatic supplies during an ELAP.

Power Source Analysis

In its FIP, the licensee stated that during the first 24 hours of an ELAP event, Cooper would rely on two, dedicated, uninterruptable power supplies (UPSs) to provide power to HCVS components. The HCVS UPS is located in the control building corridor on the 903' elevation. The PC233MV UPS is located in the reactor building on the 958' elevation. The HCVS and PC233MV UPS are installed where they are protected from applicable hazards.

The HCVS UPS is a Nova Electric On-Line UPS System Freestanding Model GCS11-1.5K60-120-120-24H-11874. The HCVS UPS has a minimum capacity capable of providing power for

24 hours using its internal power source (batteries) without recharging. During the audit process, the licensee provided the NRC staff the evaluation for the HCVS UPS sizing requirements including incorporation into the FLEX diesel generator (DG) loading calculation.

The PC233MV UPS is a Nova Jupiter Series Freestanding Model J11-15K3/6-460(3)-460(3)-11875. The PC233MV UPS is expected to be energized to provide three operating cycles of valve PC-MOV-233MV within the first hour of an ELAP. Valve PC-MOV-233MV is expected to be opened once and then de-energized in the open position.

The NRC staff audited licensee calculation 15-030, "HCVS UPS Sizing Analysis," Revision 1, which verified the capability of the HCVS UPS to supply power to the required loads during the first phase of the Cooper venting strategy for an ELAP. The licensee's calculation identified the required loads and showed that the 24-hour load requirement would be approximately 1 kilovolt Amperes (kVA). The licensee selected a UPS that can supply 1.5 kVA for 24 hours, which is adequate to supply the HCVS loads. Based on the NRC staff's audit, it appears that the dedicated HCVS UPS should have sufficient capacity to supply power at least 24 hours.

The NRC staff also audited licensee calculation 15-033, "Review of Tetra Tech Calculation CALC-CNS001-194-4933-013 Rev 3," Revision 0, which verified the capability of the PC233MV UPS to provide one cycle of operation to motor operated valve PC-MOV-233MV. The TetraTech calculation determined that each cycling of PC-MOV-233MV requires 28.4 kVA-minutes. The PC233MV UPS provides 125 kVA-minutes; therefore, more than 100 percent margin is available. Based on the NRC staff review, it appears that the dedicated PC233MV UPS should have sufficient capacity to supply power for at least one valve cycle.

The licensee's strategy includes repowering the HCVS UPS within 24 hours after initiation of an ELAP. The licensee's strategy relies on one of two, 60 kilowatt (kW), 480 Volt alternating current (Vac) FLEX DGs. Only one of the FLEX DGs is required for the HCVS electrical strategy. The 480 Vac FLEX DG would provide power to the HCVS load in addition to loads addressed under Order EA-12-049.

The NRC staff also audited licensee engineering document CED 6037041, "FLEX Electrical Connections," Revision 1, which incorporates the HCVS UPS load on the FLEX DGs. The total Phase 2 load on the FLEX DGs, including the HCVS, is 43 kW. Based on the NRC staff review of engineering document CED 6037041, it appears that either one of the two FLEX DGs should have sufficient capacity and capability to supply the necessary loads during an ELAP event.

Electrical Connection Points

The licensee's strategy to supply power to HCVS components requires using a combination of permanently installed and portable components. Staging and connecting the 60 kW FLEX DG were both addressed under Order EA-12-049. Licensee procedure FSG 5.10FLEX.05, "Reliable Hardened Containment Vent Battery Charger Tie-In," Revision 0, includes guidance for staging, cable routing, connecting, and operating the 60 kW FLEX DG.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design allows for reliable operation with dedicated and permanently installed equipment, and, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.2.7 Prevention of Inadvertent Actuation

Order EA-13-109, Attachment 2, Section 1.2.7 requires that the HCVS include means to prevent inadvertent actuation. Relevant guidance is found in NEI 13-02, Section 4.2.1.

In its FIP, the licensee states that the emergency operation procedures (EOPs) provide clear guidance that the HCVS is not to be used to defeat containment integrity during any design basis transients and accidents. In addition, the HCVS was designed to provide features to prevent inadvertent actuation due to equipment malfunction or operator error. Also, these protections are designed such that any credited containment accident pressure (CAP) that would provide net positive suction head to the emergency core cooling system (ECCS) pumps will be available (inclusive of a design basis loss-of-coolant accident). However, the ECCS pumps will not have normal power available because of the ELAP. The licensee credits CAP to maintain sufficient net positive suction head (NPSH) for ECCS pumps (core spray (CS) and residual heat removal (RHR)). Therefore, it is essential to prevent inadvertent actuation of the HCVS to ensure that the CAP can be maintained.

At Cooper, the features that prevent inadvertent actuation are two containment isolation valves in series powered from different divisions and key-lock switches. With respect to the containment isolation valves, the inboard valve (PC-MOV-233MV) is an AC motor operated valve (MOV) fed from a Division I AC power source, and the outboard valve (PC-AOV-237AV) is an AOV with an AC powered solenoid operated valve fed from a Division II AC power source. Hence, the containment isolation valves meet the requirements for redundant and diverse power sources. Furthermore, these valves can be operated from key-locked switches in the MCR. Although these valves are shared between the containment purge system and the HCVS, key-locked override switches are provided for each valve to allow operators to override the containment isolation signal. The backup pneumatic supply is controlled by locked closed valves at the MROS. The NRC staff's audit of the HCVS confirmed that the licensee's design is consistent with the guidance and appears to preclude inadvertent actuation.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design, with respect to prevention of inadvertent actuation, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.2.8 Monitoring of HCVS

Order EA-13-109, Attachment 2, Section 1.2.8 requires that the HCVS include means to monitor the status of the vent system (e.g. valve position indication) from the control panel required by Section 1.2.4. In addition, Order EA-13-109 requires that the monitoring system be designed for sustained operation during an ELAP. Relevant guidance is found in: NEI 13-02, Section 4.2.2; and HCVS-FAQs-01, -08, and -09.

The NRC staff reviewed the following channels documented in Table 1 of the FIP which support HCVS operation: HCVS effluent temperature, HCVS effluent pressure, wetwell vent radiation, HCVS valve position (labeled with specific valve numbers), nitrogen (N_2) pressure, drywell pressure, wetwell pressure, and wetwell level. The NRC staff notes that drywell pressure, wetwell pressure, and torus level are declared Cooper post-accident monitoring (PAM) variables as described in R.G. 1.97 and the existing qualification of these channels is considered acceptable for compliance with Order EA-13-109 in accordance with the guidance in NEI 13-02, Appendix C, Section C.8.1. The NRC staff also reviewed FIP Section III.B.1.2.8 and determined that the HCVS instrumentation appears to be adequate to support HCVS venting operations and is capable of performing its intended function during ELAP and severe accident conditions.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design allows for the monitoring of key HCVS instrumentation, and, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.2.9 Monitoring of Effluent Discharge

Order EA-13-109, Attachment 2, Section 1.2.9 requires that the HCVS include means to monitor the effluent discharge for radioactivity that may be released from operation of the HCVS. In addition, Order EA-13-109 requires that the monitoring system provide indication from the control panel required by Section 1.2.4 and be designed for sustained operation during an ELAP. Relevant guidance is found in: NEI 13-02, Section 4.2.4; and HCVS-FAQs-08 and -09.

The NRC staff reviewed the following channels documented in Table 1 of the FIP which support monitoring of HCVS effluent: HCVS effluent pressure, HCVS effluent temperature, and wetwell vent line radiation. The NRC staff confirmed that the effluent radiation monitor provides sufficient range to adequately indicate effluent discharge radiation levels.

In Section III.B.1.2.9 of its FIP, the licensee described the ion chamber detector installed at the 925' elevation of the reactor building stairwell with a process and control module on the 931' elevation of the reactor building and indication provided on recorder PC-R-520 on Panel P2 in the MCR. The licensee stated that the radiation monitor detector is fully qualified for the anticipated environment at the vent pipe during accident conditions. The licensee further stated that the process and control module is qualified for the mild environment in the reactor building on elevation 931'. The NRC staff reviewed the qualification summary information provided in Table 1 of the FIP and finds that it appears to meet the guidance. The NRC staff also confirmed the summary information through audit reviews of NPPD document CED 6036742, "Reliable Hardened Containment Venting System."

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design allows for the monitoring of effluent discharge, and, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.2.10 Equipment Operability (Environmental/Radiological)

Order EA-13-109, Attachment 2, Section 1.2.10 requires that the HCVS 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. Relevant guidance is found in: NEI 13-02, Sections 2.3, 2.4, 4.1.1, 5.1 and 5.2; NEI 13-02 Appendix I; and HCVS-WP-02.

Environmental

The FLEX diesel-driven Severe Accident Water Addition (SAWA) pump and FLEX DG will be staged outside so they will not be adversely impacted by a loss of ventilation.

The HCVS UPS and supporting equipment are permanently installed outside the swing battery room in the control building on the 903' elevation. The NRC staff audited licensee calculation NEDC 15-002, "Review of TetraTech Portable Equipment Calculations in support of CNS FLEX Strategy," Revision 0, which documents its review and acceptance of Tetra Tech calculations CALC-194-4933-01, CALC-194-4933-02, and CALC-194-4933-03. The TetraTech calculation predicts the temperature profile in the corridor outside the battery and switchgear rooms following an ELAP. The licensee determined that the temperature in the corridor would remain less than 120°F. The licensee plans to open doors and establish portable ventilation after the FLEX DG is placed in service. Licensee procedures 5.10FLEX.01, "125 VDC DIV 1 FLEX Operations," Revision 0, 5.10FLEX.02, "125 VDC DIV 2 FLEX Operations," Revision 0, 5.10FLEX.03, "250 VDC DIV 1 FLEX Operations," Revision 0, and 5.10FLEX.04, "250 VDC DIV 2 FLEX Operations," Revision 0, direct operators to open doors and establish portable ventilation for the 903' elevation of the control building.

The licensee conservatively sized the HCVS UPS considering a minimum operating temperature of 40°F. This is below the minimum ambient temperature of the area where the HCVS UPS is located as specified in calculation 15-030. The manufacturer's maximum design limit for the HCVS UPS internal batteries is 122°F. Therefore, the HCVS UPS appears to be adequate to perform its design function under event temperatures.

The PC233MV UPS and supporting equipment are permanently installed in the reactor building on the 958' elevation. The PC233MV UPS is required the first hour of an ELAP. Licensee procedure FSG 5.10FLEX.18, "Alternate Reactor Building Ventilation FLEX Operations," Revision 0, directs operators to open doors and a roof hatch to establish natural circulation in the reactor building.

Based on the above, the NRC staff concurs with the licensee's calculations that show the corridor outside the swing battery room in the control building on the 903' elevation will remain within the maximum temperature limit of 122°F for the HCVS UPS, and opening doors and a roof hatch in the reactor building should maintain temperature in the reactor building within acceptable limits. Therefore, the NRC staff concurs that the HCVS equipment should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

Radiological

The licensee's calculation NEDC 15-024, "Owner Acceptance of TetraTech Calculation CNS001-194-4933-005, "Radiological Conditions Resulting from the Operation of the HCVS," documents its review and acceptance of the TetraTech calculation which includes dose assessment for both personnel habitability and equipment locations associated with event response to a postulated ELAP condition. The NRC staff's audit noted that the licensee used conservative assumptions to bound the peak dose rates for the analyzed areas. For the sources considered and the methodology used in the dose calculation, the timing of HCVS vent operation or cycling of the vent will not create higher doses at personnel habitability and equipment locations (i.e., maximum doses determined in the calculation bound operational considerations for HCVS vent operation). The NRC staff's audit confirmed that the anticipated severe accident radiological conditions will not preclude the operation of necessary equipment or result in an undue risk to personnel from radiation exposure.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design, with respect to equipment operability during severe accident conditions, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.2.11 Hydrogen Combustible Control

Order EA-13-109, Attachment 2, Section 1.2.11 requires that the HCVS 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. Relevant guidance is found in: NEI 13-02, Sections 4.1.7, 4.1.7.1, and 4.1.7.2; NEI 13-02, Appendix H; and HCVS-WP-03.

In NEI 13-02, Section 4.1.7 provides guidance for the protection from flammable gas ignition for the HCVS system. The NEI issued a white paper, HCVS-WP-03, "Hydrogen /Carbon Monoxide Control Measures," Revision 1, endorsed by the NRC [Reference 34], which provides methods to address control of flammable gases. One of the acceptable methods described in the white paper is to install a check valve near or at the exhaust end of the vent stack to restrict the ingress of air to the vent pipe when venting stops and steam condenses (Option 5).

In its FIP, the licensee stated that to prevent a detonable mixture from developing in the pipe, a soft-seated check valve is installed near the top of the pipe in accordance with HCVS-WP-03. This valve will open on venting, but will close to prevent air from migrating back into the pipe after a period of venting. The check valve is installed to ensure that it limits back-leakage to preclude a detonable mixture from occurring in the case venting is stopped prior to the establishment of alternate reliable containment heat removal. The use of a check valve is consistent with the guidance to ensure the flammability limits of gases passing through the vent pipe will not be reached. The NRC staff audited the calculation provided which demonstrates that it would take over 150 days before the leakage past the check valve could reach a minimum combustible oxygen limit of 5 percent. The NRC staff confirmed that the licensee's design appears to be consistent with Option 5 of white paper HCVS-WP-03 and that the use a check valve in conjunction with the HCVS venting strategy should meet the requirement to prevent a detonable mixture from developing in the pipe.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design ensures that the flammability limits of gases passing through the system are not reached, and, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.2.12 Hydrogen Migration and Ingress

Order EA-13-109, Attachment 2, Section 1.2.12 requires that the HCVS be designed to minimize the potential for hydrogen gas migration and ingress into the reactor building or other buildings. Relevant guidance is found in NEI 13-02, Section 4.1.6; NEI 13-02, Appendix H; HCVS-FAQ-05; and HCVS-WP-03.

As discussed in Section 3.2.1.3, the vent and purge system is the only interfacing mechanical system on the HCVS flow path that could lead to the potential for hydrogen gas migration and ingress into the reactor building or other buildings. The vent and purge system is separated from the HCVS by boundary valves (PC-AOV-235AV and PC-AOV-239AV) between the two systems. Valves PC-AOV-235AV and PC-AOV-239AV will be leak tested in accordance with the guidance of 10 CFR Part 50, Appendix J. The miscellaneous vent, drain, and test connections each have a normally closed valve and are end capped. The process instrumentation lines are isolated by a manual valve or the instrument. These pathways should adequately minimize the potential for cross flow or combustible migration into the reactor building or other systems. The NRC staff's audit confirmed that the design appears to be consistent with the guidance and meets the design requirements to minimize the potential of hydrogen gas migration into other buildings.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design minimizes the potential for hydrogen gas migration and ingress, and, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.2.13 HCVS Operation/Testing/Inspection/Maintenance

Order EA-13-109, Attachment 2, Section 1.2.13 requires that the HCVS include features and provisions for the operation, testing, inspection and maintenance adequate to ensure that reliable function and capability are maintained. Relevant guidance is found in NEI 13-02, Sections 5.4 and 6.2; and HCVS-FAQs-05 and -06.

In the Cooper FIP, Table 3-3 includes testing and inspection requirements for HCVS components. The NRC staff reviewed Table 3-3 and confirmed that it is consistent with Section 6.2.4 of NEI 13-02, Revision 1. Implementation of these testing and inspection requirements for the HCVS will ensure reliable operation of the systems.

In its FIP, the licensee stated that the maintenance program was developed using the guidance provided in NEI 13-02, Sections 5.4 and 6.2, and it utilizes the standard Electric Power Research Institute (EPRI) industry preventive maintenance process for the maintenance calibration and testing for the HCVS components. The NRC staff reviewed the information provided and confirmed that the licensee has implemented adequate programs for operation, testing, inspection and maintenance of the HCVS.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design allows for operation, testing, inspection, and maintenance, and, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.2 HCVS QUALITY STANDARDS

3.2.1 Component Qualifications

Order EA-13-109, Attachment 2, Section 2.1 requires that the HCVS vent path up to and including the second containment isolation barrier 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. Relevant guidance is found in NEI 13-02, Section 5.3.

In its FIP, the licensee stated that the HCVS upstream of and including the outboard containment isolation valve (PC-AOV-237AV) and penetrations were not modified for order compliance so that they continue to be designed consistent with the design basis of primary containment including pressure, temperature, radiation, and seismic loads.

The HCVS downstream of the outboard containment isolation valve, including piping and supports, electrical power supply, valve actuator pneumatic supply, and instrumentation (local and remote) components, have been designed and analyzed to conform to the requirements consistent with the applicable design codes for the plant and to ensure functionality following a design basis earthquake. This includes environmental qualification consistent with expected conditions at the equipment location.

Table 1 of the FIP contains a list of components, controls and instruments required to operate the HCVS, their qualification limits, and a summary of the expected environmental conditions. All instruments are fully qualified for the expected seismic conditions so that they will remain functional following a seismic event. The NRC staff reviewed this table and confirmed that the components required for HCVS venting are designed to remain functional following a design basis earthquake. The NRC staff also confirmed the seismic qualification through audit reviews of NPPD document CED 6036742, "Reliable Hardened Containment Venting System."

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design, with respect to component qualifications, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.2.2 Component Reliability and Rugged Performance

Order EA-13-109, Attachment 2, Section 2.2 requires that all other HCVS components be designed for reliable and rugged performance, 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. Relevant guidance is found in NEI 13-02, Sections 5.2 and 5.3.

In its FIP, the licensee stated that the HCVS components downstream of the outboard containment isolation valve and components that interface with the HCVS are routed in seismically qualified structures or supported from seismically qualified structure(s). The existing piping, valves, and components upstream of the outboard containment isolation valve are located in the reactor building which is a seismically qualified structure which also provides protection from wind generated missiles.

As part of the NRC staff's audit, NRC staff requested information verifying the existing containment isolation valves, relied upon for the HCVS, will open under the maximum expected differential pressure during beyond design basis and severe accident wetwell venting. The licensee made calculations NEDC 96-025B, "Review of Advent LCA Calculation 96007TR-41B, Rev. 1 for PC-MOV-232MV and -233MV," Revision 1C1, NEDC 95-003, "Determination of Allowable Operating Parameters for CNS MOV Program MOVs," Revision 31C1, NEDC 00-110, "MOV Program Valve Margin Determination," Revision 10C1, NEDC 00-065, "Functional and MEDP Evaluation for PC-AOV-237AV," Revision 1C2, and NEDC 05-013, "AOV Component Level Calculation for PC-AOV-237AV," Revision 1C1 available for audit. The NRC staff audited the various AOV and MOV calculations and confirmed in each case that the PCIVs should open under the maximum expected differential pressure during beyond design basis and severe accident wetwell venting.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design, with respect to component reliability and rugged performance, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.3 Conclusions for Order EA-13-109, Phase 1

Based on its review, the NRC staff concludes that the licensee has developed guidance and a HCVS design that, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

4.0 TECHNICAL EVALUATION OF ORDER EA-13-109, PHASE 2

As stated above in Section 2.2, Order EA-13-109 provides two options to comply with the Phase 2 order requirements. Cooper has elected the option to develop and implement a reliable containment venting strategy that makes it unlikely the licensee would need to vent from the containment drywell before alternate reliable containment heat removal and pressure control is reestablished.

For this method of compliance, the order requires licensees to meet the following:

- 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;

- 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; and,

- 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.

Relevant guidance is found in NEI 13-02, Sections 4, 5 and 6; and Appendices C, D, and I.

4.1 Severe Accident Water Addition (SAWA)

The licensee plans to use the portable, diesel-driven FLEX pump (DDFP) to provide SAWA flow. The SAWA flow path is the same as the FLEX alternate injection flow path. The water source will be either the Missouri River or the unit's condensate storage tank (CST 1A). The SAWA flow path hose routing is from the FLEX pump to a residual heat removal service water (RHRSW) FLEX connection isolation valve (SW-V-1531) in the control building and finally through the RHR subsystem low pressure coolant injection (LPCI) flow path into the RPV. These SAWA actions take place outside the reactor building and are in locations shielded from the severe accident radiation by the thick concrete walls of the reactor building. Once SAWA flow is initiated, operators will have to monitor and maintain SAWA flow and ensure refueling of the diesel-driven equipment as necessary. Operators may also have to reduce flow as part of the severe accident water management (SAWM) strategy, if necessary, using one of the manifolds described below.

4.1.1 Staff Evaluation

4.1.1.1 Flow Path

The SAWA flow path is the same as the FLEX alternate injection flow path. The SAWA flow path's primary water source is from the Missouri River with a backup suction source from the unit's CST 1A. The primary SAWA flow path hose routing is from the FLEX pump to isolation valve SW-V-1531 in the control building. The backup flow path starts at the CST 1A through the FLEX pump to SW-V-1531. Flow then passes through the RHRSW crosstie to the RHR LPCI flow path to the RPV. Backflow prevention is provided by existing, safety-related, check valves installed in the RHR system, which are leak tested using the existing leakage testing programs. Drywell pressure and wetwell level will be monitored and flow rate will be adjusted by use of the FLEX pump speed control. The SAWA flow indication is placed near the pump in the discharge piping.

4.1.1.2 SAWA Pump

In its FIP, the licensee states that the strategy is to use one of two diesel driven pumps for FLEX and SAWA. As described in the NRC staff's safety evaluation [Reference 37] for compliance with Order EA-12-049, the licensee obtained a Godwin HL100M pump that can provide 925 gallons per minute (gpm) at 378' of head. The licensee described the hydraulic analysis performed to demonstrate the capability of FLEX pumps to provide the required 344 gpm of SAWA flow. Section IV.C.9.1 of the FIP states that the FLEX pumps are protected from all applicable external hazards.

The NRC staff audited calculation NEDC 15-002, "Review of TetraTech Portable Equipment Calculations in Support of the CNS FLEX Strategy," Revision 0, which determined the required SAWA flow rate of 344 gpm. The NRC staff audited the flow rates and pressures evaluated in the hydraulic analysis and confirmed that the equipment is capable of providing the needed flow. Based on the NRC staff's audit of the FLEX pumping capabilities at Cooper, as described in the above hydraulic analysis and the FIP, it appears that the licensee has demonstrated that the FLEX pump should perform as intended to support SAWA.

4.1.1.3 SAWA Analysis of Flow Rates and Timing

The licensee developed the overall accident management plan for Cooper from the BWROG emergency procedure guidelines and severe accident guidelines (EPG/SAG) and NEI 13-02, Appendix I. The SAWA/SAWM [Severe Accident Water Management] implementing procedures are integrated into the CNS severe accident operating guidelines (SAMGs). In particular, EPG/SAG, Revision 3, when implemented with Emergency Procedures Committee Generic Issue 1314, allows throttling of SAWA valves in order to protect containment while maintaining the wetwell vent in service. The SAMG flow charts direct the use of the hardened vent, as well as SAWA/SAWM when the appropriate plant conditions have been reached.

The licensee used the validation guidance in Appendix E to NEI 12-06, Revision 2, to demonstrate that the FLEX/SAWA portable pump can be deployed and commence injection in less than 8 hours. The studies referenced in NEI 13-02, Revision 1, demonstrate that establishing flow within 8 hours will protect containment. Guidance document NEI 13-02, Appendix I, establishes an initial water addition rate of 500 gpm based on EPRI Technical Report 3002003301, "Technical Basis for Severe-Accident Mitigating Strategies." The initial SAWA flow rate at Cooper will be approximately 344 gpm. After approximately 4 hours, during which the maximum flow rate is maintained, the SAWA flow will be reduced. The reduction in flow rate and the timing of the reduction will be based on stabilization of the containment parameters of drywell pressure and wetwell level.

The licensee used the referenced plant analysis included in NEI 13-02, Revision 1, information from EPRI Technical Report 3002003301, and CNS-specific parameters to demonstrate that SAWA flow could be reduced to 69 gpm after 4 hours of initial SAWA flow rate and containment would remain protected. At some point, if wetwell level begins to rise, indicating that the SAWA flow is greater than the steaming rate due to containment heat load, SAWA flow can be further reduced as directed by the SAMGs.

In its FIP, the licensee stated that the wetwell vent was designed and installed to meet NEI 13-02, Revision 1, guidance and is sized to prevent containment overpressure under severe accident conditions. Cooper will follow the guidance (flow rate and timing) for SAWA/SAWM described in BWROG-TP-15-008, "Severe Accident Water Addition Timing," [Reference 35] and BWROG-TP-15-011 "Severe Accident Water Management" [Reference 36]. The wetwell vent will be opened prior to exceeding the PCPL value of 62 psig. The licensee also referenced analysis included in BWROG-TP-15-008, which demonstrates adding water to the reactor vessel within 8 hours of the onset of the event will limit the peak containment drywell temperature, significantly reducing the possibility of containment failure due to temperature. Drywell pressure can be controlled by venting the containment from the suppression chamber.

The NRC staff audited the information referenced above. Guidance document NEI 13-02, uses an initial SAWA flow of 500 gpm reduced after four hours to 100 gpm. The NRC staff noted that Cooper determined plant-specific flow rates by scaling using the ratio of Cooper licensed thermal power (2,419 MWt) to that of the reference plant (3,514 MWt) used in the EPRI Technical Report 3002003301, "Technical Basis for Severe-Accident Mitigating Strategies." This is consistent with NEI 13-02, Section 4.1.1.2.

4.1.2 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed SAWA guidance that should ensure protection of the containment during severe accident conditions following an ELAP event, and, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

4.2 Severe Accident Water Management (SAWM)

The strategy for Cooper, to preclude the necessity for installing a hardened drywell vent, is to implement the containment venting strategy utilizing SAWA and SAWM. This strategy consists 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. The SAWA system consists of a FLEX (SAWA) pump injecting into the RPV. The overall strategy consists of flow control at the FLEX (SAWA) pump along with instrumentation and procedures to ensure that the wetwell vent is not submerged (SAWM). Water from the SAWA (FLEX) pump will be routed through the RHRSW FLEX connection to the RHR system. This RHR connection allows the water to flow into the RPV. Throttling valves and flow meters will be used to control water flow to maintain wetwell availability. Procedures have been issued to implement this strategy, including site specific implementation of the generic BWROG EPG/SAG Revision 3 with Emergency Procedures Committee Generic Issue 1314.

The BWROG generic assessment, BWROG-TP-15-008 [Reference 35], provides the principles of SAWA to ensure protection of containment. This strategy has been shown via Modular Accident Analysis Program and MELCOR Accident Consequence Code System analysis to protect containment without requiring a drywell vent for at least seven days, which is consistent with the guidance from NEI 13-02 for the period of sustained operation.

4.2.1 Staff Evaluation

4.2.1.1 Available Freeboard Use

As stated in the FIP, the freeboard between the 12'-11" and 28'-9" elevation in the wetwell provides approximately 813,820 gallons of water volume before the water level reaches the bottom of the vent pipe. Generic assessment BWROG-TP-15-011 (Reference 36) provides the principles of SAWM to preserve the wetwell vent for a minimum of 7 days. After containment parameters are stabilized with SAWA flow, SAWA flow will be reduced to a point where containment pressure will remain relatively low while wetwell level is stable or very slowly rising. For Cooper, the SAWA/SAWM design flow rates (344 gpm at 8 hours followed by 69 gpm from 12 hours to 168 hours) and available freeboard volume (described above) are bounded by the values utilized in the BWROG-TP-15-011 reference plant analysis that demonstrates the success of the SAWA/SAWM strategy. As shown in Engineering Report 1252, "NRC Order EA-13-109 Phase 2 Reliable Hardened Containment Vent Engineering Study, Revision 1, the wetwell water level will not reach the wetwell vent for at least 7 days. The NRC staff audited the information provided and agrees that starting water addition at a higher rate of flow and throttling after approximately 4-hours will not increase the suppression pool level to a point that could block the suppression chamber HCVS.

4.2.1.2 Strategy Time Line

As noted in Section 4.1.1.3, "SAWA Analysis of Flow Rates and Timing," the SAWA flow is based on the site-specific, scaled flow rate of 344 gpm to start at about 8 hours. Engineering Report 1252 demonstrated that, SAWA flow could be reduced to 69 gpm after 4 hours of initial SAWA flow rate and containment would be protected. The NRC staff concurs that the SAWM approach should provide operators sufficient time to reduce the water flow rate and to maintain wetwell venting capability. The strategy is based on BWROG generic assessments in BWROG-TP-15-008 and BWROG-TP-15-011.

As noted above, BWROG-TP-15-008 demonstrates adding water to the reactor vessel within 8-hours of the onset of the event will limit the peak containment drywell temperature significantly, reducing the possibility of containment failure due to temperature. Drywell pressure can be controlled by venting the containment from the suppression chamber. Technical Paper BWROG-TP-011 demonstrates that, for a reference plant, starting water addition at a higher rate of flow and throttling after approximately 4-hours will not increase the suppression pool level to a point that could block the suppression chamber HCVS.

4.2.2 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed SAWM guidance that should make it unlikely that the licensee would need to vent from the containment drywell during severe accident conditions following an ELAP event, and, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

4.3 SAWA/SAWM Motive Force

4.3.1 Staff Evaluation

4.3.1.1 SAWA Pump Power Source

As described in Section 4.1, the licensee plans to use one of two FLEX pumps to provide SAWA flow. The pumps are diesel-driven by an engine mounted on the skid with the pump. Operators will refuel the pump and DGs in accordance with Order EA-12-049 procedures using fuel oil from the installed, underground DG fuel oil storage tanks. In its FIP, the licensee states that refueling will be accomplished in areas that are shielded and protected from the radiological conditions during a severe accident scenario. The fuel tanks on the DDFP pumps are sized such that the pumps can run for approximately 5 hours prior to needing to be refueled. The pumps will be refueled by the FLEX refueling equipment that has been qualified for long-term refueling operations per Order EA-12-049.

4.3.1.2 DG Loading Calculation for SAWA/SAWM Equipment

In its FIP, the licensee lists drywell pressure, suppression pool level and the SAWA flow meter as instruments required for SAWA and SAWM implementation. The drywell pressure and suppression pool level instruments are used for HCVS venting operation. These instruments are powered by the Class 1E station batteries until the FLEX DG is deployed and available. The SAWA flow meter is self-powered by an internal battery which will power the flow meter for 5-7 years.

The NRC staff audited licensee's sizing calculations NEDC 87-131A, "250 VDC Division 1 Load and Voltage Study," Revision 13C1, NEDC 87-131B, "250 VDC Division 2 Load and Voltage Study," Revision 12C2, NEDC 87-131C, "125 VDC Division 1 Load and Voltage Study," Revision 15C1, and NEDC 87-131D, "125 VDC Division 2 Load and Voltage Study," Revision 13C13, under Order EA-12-049, which verified the capability of the Class 1E station batteries to supply power to the required loads (e.g. drywell pressure and suppression pool level) during the first phase of the Cooper FLEX mitigation strategy plan for an ELAP event. The NRC staff also reviewed licensee engineering document 6037041, which verified that the 175 kW and 60 kW FLEX DGs are adequate to support the addition of the HCVS electrical loads. The NRC staff confirmed that the Class 1E batteries, 175 kW and 60 kW FLEX DGs should have sufficient capacity and capability to supply the necessary SAWA/SAWM loads during an ELAP event.

4.3.2 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has established the necessary motive force capable to implement the water management strategy during severe accident conditions following an ELAP event, and, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

4.4 SAWA/SAWM Instrumentation

4.4.1 Staff Evaluation

4.4.1.1 SAWA/SAWM Instruments

In Section IV.C.10.2 of its FIP, the licensee stated that the instrumentation needed to implement the SAWA/SAWM strategy is wetwell level, drywell pressure and SAWA flow metering. The wetwell level and drywell pressure are existing R.G. 1.97 instruments that were designed and qualified for severe accident conditions. The SAWA flow instrument range is 70 to 800 gpm, which appears to be consistent with the licensee's strategy. The NRC staff reviewed Section IV.C.10.1, Section IV.C.10.2, and Table 1 of the FIP and found that the instruments appear to be consistent with the NEI 13-02 guidance.

4.4.1.2 SAWA Instruments and Guidance

In Section IV.C.10.2 of the FIP, the licensee stated that the drywell pressure and wetwell level instruments, used to monitor the condition of containment, are pressure and differential pressure detectors that are safety-related and qualified for post-accident use. The licensee also stated that these instruments are referenced in SAGs for control of SAWA flow to maintain the wetwell vent in service while maintaining containment protection and that these instruments are powered initially by batteries until the FLEX generator is deployed.

In Section IV.C.10.2 of its FIP, the licensee stated that the SAWA flow meter is a paddle-wheel flow meter mounted in the piping that is attached to the discharge of the FLEX/SAWA pump and is powered by its own internal battery.

The NRC staff reviewed the FIP, including Section IV.C.10.2 and found the licensees response appears to be consistent with the guidance. Most FLEX electrical strategies repower (via the FLEX DGs) other containment instruments including drywell temperature. The NRC staff notes that NEI 13-02, Revision 1, Section C.8.3 clarifies that drywell temperature is not required, but may provide further information for the operations staff to evaluate plant conditions under severe accident and provide confirmation to adjust SAWA flow rates.

4.4.1.3 Qualification of SAWA/SAWM Instruments

In Section IV.C.10.3 of its FIP, the licensee stated that the drywell pressure and wetwell level instruments are declared Cooper PAM variables as described in R.G. 1.97 and the existing qualification of these channels is considered acceptable for compliance with Order EA-13-109 in accordance with the guidance in NEI 13-02, Appendix C, Section C.8.1. The NRC staff verified the R.G. 1.97 variables in the Cooper FSAR.

In its FIP, the licensee stated that the SAWA flow meter is rated for continuous use under the expected ambient conditions and so will be available for the entire period of sustained operation. Furthermore, since the pump is deployed outside the reactor building, and on the opposite end of the reactor building from the vent pipe, there is no concern for any effects of radiation exposure to the flow instrument. The licensee stated in Table 1 of the FIP, that the anticipated temperature at this location is 97°F and the qualification temperature is 120°F. The licensee further stated in Table 1 of the FIP, that the flow meter is located outside and radiation is not a concern. The NRC staff confirmed the proposed location of the SAWA flow meter relative to the vent in the FIP Attachment 8 drawing.

The NRC staff reviewed Table 1 of the FIP and determined that the SAWA flow meter appears to be qualified for the anticipated environment.

4.4.2 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has in place, the appropriate instrumentation capable to implement the water management strategy during severe accident conditions following an ELAP event, and, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

4.5 SAWA/SAWM Severe Accident Considerations

4.5.1 Staff Evaluation

4.5.1.1 Severe Accident Effect on SAWA Pump and Flowpath

To address SAWA/SAWM severe accident dose considerations, the licensee documented its review and acceptance in calculation NEDC 15-024, Owner Acceptance of TetraTech Calculation CNS001-194-4933-005, "Radiological Conditions Resulting from the Operation of the HCVS," which documents the dose assessment for designated areas inside the CNS reactor building (outside of containment) and outside the CNS reactor building caused by the sustained operation of the HCVS under severe accident conditions. This calculation also analyzed the dose at different locations and times where operator actions will take place during FLEX/SAWA/SAWM activities. The analyzed locations include the MCR, MROS, travel paths for hose routing, and FLEX/SAWA pump locations.

In its FIP, the licensee stated that the FLEX pump is stored in the FLEX storage building where it is protected from screened-in hazards. The licensee further stated that, since the FLEX pump will be operated from outside the reactor building near condensate storage tank (CST) 1A or near the Missouri River, there will be no issues with radiation dose rates at the FLEX pump control location and there will be no significant dose to the FLEX pump. Based on an audit of the licensee's evaluations, it appears that there should be no significant issues with radiation dose rates at the SAWA pump control location, and there should be no significant dose to the SAWA pump.

The SAWA flow path inside the reactor building consists of steel piping that will be unaffected by the radiation dose. The licensee analyzed the radiological conditions along the SAWA flow path to ensure that hoses will only be run in locations that are shielded from significant radiation dose or that have been evaluated for the integrated dose effects over the period of sustained operation. The NRC staff audited the information and agrees that the SAWA flow path will not be adversely affected by radiation effects due to the severe accident conditions.

4.5.1.2 Severe Accident Effect on SAWA/SAWM Instruments

The licensee's SAWA strategy relies on three instruments: wetwell level, containment pressure, and SAWA flow. Containment pressure and wetwell level are declared CNS PAM variables as described in R.G. 1.97 and the existing qualification of these channels is considered acceptable for compliance with Order EA-13-109 in accordance with the guidance in NEI 13-02, Appendix C, Section C.8.1.

As discussed above in Section 4.5.1.1, the SAWA pump will be operated from outside the reactor building near CST 1A or near the Missouri River. Therefore, there will be no issues with radiation dose rates at the FLEX pump control location and there will be no significant radiation exposure to the flow instruments mounted on the SAWA pump cart. Based on this information, the NRC staff agrees that the SAWA/SAWM instruments should not be adversely affected by radiation effects due to severe accident conditions.

4.5.1.3 Severe Accident Effect on Personnel Actions

According to the FIP, actions inside the reactor building needed to support SAWA occur within the first hour of a loss of injection per Procedure 5.3SBO. These include the opening of PC-MOV-233MV and the opening of the reactor building alternate ventilation path. These times were validated as part of the Time Sensitive Action validation for compliance with Order EA-12-49.

The operators make all hose connections, control the FLEX pump to perform SAWA/SAWM operations, and observe the necessary instruments all from outside the reactor building. Therefore, the loss of ventilation inside the building will not impede these actions. Existing plant guidance will provide protection for operators performing outdoor work.

Table 2 of the FIP provides a list of SAWA/SAWM operator actions as well as an evaluation of each for suitability during a severe accident. Attachment 8 of the FIP shows the approximate locations of the actions. All SAWA/SAWM controls and indications are accessible during severe accident conditions.

The FLEX pump and monitoring equipment can all be operated from the MCR (the MCR was evaluated earlier in Section 3.1.1.2, "Personnel Habitability – Environmental") or from outside the reactor building at ground level. The CNS FLEX response ensures that the FLEX pump, FLEX air compressors, FLEX generators and other equipment can all be run for a sustained period by refueling. All the refueling locations are located in shielded or yard areas so that there is no radiation hazard from core material during a severe accident. The monitoring instrumentation includes SAWA flow at the pump, and wetwell level and containment pressure in the MCR.

The licensee documented its review and acceptance in calculation NEDC 15-024, Owner Acceptance of TetraTech Calculation CNS001-194-4933-005, "Radiological Conditions Resulting from the Operation of the HCVS," which documents the dose assessment for designated areas inside the CNS reactor building (outside of containment) and outside the CNS reactor building caused by the sustained operation of the HCVS under the beyond-design-basis severe accident condition of an ELAP. This assessment used conservative assumptions to determine the expected dose rates in all areas that may require access during a beyond-design-basis ELAP. As stated in Section 3.1.1.3, Personnel Habitability - Radiological, the NRC staff agrees, based on the audit of the licensee's detailed evaluation, that mission doses associated with actions taken to protect the public under beyond-design-basis severe accident conditions should not subject plant personnel to an undue risk from radiation exposure.

4.5.2 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has considered the severe accident effects on the water management strategy and that the operation of components and instrumentation should not be adversely affected, and the performance of personnel actions should not be impeded, during severe accident conditions following an ELAP event. The NRC staff further concludes that the water management strategy, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

4.6 Conclusions for Order EA-13-109, Phase 2

Based on its review, the NRC staff concludes that the licensee has developed guidance and a water management strategy that, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

5.0 HCVS/SAWA/SAWM PROGRAMMATIC CONTROLS

5.1 Procedures

Order EA-13-109, Attachment 2, Section 3.1 requires that the licensee develop, implement, and maintain procedures necessary for the safe operation of the HCVS. Furthermore, Order EA-13-109 requires that procedures be established for system operations when normal and backup power is available, and during an ELAP. Relevant guidance is found in NEI 13-02, Sections 6.1.2 and 6.1.2.1.

In its FIP, the licensee states that a site-specific program and procedures were developed following the guidance provided in NEI 13-02, Sections 6.1.2, 6.1.3, and 6.2. They address the use and storage of portable equipment including routes for transportation from the storage locations to deployment areas. In addition, the procedures have been established for system operations when normal and backup power is available, and during ELAP conditions. The FIP also states that provisions have been established for out-of-service requirements of the HCVS and the compensatory measures. In the FIP, Section V.B provides specific time frames for out-of-service requirements for HCVS functionality.

The FIP also provides a list of key areas where either new procedures were developed or existing procedures were revised. The NRC staff audited the overall procedures and programs developed, including the list of key components included, and noted that they appear to be consistent with the guidance found in NEI 13-02, Revision 1. The NRC staff determined that procedures developed appear to be in accordance with existing industry protocols. The provisions for out-of-service requirements appear to reflect consideration of the probability of an ELAP requiring severe accident venting and the consequences of a failure to vent under such conditions.

Based on the evaluation above, the NRC staff concludes that the licensee's procedures for HCVS/SAWA/SAWM operation, if implemented appropriately, appear to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the Order.

5.2 Training

Order EA-13-109, Attachment 2, Section 3.2 requires that the licensee train appropriate personnel in the use of the HCVS. Furthermore, Order EA-13-109 requires that the training include system operations when normal and backup power is available, and during an ELAP. Relevant guidance is found in NEI 13-02, Section 6.1.3.

In its FIP, the licensee stated that all personnel expected to perform direct execution of the HCVS/SAWA/SAWM actions will receive necessary training. The training plan has been developed per the guidance provided in NEI 13-02, Section 6.1.3, and will be refreshed on a periodic basis as changes occur to the HCVS actions, systems, or strategies. In addition, training content and frequency follows the systems approach to training process. The NRC staff reviewed the information provided in the FIP and confirmed that the training plan is consistent with the established systems approach to training process.

Based on the evaluation above, the NRC staff concludes that the licensee's plan to train personnel in the operation, maintenance, testing, and inspection of the HCVS design and water management strategy, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

6.0 CONCLUSION

In June 2014, the NRC staff started audits of the licensee's progress in complying with Order EA-13-109. The staff issued an ISE for implementation of Phase 1 requirements on February 11, 2015 [Reference 15], an ISE for implementation of Phase 2 requirements on September 29, 2016 [Reference 16], and an audit report on the licensee's responses to the ISE open items on March 29, 2018 [Reference 17]. The licensee reached its final compliance date on November 14, 2018, and has declared in letter dated January 14, 2019 [Reference 18], that Cooper Nuclear Station is in compliance with the order.

Based on the evaluations above, the NRC staff concludes that the licensee has developed guidance that includes the safe operation of the HCVS design and a water management strategy that, if implemented appropriately, should adequately address the requirements of Order EA-13-109.

7.0 REFERENCES

1. 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. Letter from Cooper to NRC, "Cooper Nuclear Station – Phase 1 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 Phase 1 (Order Number EA-13-109)," dated June 30, 2014 (ADAMS Accession No. ML14189A415)

3. Letter from Cooper to NRC, "First Six-Month Status Report For Phase 1 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 December 19, 2014 (ADAMS Accession No. ML14364A154)

4. Letter from Cooper to NRC, "Second Six-Month Status Report For Phase 1 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 June 30, 2015 (ADAMS Accession No. ML15189A047)

5. Letter from Cooper to NRC, "Cooper Nuclear Station – Phase 1 (Updated) and Phase 2 Overall Integrated Plan in Response to June 6, 2013, Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order EA-13-109)," dated December 21, 2015 (ADAMS Accession No. ML15364A011)

6. Letter from Cooper to NRC, "Fourth Six-Month Status Report For Phases 1 and 2 Overall Integrated Plan in Response to June 6, 2013, Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated June 30, 2016 (ADAMS Accession No. ML16196A058)

7. Letter from Cooper to NRC, "Fifth Six-Month Status Report For Phases 1 and 2 Overall Integrated Plan in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated December 28, 2016 (ADAMS Accession No. ML17006A005)

8. Letter from Cooper to NRC, "Sixth Six-Month Status Report For Phases 1 and 2 Overall Integrated Plan in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated June 19, 2017 (ADAMS Accession No. ML17177A091)

9. Letter from Cooper to NRC, "Seventh Six-Month Status Report For Phases 1 and 2 Overall Integrated Plan in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation

Under Severe Accident Conditions (Order Number EA-13-109)," dated December 21, 2017 (ADAMS Accession No. ML17362A037)

10. Letter from Cooper to NRC, "Eighth Six-Month Status Report For Phases 1 and 2 Overall Integrated Plan in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated June 26, 2018 (ADAMS Accession No. ML18190A181)

11. Letter from Cooper to NRC, "Ninth Six-Month Status Report For Phases 1 and 2 Overall Integrated Plan in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated December 4, 2018 (ADAMS Accession No. ML18351A090)

12. Nuclear Regulatory Commission Audits of Licensee Responses to Phase 1 of Order EA-13-109 to Modify Licenses With Regard To Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions, dated May 27, 2014 (ADAMS Accession No. ML14126A545)

13. Nuclear Regulatory Commission Audits of Licensee Responses to Phase 2 of Order EA-13-109 to Modify Licenses With Regard To Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions, dated August 10, 2017 (ADAMS Accession No. ML17220A328)

14. Nuclear Regulatory Commission Office of Nuclear Reactor Regulation Office Instruction LIC-111, "Regulatory Audits" (ADAMS Accession No. ML082900195)

15. Letter from NRC to Cooper, "Cooper Nuclear Station – Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Phase 1 of Order EA-13-109 (Severe Accident Capable Hardened Vents)," dated February 11, 2015 (ADAMS Accession No. ML15006A234)

16. Letter from NRC to Cooper, "Cooper Nuclear Station – Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Phase 2 of Order EA-13-109 (Severe Accident Capable Hardened Vents)," dated September 29, 2016 (ADAMS Accession No. ML16266A066)

17. Letter from NRC to Cooper, "Cooper Nuclear Station – Report for The Audit of Licensee Responses to Interim Staff Evaluations Open Items Related to NRC Order EA-13-109 to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions," dated March 29, 2018 (ADAMS Accession No. ML18081A870)

18. Letter from Cooper to NRC, "Cooper Nuclear Station, Report of Full Compliance with Phase 1 and Phase 2 of June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated January 14, 2019 (ADAMS Accession No. ML19022A365)

19. SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," dated July 12, 2011 (ADAMS Accession No. ML111861807)

20. 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)

21. 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)

22. Order EA-12-050, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents," March 9, 2012 (ADAMS Accession No. ML12054A694)

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

24. 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)

25. NEI 13-02, "Industry Guidance for Compliance with Order EA-13-109," Revision 0, November 12, 2013 (ADAMS Accession No. ML13316A853)

26. Interim Staff Guidance JLD-ISG-2013-02, "Compliance with Order EA-13-109, Severe Accident Reliable Hardened Containment Vents," November 14, 2013 (ADAMS Accession No. ML13304B836)

27. NEI 13-02, "Industry Guidance for Compliance with Order EA-13-109," Revision 1, April 23, 2015 (ADAMS Accession No. ML15113B318)

28. Interim Staff Guidance JLD-ISG-2015-01, "Compliance with Phase 2 of Order EA-13-109, Severe Accident Reliable Hardened Containment Vents," April 29, 2015 (ADAMS Accession No. ML15104A118)

29. NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 2, December 2015 (ADAMS Accession No. ML16005A625)

30. NEI Industry White Paper – HCVS-WP-02, "Sequences for HCVS Design and Method for Determining Radiological Dose from HCVS Piping," Revision 0, October 30, 2014 (ADAMS Accession No. ML14358A038)

31. Letter from NEI to NRC, "Hardened Containment Venting System (HCVS) Phase 1 and 2 Overall Integrated Plan Template," Revision 1, dated September 28, 2015, and Frequently Asked Questions (FAQs) 10, 11, 12, and 13 (ADAMS Accession No. ML15273A141)

32. NEI Industry White Paper – HCVS-WP-04, "Missile Evaluation for HCVS Components 30 Feet Above Grade," Revision 0, August 17, 2015 (ADAMS Accession No. ML15244A923)

33. Appendix J to 10 Code of Federal Regulations Part 50, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors"

34. NEI Industry White Paper – HCVS-WP-03, "Hydrogen/Carbon Monoxide Control Measures," Revision 1, October 2014 (ADAMS Accession No. ML14295A442)

35. BWROG-TP-15-008, "BWROG Fukushima Response Committee, Severe Accident Water Addition Timing," September 2015

36. BWROG-TP-15-011, "BWROG Fukushima Response Committee, Severe Accident Water Management Supporting Evaluations," October 2015

37. NRC Letter to Cooper, "Cooper Nuclear Station – Safety Evaluation Regarding Implementation of Mitigating Strategies And Reliable Spent Fuel Pool Instrumentation Related To Orders EA-12-049 And EA-12-051," September 20, 2017 (ADAMS Accession No. ML17226A032)

38. Letter from Cooper to NRC, "Cooper Nuclear Station, Report of Full Compliance with Phase 1 and Phase 2 of June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," Revision 1, dated April 16, 2019 (ADAMS Accession No. ML19127A022)

Principal Contributors: Rajender Auluck
Bruce Heida
Brian Lee
Kerby Scales
Kevin Roche
Steve Wyman
John Parillo

Date: May 7, 2019

SUBJECT: COOPER NUCLEAR STATION – SAFETY EVALUATION REGARDING IMPLEMENTATION OF HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS RELATED TO ORDER EA-13-109 (CAC NO. MF4384; EPID NO. L-2014-JLD-0046) DATED: May 7, 2019

DISTRIBUTION:
PUBLIC
PBEB R/F
RidsNrrDorlLpl4 Resource
RidsNrrPMCooper Resource
RidsNrrLaSLent Resource
RidsRgn4MailCenter Resource
BTitus, NRR
RAuluck, NRR
BLee, NRR
RidsACRS_MailCTR Resource

ADAMS Accession No. ML19079A070

OFFICE	NRR/DLP/PBEB/PM	NRR/DLP/PBMB/LA	NRR/DLP/PBEB/BC
NAME	RAuluck	SLent	BTitus
DATE	4/3/19	3/20/19	5/7/19

OFFICIAL RECORD COPY