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

October 11, 2018

Mr. Bryan C. Hanson
Senior Vice President
Exelon Generation Company, LLC
President and Chief Nuclear Officer
Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: NINE MILE POINT NUCLEAR STATION, UNIT 2 - SAFETY EVALUATION REGARDING IMPLEMENTATION OF HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS RELATED TO ORDER EA-13-109 (CAC NO. MF4482; EPID NO. L-2014-JLD-0043)

Dear Mr. Hanson:

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 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 27, 2014 (ADAMS Accession No. ML14184B340), Exelon Generation Company, Inc. (the licensee) submitted its Phase 1 OIP for Nine Mile Point Nuclear Station, Unit 2 (NMP2) 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 NMP2, including the combined Phase 1 and Phase 2 OIP in its letter dated December 15, 2015 (ADAMS Accession No. ML15364A075). 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 Boiling Water Reactor 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. ML15028A149), August 25, 2016 (Phase 2) (ADAMS Accession No. ML16223A853), and October 17, 2017 (ADAMS Accession No. ML17286A263), the NRC issued Interim Staff Evaluations (ISEs) and an audit report, respectively, on the licensee's progress. By letter dated July 3, 2018 (ADAMS Accession No. ML18184A196), the licensee reported that NMP2 is in full compliance with the requirements of Order EA-13-109, and submitted a Final Integrated Plan for NMP2.

The enclosed safety evaluation provides the results of the NRC staff's review of NMP2's hardened containment vent design and water management strategy for NMP2. The intent of the safety evaluation is to inform NMP2 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 via e-mail at Rajender.Auluck@nrc.gov.

Sincerely,

Nathan T. Sanfilippo, Chief
Beyond-Design-Basis Engineering Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Docket No. 50-410

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO ORDER EA-13-109

EXELON GENERATION COMPANY, LLC

NINE MILE POINT NUCLEAR STATION, UNIT 2

DOCKET NO. 50-410

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 27, 2014 [Reference 2], Exelon Generation Company, Inc. (the licensee) submitted a Phase 1 Overall Integrated Plan (OIP) for Nine Mile Point Nuclear Station, Unit 2 (NMP2, Nine Mile Point, Unit 2) in response to Order EA-13-109. By letters dated December 16, 2014 [Reference 3], June 30, 2015 [Reference 4], December 15, 2015 (which included the combined Phase 1 and Phase 2 OIP) [Reference 5], June 30, 2016 [Reference 6], December 14, 2016 [Reference 7], June 30, 2017 [Reference 8], and December 15, 2017 [Reference 9], the licensee submitted 6-month updates to its OIP. By letters dated May 27, 2014 [Reference 10], and August 10, 2017 [Reference 11], 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

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accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" [Reference 12]. By letters dated February 11, 2015 (Phase 1) [Reference 13], August 25, 2016 (Phase 2) [Reference 14], and October 17, 2017 [Reference 15], the NRC issued Interim Staff Evaluations (ISEs) and an audit report, respectively, on the licensee's progress. By letter dated July 3, 2018 [Reference 16], 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 17]. Following interactions with stakeholders, these recommendations were enhanced by the NRC staff and presented to the Commission.

On February 17, 2012, 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" [Reference 18], 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 19], the NRC staff issued Order EA-12-050, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents" [Reference 20], 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 21]. In the SRM for SECY-12-0157 [Reference 22], 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, NEI issued NEI 13-02, "Industry Guidance for Compliance with Order EA-13-109," Revision 0 [Reference 23] 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, 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'" [Reference 24], 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, NEI issued NEI 13-02, "Industry Guidance for Compliance with Order EA-13-109," Revision 1 [Reference 25] 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, 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'" [Reference 26], 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

To implement the Phase 1 HCVS requirements of Order EA-13-109, the licensee utilized the existing Containment Purge System (CPS) piping from the suppression chamber and attached new piping to route the HCVS effluent outside the Reactor Building (RB) and up to a sufficient height above the RB roof. The HCVS will be initiated via manual action at the Remote Operating Station (ROS) combined with control from either the Main Control Room (MCR) or the

ROS at the appropriate time based on procedural guidance in response to plant conditions from observed or derived symptoms. The ROS provides backup manual operation of the HCVS valves and purge system as required by the order. The vent will utilize containment parameters of pressure and level from the MCR instrumentation to monitor effectiveness of the venting actions. The vent operation will be monitored by HCVS valve position, temperature, and effluent radiation levels. The HCVS motive force has the capacity to operate for 24 hours with installed equipment. Replenishment of the motive force will be by use of portable equipment once the installed motive force is exhausted. Venting actions will be capable of being maintained for a sustained period of up to 7 days.

3.1 HCVS Functional Requirements

3.1.1 Performance Objectives

Order EA-13-109 requires that the design and operation of 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 operator actions to initiate the HCVS vent path can be completed by plant personnel and include the capability for remote-manual initiation from the HCVS control station. After initial valve line-up at the ROS, the vent system is initiated, operated, and monitored from the MCR. The vent system can also be initiated and operated from the ROS located on the 261' elevation in the RB Track Bay (grade elevation). 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. A HCVS extended loss of alternating current (ac) power (ELAP) Failure Evaluation table (Table 3-2), which shows alternate actions that can be performed, is 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 portable equipment is needed 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 (or small generator), spare protected nitrogen/argon bottles, and air compressors 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 the guidance document NEI 13-02, and determined that these actions should minimize the reliance on operator actions. The actions are consistent with the types of actions described in the guidance found 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 the actions described adequately address all the failure modes listed in the guidance provided by 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.

During the audit period, the licensee discussed communication between the remote HCVS operation locations and HCVS decision makers during ELAP and severe accident conditions. Procedure CC-NM-118, "Site Implementation of Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program," Revision 1, provides communications protocol for BDBEE along with procedure N2-OP-76, "Plant Communications," Revision 3. Onsite communications are performed using either the installed sound-powered headset system or the 450 MHz [megahertz] radios in 'talk around' mode, or a combination thereof. A sound-powered phone jack is available near the ROS to communicate with the rest of the plant. Offsite communications will utilize fixed satellite phones in the Control Room and Technical Support Center (TSC). Both locations have portable satellite phones staged.

These communication methods are consistent with FLEX communication practices at NMP2 and have been previously reviewed and accepted by the NRC staff under Order EA-12-049. These items will be powered and remain powered using the same methods as evaluated under Order EA-12-049 for the period of sustained operation.

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 system. 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 accessing HCVS equipment following an external event that results in an ELAP will subject the operator to prevailing area temperatures. The majority of the operator travel path from the MCR to the ROS is outdoors. Therefore, the travel path does not pose any habitability concerns with respect to temperature. The MCR and ROS are expected to remain habitable with respect to temperature during the event. During the ELAP, as with the station blackout, normal ventilation systems are inoperable, but non-vital equipment is also inoperable and thus does not contribute to the area heat load.

In its FIP, NMP2 indicated that primary control of the HCVS is accomplished from the MCR and that alternate control of the HCVS is accomplished from the ROS in the RB Track Bay. FLEX actions that will maintain the MCR and ROS habitable were implemented in response to NRC Order EA-12-049. These actions include:

1. Opening MCR and Relay Room access doors (if required)
2. Restoring MCR ventilation via the FLEX diesel generator (DG)
3. Opening selected doors and a roof hatch in the RB to establish natural circulation air flow in the RB

Procedures N2-SOP-02, "Station Blackout/Extended Loss of AC Power Support Procedure," Revision 11, N2-DRP-FLEX-MECH, "Emergency Damage Repair – BDB/FLEX Pump Deployment Strategy," Revision 3, N2-DRP-FLEX-ELEC, "Emergency Damage Repair – BDB/FLEX Generator Deployment Strategy," Revision 2, and N2-SOP-01, "Station Blackout/Extended Loss of AC Power," Revision 15, provide guidance for opening selected doors and restoring MCR ventilation via the FLEX DG.

The licensee performed calculation ES-198, "Control Building Station Blackout Analysis," Revision 1, which predicts the control room heat-up following a station blackout. The licensee's MCR heat-up analysis determined that the peak area temperature for the MCR is 100 degrees Fahrenheit (°F). The licensee also performed calculation ES-289, "Reactor Building Thermal Response Following an Extended Loss of AC Power," Revision 1, which predicts the temperature profile in the RB following an ELAP. This calculation estimated the maximum temperature in the area in the RB, where the ROS is located, to be approximately 120°F.

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 reviewed the information in Table 2 and the calculations referenced in the FIP and used NUMARC 87-00, "Guidelines and Technical bases for NUMARC Initiatives Addressing Station Blackout at Light water reactors," as a basis for the habitability temperature limit as referenced in the guidance document NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide" (endorsed by the NRC in JLD-ISG-2012-01 (ADAMS Accession No. ML12229A174)). The acceptance criteria in NUMARC 87-00 for the habitability temperature limit is 110°F for personnel performing light work. The NUMARC guidance states that a dry bulb temperature of 110°F is tolerable for light work for a four-hour period. The NRC staff noted that even though NMP2 predicted a maximum temperature of 120°F at the ROS, which is greater than the guidance in NUMARC 87-00, operators will not be staying in areas with elevated temperatures very long. Most HCVS actions will take place in the MCR, which is predicted to remain well below the 110°F temperature limit. When manual actions are needed in the ROS, work performed in this area will be of limited time and effort. In addition, existing plant procedures for hot area work will also provide protection for plant personnel. The NRC staff concludes that with the limited stay time, the absence of strenuous work tasks required to be performed, and existing procedures for working in elevated temperatures should not impede operators from completing their required tasks.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design, with respect to personnel habitability during severe accident conditions, 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.

3.1.1.3 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 calculation H21C-114, "Hardened Containment Vent System (HCVS) Radiological Dose Analysis as amended by ECP-17-000280-CN-001 H21C-114," which documents the dose assessment for designated areas inside the NMP2 RB (outside of containment) and outside the NMP2 RB caused by the sustained operation of the HCVS under the beyond-design-basis severe accident condition of an ELAP. Calculation H21C-114 was performed using NRC-endorsed HCVS-WP-02 [Reference 27] and HCVS-FAQ-12 [Reference 28] 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 was determined in the licensee's dose calculation to be no greater than 10 rem[2]. The 7-day dose determined in the calculation due to HCVS operation is a conservative maximum integrated radiation dose over a 7-day period with ELAP and fuel failure starting at reactor shutdown. For the sources considered and the methodology used in the 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 licensee determined the expected dose rates in all locations requiring access following a beyond-design-basis ELAP. The licensee's evaluation indicates that for the areas requiring access in the early stages of the ELAP, 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 accident, the licensee has determined that the expected stay times would ensure that operations could be accomplished without exceeding the emergency response organization (ERO) emergency worker dose guidelines.

The licensee calculated the maximum dose rates and 7-day integrated whole body gamma dose equivalents for the primary operating station (POS), which is the control room, and the ROS. The calculation 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 will 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 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 reviewed 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 POS and ROS during the

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[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/radiation/health-effects/rad-exposure-cancer.html

sustained operating period, the NRC staff concludes, with reasonable assurance, 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, 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.

3.1.1.4 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 (SE), respectively.

The HCVS is located in Primary Containment, Secondary Containment, the RB Track Bay, the Control Room, and outside the RB. Regarding the functionality of the HVCS controls and indications, the licensee evaluated the environmental conditions and impacts for the components (valves, instrumentation, sensors, transmitters, indicators, electronics, control devices, etc.) required for HCVS venting. In the NMP2 engineering change package ECP-13-000087-103-02, Revision 6 provides detailed design considerations for the instrumentation including the seismic, temperature and radiation environmental qualifications. The licensee also provided a complete list of the instrumentation components, their locations, the anticipated environmental conditions, and summary qualification details in Table 1 of its FIP.

The NRC staff reviewed the instrumentation and controls (I&C) configuration in NMP2's FIP and confirmed the qualification summary information provided in Table 1 for each channel based on an electronic portal audit of NMP2 document ECP-13-000086. The NRC staff reviewed the following channels which support HCVS operation: HCVS Effluent Temperature; HCVS Effluent Radiation; HCVS Effluent Pressure; HCVS Valve Position; HCVS direct current (dc) Voltage; HCVS Pneumatic Supply Pressure; HCVS Purge System Pressure; Containment Pressure; Torus Pressure; and Torus Level. The staff notes that Containment Pressure, Torus Pressure, and Torus Level are declared NMP2 post-accident monitoring (PAM) variables as described in Regulatory Guide 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Power Plants," 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 reviewed the licensee's evaluation and confirmed that the HCVS instrumentation is 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, with respect to the accessibility and functionality of the HCVS controls and indications during severe accident conditions, 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 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 have 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 HCVS wetwell path is designed for venting steam/energy at a minimum capacity of 1 percent of 3988 MW thermal power at a pressure of 45 pounds per square inch gauge (psig) assuming nominal suppression pool water level. This pressure is the lower of the containment design pressure and the primary containment pressure limit (PCPL) value; however, in this case, both are 45 psig. The size of the wetwell portion of the HCVS is greater than 12 inches in diameter, which provides adequate capacity to meet or exceed the order criteria, as confirmed in the vent capacity calculation discussed below.

The licensee performed calculation A10.1-A-050, "Hardened Containment Vent Capacity," Revision 0, to confirm the HCVS venting capacity. The RELAP5 computer code was used to model the HCVS to perform this analysis. The RELAP5 is a code to simulate transient two-phase flow conditions in piping systems. The RELAP5 program generates time-dependent thermal-hydraulic conditions within the piping at user-specified time increments. The design pressure was used, which is 45 psig at NMP2. The energy for 1 percent thermal power is calculated to be equivalent to a steam flow rate of approximately 148,607 pound mass per hour (lbm/hr). The current design was evaluated considering pipe diameter, length, and geometry, as well as vendor provided valve loss of coefficients, and the losses associated with a burst rupture disc. The licensee's RELAP5 calculation concludes that at the wetwell design pressure of 45 psig, the HCVS can vent 153,900 lbm/hr of steam, which provides margin to the minimum required flow rate. The NRC staff reviewed the licensee's evaluations and confirmed that the HCVS vent design will support the capacity to vent 1 percent of rated thermal power during ELAP and severe accident conditions.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design characteristics, 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.

3.1.2.2 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 NMP2 vent path is completely separate from the NMP, Unit 1 vent path. The wetwell vent path at NMP2 exits the Primary Containment through the existing CPS piping through two outboard CPS primary containment isolation valves (PCIVs) and the HCVS isolation valve. Downstream of the HCVS isolation valve, the vent piping exits the containment into the RB and continues until it ties into a combined drywell/wetwell 20-inch header. New 16-inch piping ties into this header upstream of two Standby Gas Treatment System (SGTS) isolation valves. A new air-operated valve has been provided in this piping that serves as the means to control HCVS flow. Although this control valve is not a PCIV, the licensee confirmed that it is designed and fabricated to the same requirements as the HCVS PCIVs. A rupture disc has been added downstream of this control valve to serve as the secondary containment pressure boundary and to prevent secondary containment bypass leakage due to valve leakage during a design-basis loss of cooling accident. The discharge piping exits through the RB wall approximately 52 feet above ground elevation and has been routed over to and up the northwest side of the RB to a discharge point approximately 3 feet above the highest point of the RB roof. This satisfies the guidance provided for vent height in HCVS-FAQ-04.

For the seismic design of the outdoor HCVS stack, the licensee performed calculation AX-515B, "Pipe Stress Calculation for Vent'N R.B. Air Cool & Purge Piping Lines From Penetration Z-48 To Penetration Z-51," Revision 4, to determine seismic adequacy of the HCVS stack. In its FIP, the licensee states that HCVS contains American Society of Mechanical Engineers Class 2, 3, and ANSI B31.1 piping and that the entire HCVS system has been evaluated to Seismic Category I requirements in pipe stress calculation AX-515B. This is consistent with the plant's seismic design basis that complies with NEI 13-02, Section 5.2 seismic design guidance.

All effluents are exhausted above the unit's RB. This discharge point is above the unit's RB parapet wall. Part of the guidance in HCVS-FAQ-04 is designed to ensure that vented effluents are not drawn immediately back into any ELAP emergency ventilation intake and exhaust pathways. The MCR emergency air intake in the ELAP event is at the 316-foot elevation which is approximately 119 feet below the HVCS pipe outlet. Therefore, the vent pipe discharge point meets the guidance of HCVS-FAQ-04 for stack discharge relative to the ELAP air intake.

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 29], 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 requirements contained in HCVS-WP-04. The evaluation demonstrated that the pipe was robust with respect to external missiles per HCVS-WP-04 in that:

1. The HCVS vent piping exits the RB at an elevation of 313 feet, which is 52 feet above grade. Therefore, none of the HCVS vent pipe outside the RB is less than 30 feet above grade.

2. The exposed piping greater than 30 feet above grade has the following characteristics:

a. The total vent pipe exposed area is 240 square feet, which is less than the 300 square feet criteria that is discussed in HCVS-WP-04.
b. The pipe is made of standard schedule 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. NMP2 maintains a large cutoff saw as part of the FLEX equipment. This saw is capable of cutting the vent pipe should it become damaged such that it restricts flow to an unacceptable level.

4. Hurricanes are not a screened-in hazard for NMP2.

The conclusion of the evaluation is that NMP2 meets all of the tornado missile assumptions identified in HCVS-WP-04. The NRC staff reviewed the information provided and concludes 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, 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 in HCVS-FAQ-05.

In its FIP, the licensee described that the HCVS for NMP2 is fully independent of NMP, Unit 1 with separate discharge points. Therefore, the capacity at each unit is independent of the status of the other unit's HCVS. The only interfacing system with the HCVS is the SGTS. There are two parallel interface isolation valves separating the SGTS and the HCVS discharge piping (one 20-inch air-operated butterfly valve (2GTS*SOV101) and one 2-inch ac solenoid-operated globe valve (2GTS*SOV102)).

The interface valves between the HCVS and the SGTS are normally-closed, fail-closed (spring and solenoid operated) valves. Upon initiation of an ELAP and associated loss of instrument air, the valves would automatically shut due to spring pressure or loss of power to the solenoid. Therefore, no additional power is necessary. These boundary valves are located at a high point of the SGTS piping. When closed, the leakage is minimized. At slow leakage rates, there would be no motive force to move any accumulated hydrogen away from the high point of the piping, thereby preventing a combustible mixture in any areas of the RB. A test connection was installed downstream of the boundary valves to facilitate local leak rate testing of the interface valves. These valves are part of the 10 CFR Part 50, Appendix J, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors," Program [Reference 30] and go through periodic surveillance testing to ensure the leak rates to be within the acceptable limits. The NRC staff's review of the HCVS confirmed that the licensee's design is consistent with the guidance and appears to minimize unintended cross flow of vented fluids.

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 identified that a HCVS control panel is located in the MCR, which allows for the operating and monitoring of the HCVS. In addition, a secondary location for the HCVS operation is the ROS, which is located in the RB Track Bay. Both locations are protected from adverse natural phenomena and are sufficiently radiologically shielded. The MCR is the normal control point for HCVS operation and Plant Emergency Response actions. The seismic adequacy for the ROS location in the RB Track Bay was analyzed by the licensee and is discussed in Section 3.2.2 of this SE.

Based on the evaluation above, the NRC staff concludes that the licensee's location and design of the HCVS control panels, 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.

3.1.2.5 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 described the ROS as a readily accessible alternate location, with the means to operate HCVS valves via pneumatic motive force. The ROS 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 that may be actuated. This provides a diverse method of valve operation, thus improving system reliability.

Following alignment of the three-way valve and gas isolation valves (Table 3-1 of the FIP) at the ROS, the HCVS has been designed to allow initiation, control, and monitoring of venting from the MCR and will be able to be operated from the ROS consistent with the requirements of the order. Both locations minimize plant operators' exposure to adverse temperature and radiological conditions, as discussed in Sections 3.1.1.2 and 3.1.1.3 above, are protected from adverse natural phenomena, and are sufficiently shielded.

Permanently installed electrical power, argon purge gas, and motive air/gas capability will be available to support operation and monitoring of the HCVS for the first 24 hours. Power will be provided by installed batteries for up to 24 hours before generators will be required to be functional. Operator actions required to extend venting beyond 24 hours include replenishing pneumatic supplies and argon purge system-stored gases and recharging the electrical supply.

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, the motive supply for the air-operated valves (AOVs) will be nitrogen gas bottles that will be pre-installed and available. These bottles have been sized such that they can provide motive force for at least eight cycles of a vent path, which includes two openings for each of the two PCIVs (CPS*AOV109 and 2CPS*AOV111) and at least eight openings of the HCVS isolation valve (2CPS-AOV134). In its FIP, the licensee stated that based on its evaluation, only 6 venting cycles are needed in the first 24 hours.

The licensee also determined [Reference 5] 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 A10.1-P-051, "Nitrogen Requirement For Operation of the HCVS Valves," Revision 0. The licensee's calculation determined that two nitrogen bottles filled to a minimum pressure of 1993 psig provide sufficient capacity for operation of the HCVS valves for 24 hours following an ELAP. This minimum pressure includes an allowance for leakage. The NRC staff reviewed the calculation and confirmed that there should be sufficient pneumatic supply available to provide motive force to operate the HCVS AOVs for 24 hours following a loss of normal pneumatic supplies during an ELAP. Following the initial 24 hours, the licensee states that replacement nitrogen bottles are stored in the FLEX Storage Building.

Power Source Analysis

In its FIP, the licensee stated that during the first 24 hours of an ELAP event, NMP2 would rely on the new HCVS battery to provide power to HCVS components. The 125 volt direct current (Vdc) HCVS battery and battery chargers are located on the 261' elevation in the RB Track Bay on the northeast side of the Reactor Building near the ROS, where they are protected from screened in hazards. Exide Technologies manufactured the HCVS battery.

The HCVS battery is model Absolyte GP 6-50G05 with a nominal capacity of 104 ampere-hours (A-H). The HCVS battery has a minimum capacity capable of providing power for 24 hours without recharging. During the audit period, the licensee provided the NRC staff an evaluation for the HCVS battery/battery charger sizing requirements including incorporation into the FLEX diesel generator (DG) loading calculation.

The NRC staff reviewed licensee engineering change package ECP-13-000087-103-02, "Engineering Change Package Design Consideration Summary FORM-103-DCS, Attachment 3, 125 VDC Battery Sizing Calculation," Revision 7, which verified the capability of the HCVS battery to supply power to the required loads during the first phase of the NMP2 venting strategy for an ELAP. The HCVS battery was sized in accordance with Institute of Electrical and Electronics Engineers (IEEE) Standard 485-2010, "IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications," which is endorsed by Regulatory Guide 1.212, "Sizing of Large Lead-Acid Storage Batteries," published in 2015. The licensee's evaluation identified the required loads and their associated ratings (watts (W) and minimum system operating voltage). The licensee's battery sizing calculation showed that based on 2.3 amperes of loading for a 24-hour duty period, a 90.3 A-H battery is required to satisfy the necessary battery duty cycle and end-of cycle battery terminal voltage requirements. The battery selected by the licensee has a capacity of 104 A-H, which is more than the minimum required (90.3 A-H). Therefore, the NMP2 HCVS battery should have sufficient capacity to supply power for at least 24 hours.

The licensee's strategy includes repowering the HCVS battery chargers within 24 hours after initiation of an ELAP. The licensee's strategy relies on one of two portable 450 kilowatt (kW) FLEX DGs. Only one of the FLEX DGs is required for the HCVS electrical strategy. The 600 Vac FLEX DG would provide power to the HCVS load in addition of loads addressed under Order EA-12-049. The licensee also has 120 Vac portable generators available to repower the HCVS battery chargers.

The NRC staff audited licensee calculation EC-206, "600 VAC FLEX Phase II Portable 450KW Diesel Generator Sizing Calculation," Revision 0 (minor dated 5-4-16), which incorporated the HCVS loads on the FLEX DG. The loads added include an HCVS battery charger and oxygen monitor. These loads combine for a total of 3.1 kVA. The total load on the FLEX DG including the HCVS is 493.2 kVA. Based on its audit of calculation EC-206, the NRC staff concludes that the 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 450 kW FLEX DG was addressed under Order EA-12-049. Licensee procedure N2-DRP-FLEX-ELEC, "Emergency Damage Repair - BDB/FLEX Generator Deployment Strategy," Revision 3, provides guidance to power 600 Vac buses from the FLEX DGs to power the HCVS battery chargers. Procedure N2-DRP-FLEX-ELEC also provides guidance to power the HCVS battery chargers from a 120 Vac portable generator.

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 stated that the emergency operating procedures (EOPs)/Emergency Response Guidelines provide clear guidance to operators that the HCVS is not to be used to defeat containment integrity during any design basis transients and accident. In addition, the HCVS was designed to provide features that 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 containment isolation valves must be opened to permit vent flow. The physical features that prevent inadvertent actuation are the key lock switches for 2(3)-1604-1, 2(3)-1604-1 OA, 2(3) 1604-20A, and 2(3)-1605-25A at the 902(3)-13 panel in the MCR and locked closed valves at the ROS.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design, with respect to prevention of inadvertent actuation, 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.

3.1.2.8 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 in 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 Radiation; HCVS Effluent Pressure; HCVS Valve Position; HCVS dc Voltage; HCVS Pneumatic Supply Pressure; HCVS Purge System Pressure; Containment Pressure; Torus Pressure; and Torus Level. The staff notes that Containment Pressure, Torus Pressure and Torus Level are declared NMP2 PAM variables as described in Regulatory Guide 1.97, "Criteria for Accident Monitoring Instrumentation for Nuclear Plants," 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 audited the licensee's evaluation in ECP-13-000087-103-02, Revision 6 and confirmed that the HCVS instrumentation should have the ability to support HCVS venting operations and be 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 in 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 Temperature; HCVS Effluent Radiation; and HCVS Effluent Pressure. The NRC staff found that the effluent radiation monitor provides sufficient range to adequately indicate effluent discharge radiation levels. In Section 1.2.9 of its FIP, the licensee described the ion chamber detector installed at 306'-6" elevation of the RB with a process and control module in the RB Track Bay ROS with local indication and a remote indicator in the MCR. The licensee stated that the detector is qualified for anticipated environment at the vent pipe during accident conditions. The licensee further stated that the process and control module is qualified for conditions in the ROS in the RB Track Bay. The NRC staff reviewed the qualification summary information provided in Table 1 of the FIP and found it was acceptable.

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 pumps and FLEX DG will be staged outside so they will not be adversely impacted by a loss of ventilation.

As discussed above in Section 3.1.1.2, the licensee performed calculation ES-289, "Reactor Building Thermal Response Following an Extended Loss of AC Power," Revision 1, which predicts the temperature profile in the RB following an ELAP. The licensee determined that the temperature on the 261' elevation, where the ROS and HCVS batteries / battery charger is located, is expected to remain below 120°F. The licensee plans to implement passive cooling actions such as opening specified doors in the RB and turbine building. This action is expected to create a natural circulation vent path through the upper levels of the reactor building, which would help to minimize the temperature rise within the reactor building. Licensee procedures N2-SOP-02, "Station Blackout/Extended Loss of AC Power Support Procedure," Revision 11 and N2-DRP-FLEX-MECH, "Emergency Damage Repair – BDB/FLEX Pump Deployment Strategy," Revision 3 provide guidance to open doors in the reactor building at elevations 261', 353', and 427'.

Based on the above, the NRC staff concludes that the licensee's ventilation strategy should be able to maintain the RB temperature on the 261' elevation in the area of the HCVS battery within the maximum temperature limit (122°F) specified by the battery manufacturer (Exide

Technologies). Therefore, the NRC staff concludes that the HCVS equipment located in the RB should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

Radiological

The licensee's calculation H21C-114, "Hardened Containment Vent System (HCVS) Radiological Dose Analysis" (as amended by ECP-17-000280-CN-001 H21C-114), documents the dose assessment for both personnel habitability and equipment locations associated with event response to a postulated ELAP condition. The NRC staff's review of H21C-114 found 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 staff's review concludes 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, 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.

3.1.2.11 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 31], which provides methods to address control of flammable gases. One of the acceptable methods described in the white paper is the installation of an active purge system (Option 3) that ensures the flammability limit of gases passing through the system are not reached.

In its FIP, the licensee stated that in order to prevent a detonable mixture from developing in the pipe, a purge system is installed to purge hydrogen from the pipe with argon after a period of venting. Prior to operating the purge system, valves need to be properly aligned. Valve 2CPS*V169 is to be unlocked and opened, valves 2CPS-V160A-H are to be opened, vent valve 2CPS-V165 is to be closed, and three-way valve 2CPS*V168 is to be unlocked and repositioned into the "PURGE" position. Once aligned, purge operations can be performed from MCR panel 2CEC-PNL801 using 2CPS-SOV140. The argon purge system is utilized to provide the pressure needed to burst the rupture disc. The installed capacity for the argon purge system has been sized for six purges within the first 24 hours of the ELAP. Evaluation N2-MISC-003, "MAAP Analysis to Support SAWA Strategy," Revision 0, shows that in a severe accident, NMP2 would not be expected to exceed 6 vent cycles in the first 24-hour period. The licensee performed evaluation A10.1-P-053, "Hardened Containment Vent Purge System Design Calculation," Revision 0, which computes the number of purge cycles that can be achieved per argon bottle, as well as the purge rate required to adequately prevent a combustible mixture of air and hydrogen. The calculation determined that a 10-second purge time is required to burst the rupture disc; and a 45-second purge time has been calculated for purging the combustibles after a vent cycle. The design allows for argon bottle replacement for continued operation past 24 hours. The MCR panel will include an indication of vent line pressure upstream of the disc to show when the disc has burst due to the increased argon pressure. The NRC staff confirmed that the licensee's design appears to be consistent with Option 3 of white paper HCVS-WP-03. The NRC staff also audited the licensee's analysis and confirmed the installed purge system capacity is sufficient.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design should ensure 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 RB 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 above in Section 3.2.1.3, the only interfacing system with the HCVS is the SGTS and there are two parallel interface isolation valves separating the SGTS and the HCVS discharge piping. The interface valves between the HCVS and the SGTS are normally-closed, fail-closed (spring and solenoid operated) valves. Upon initiation of an ELAP and associated loss of instrument air, the valves would automatically shut due to spring pressure or loss of power to the solenoid. Therefore, no additional power is necessary. These boundary valves are located at a high point of the SGTS piping. When closed, the leakage is minimized. At slow leakage rates, there would be no motive force to move any accumulated hydrogen away from the high point of the piping, thereby preventing a combustible mixture in any areas of the RB. A test connection was added downstream of the boundary valves to facilitate 10 CFR 50, Appendix J-type testing of the interface valves. Testing and maintenance will be performed to ensure that the valves remain leak-tight within established leakage criteria. The NRC staff's review confirmed that the design appears to be consistent with the guidance and that the proposed design will 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 should minimize 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 in HCVS-FAQs-05 and -06.

In the FIP, Table 3-3 includes testing and inspection requirements for HCVS components. The NRC staff reviewed Table 3-3 and found that it appears to be consistent with Section 6.2.4 of

NEI 13-02, Revision 1. Implementation of these testing and inspection requirements for the HCVS should 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 utilizes the standard Electric Power Research Institute 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 should allow 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 second containment isolation valve (2CPS*AOV111) and penetrations are not being modified for order compliance. The design is consistent with the design basis of primary containment including pressure, temperature, radiation, and seismic loads.

During the audit period, the licensee provided a discussion on the operations of the existing containment isolation valves 2CPS*AOV109 and 2CPS*AOV111 relied upon for the HCVS. The licensee also discussed the HCVS containment pressure control valve (2CPS-AOV134) located downstream of the containment isolation valves, which was added to control vent flow after the containment isolation valves are opened during a BDBEE. The licensee performed calculations A10.1-P-047, "Component Level Assessment for Drywell Purge Exhaust Inboard and Outboard Isolation Valves 2CPS*AOV109 & 2CPS*AOV111," Revision 2, and A10.1-P-052, "Component Level Assessment for HCVS Isolation Valve 2CPS-AOV134," Revision 0, to determine actuator capability and margin calculations using the Sargent & Lundy AirBase software program for the three AOVs. The NRC staff reviewed these licensee calculations and confirmed that the AOVs can open under the maximum expected differential pressure (MEDP) during BDBEE and severe accident wetwell venting, as described below.

Under an ELAP or for severe accident wetwell venting the subject valves are closed and without their normal supply of air power. Prior to exceeding the PCPL, operators open the valves remotely using the dedicated HCVS batteries and nitrogen bottles. The MEDP is determined based on assuming the maximum upstream pressure is equal to the PCPL of 45 psig and by conservatively using a downstream pressure equal to vacuum pressure (-14.7 psig) since exhausting steam may condense in the HCVS line, creating a negative pressure. Thus, the MEDP used in the calculations is 59.7 pounds per square inch differential.

Calculation A10.1-P-047 for 2CPS*AOV109/111 shows actuator torque required versus actuator torque available margins for the closed to full open stroke in the range of 49 percent to 189 percent. Calculation A10.1-P-052 for 2CPS-AOV134 shows margins from the closed to full open stroke in the range of 78 percent to 233 percent. The licensee's calculations demonstrate that there is positive margin in the opening direction.

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design, with respect to component qualifications, 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.

3.2.2 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 that is capable of ensuring HCVS functionality following a seismic event. These items include electrical power supply, valve actuator pneumatic supply, and instrumentation (local and remote) components. Relevant guidance is found in NEI 13-02, Sections 5.2 and 5.3.

In its FIP, the licensee states 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 structures. 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 has 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.

New components related to HCVS operation are required to be designed to operate following a seismic event. During the audit period, the licensee discussed that most equipment came qualified or evaluated by the vendor. However, some equipment was purchased as commercial grade (non-safety related) and was shake tested in order to prove the components' ability to withstand a bounding seismic event. The licensee provided several reports that demonstrate the seismic adequacy of the HCVS components. Qualification/evaluation documentation provided by the vendor or results from shake tests were compiled into a single report for HCVS dedicated equipment (VENRPT-15-000013) with the exception of separate seismic design reports for the PCIVs and HCVS pressure control valve 2CPS-AOV134. Table 1 of the FIP contains a list of components and instruments required to operate the HCVS, their qualification and evaluation against the expected conditions. 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.

In accordance with the design requirements, the HCVS components and their supports must remain functional post seismic and tornado events. For the tornado event, both tornado wind and missile impact must be considered. In the FIP, the licensee described that HCVS components are located in the RB, Control Building, and RB Track Bay. According to the NMP2 Updated Final Safety Analysis Report (UFSAR), Table 3.2-1 and UFSAR, Section 3.8.4.1.9, the RB Track Bay is a seismic, tornado-protected structure. In addition, the outer track bay doors are designed to withstand tornado missiles. The NRC staff confirmed that the location of HCVS components in the RB, Control Building, and RB Track Bay are in safety-related, seismic class I structures, and determined that the HCVS components are protected from and will not fail during a safe shutdown earthquake (SSE) or tornado missile strike.

The only portion of the HCVS system not contained within a seismic, missile protected structure is the vent pipe external to the RB. However, the external piping meets the tornado reasonable protection criteria of HCVS-WP-04. All external components are limited to large bore piping and its supports, are located above 30' from ground level, and the piping cross section is less than 300 square feet. The vent pipe penetration through the RB wall is protected from a direct missile which would have any chance of entering the RB by the steam tunnel vent hood which is located in front of the penetration.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design, with respect to component reliability and rugged performance, 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.

3.3 Conclusion 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, 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.

4.0 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. Nine Mile Point, Unit 2 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 Additions

The licensee plans to use the portable, diesel-driven FLEX pump to provide severe accident water addition (SAWA) flow. The pump discharge to a FLEX (SAWA) manifold, which will direct flow to the residual heat removal (RHR) system and then into the reactor pressure vessel (RPV). Since operators will use the FLEX diesel generator to power SAWA instrumentation and realign RHR motor-operated valves (MOVs), they will have to deploy, connect, and power up the FLEX DG prior to initiating SAWA flow. To minimize operator exposure to hazardous radiological conditions, Procedure N2-SOP-01 directs operators to deploy hoses and make connections in the RB first, then make the remaining necessary connections. The other SAWA actions take place outside the RB and are in locations shielded from the severe accident radiation by the thick concrete walls of the RB. Once SAWA flow is initiated, operators will have to monitor and maintain SAWA flow and ensure refueling 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 injection flow path starts from the FLEX suction at the intake structure for the plant UHS through the SAWA (FLEX) pump to the FLEX/SAWA manual manifold having connections for the SAWA pump and the hose that will deliver SAWA flow to the RPV. This valve manifold will also provide minimum flow and freeze protection for the pump. From this valve manifold, the hose will be routed to the permanent SAWA connection points located on the inside of the RB on the A or B loop of the RHR system via the low pressure coolant injection (LPCI) valves 2RHS*MOV24A/B. Once the SAWA components are deployed and connected, the SAWA flow path is controlled at the valve manifold. Backflow prevention is provided by check valves installed in the LPCI system which are leak tested using the existing leakage testing programs. Cross flow into other portions of the RHR system will be isolated by ensuring closure of the motor-operated valves from the MCR. Drywell pressure and suppression pool level will be monitored and flow rate will be adjusted by use of the FLEX (SAWA) pump control valve at the valve manifold that also contains the SAWA flow indication. Alternately, the flow indication and flow control may be from the pump discharge. Communication will be established between the MCR and the SAWA flow control location, which is discussed below in Section 4.2 of this SE.

4.1.1.2 SAWA Pump

The licensee plans to use a portable pump to provide SAWA flow to both units. In its FIP, the licensee described the hydraulic analysis performed to demonstrate the capability of one of the two available portable FLEX pumps to provide the required 300 gallons per minute (gpm) of SAWA flow to the unit while simultaneously providing 30 gpm to the spent fuel pool (SFP). During the audit, the staff reviewed calculation A10.1-A-016, "Hydraulic Analysis of NMP2 FLEX Water Makeup to the RPV and SFP," Revision 1, which determined that the required SAWA flowrate of 300 gpm was within the capacity of the portable FLEX pumps.

The NRC staff audited the flow rates and pressures evaluated in the hydraulic analyses and confirmed that the equipment is capable of providing the needed flow rates. Based on the NRC staff's audit of the FLEX pumping capabilities, as described in the above hydraulic analyses and the FIP, it appears that the licensee has demonstrated that its portable FLEX pump should perform as intended to support SAWA flow.

4.1.1.3 SAWA Analysis of Flow Rates and Timing

The licensee performed a plant-specific Modular Accident Analysis Program (MAAP) analysis (N2-MISC-003, Revision 2) to establish an initial SAWA flow rate using parameters of an initial flow of 300 gpm starting at 8 hours followed by 100 gpm from 14 hours to 168 hours, and a total freeboard volume of 782,000 gallons. The MAAP analysis demonstrates that the plant is bounded by the reference plant analysis, described in NEI 13-02, Section 4.1.1.2.1, and that the SAWM strategy is successful in making it unlikely that a drywell vent is needed to prevent containment failure.

The NRC staff audited calculation N2-MISC-003. Calculation Cases 2 through Case 2d address SAWA and the ability to maintain containment integrity. All cases assume wetwell venting at 45 psig. Cases 2, 2a, and 2d assume 300 gpm water addition at 8 hours followed by a reduction to 100 gpm 6 hours later. Case 2b assumed 500 gpm water addition at 8 hours followed by a reduction to 100 gpm 4 hours later. All cases show that sufficient water is added to maintain or increase the water level in the suppression pool and demonstrate a successful SAWA strategy. The calculation demonstrated that the containment integrity will be maintained.

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.

4.1.2 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has developed SAWA 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.

4.2 Severe Accident Water Management

The strategy for NMP2 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; SAWM consists of flow control at the FLEX (SAWA) valve distribution manifold cart along with instrumentation and procedures to ensure that the wetwell vent is not submerged (SAWM). Procedures have been issued to implement this strategy including Revision 3 to the Severe Accident Management Guidelines (SAMG). This strategy has been shown via MAAP analysis to protect containment without requiring a drywell vent for at least seven days, which meets the guidance from NEI 13-02 for the period of sustained operation.

The SAWA system consists of a SAWA pump injecting into the RPV (discussed above). SAWM consists of flow control at the FLEX (SAWA) valve distribution manifold in the RB Track Bay along with wetwell level indication in the MCR, to ensure that the wetwell vent is not submerged (SAWM). Water from the SAWA (FLEX) pump will be routed through the FLEX (SAWA) valve distribution manifold to the RHR system. This RHR connection allows the water to flow into the RPV. Throttling valves and flow meters will permit water flow to maintain wetwell availability. Boiling-Water Reactors Owners Group (BWROG) generic assessment, BWROG-TP-15-008 [Reference 32], provides the principles of SAWA to ensure protection of containment.

In its FIP, the licensee discussed the adequate communication between the MCR and the operator at the FLEX manual valve during severe accident conditions. Procedure CC-NM-118 "Site Implementation of Diverse and Flexible Coping Strategies (FLEX) and Spent Fuel Pool Instrumentation Program," Revision 1, provides communications protocol for BDBEE along with procedure N2-OP-76, "Plant Communications," Revision 3. Nine Mile Point, Unit 2 utilizes the installed sound powered headset system and/or the 450 MHz radios in the talk around mode to communicate between the MCR and the SAWA flow control location. These communication methods are consistent with FLEX communication practices at NMP2 and have been previously reviewed and accepted by the NRC staff under Order EA-12-049. These items will be powered and remain powered using the same methods as evaluated under EA-12-049 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 normal suppression pool water level of 200 feet and 217 feet elevation in the wetwell provides approximately 782,000 gallons of water volume before the level instrument would be off scale high. Generic assessment BWROG-TP-15-011 [Reference 33], 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 low while wetwell level is stable or very slowly rising. For NMP2, the SAWA flow rate is 300 gpm for first 6 hours followed by 100 gpm until an alternate means of removing reactor decay heat can be implemented. Calculation N2-MISC-003 shows the suppression pool water level reaching approximately 35 feet (elevation 211 feet) over the course of the 7-day event, resulting in 6 feet (or 276,000 gallons) of freeboard level to the limit of the level instrument at 217 feet and 16 feet of freeboard to the inlet of the HCVS vent pipe at 227 feet. The NRC staff reviewed the information provided and concurs that the flow of water added to the suppression pool can be controlled such that the wetwell vent remains operational.

4.2.1.2 Strategy Time Line

As noted above, the SAWA/SAWM strategy is based on BWROG generic assessments in BWROG-TP-15-008 and BWROG-TP-15-011. NMP2 performed a site-specific evaluation (N2-MISC-003) to justify the use of an initial SAWA flow rate of 300 gpm. This initial flow rate will be established within 8 hours of the loss of all RPV injection following an ELAP/severe accident and will be maintained for 6 hours before reduction to the wetwell vent preservation flow rate. 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. MAAP version 5.03 was used to perform this site-specific evaluation and the results demonstrate that SAWA flow could be reduced to 100 gpm after 6 hours of initial SAWA flow rate and containment would be protected. A sensitivity case using 500 gpm for 4 hours was also performed and found that the containment response for the base case (300 gpm for 6 hours) is virtually the same as the sensitivity case (500 gpm for 4 hours). At some point, the wetwell level will begin to rise indicating that the SAWA flow is greater than the steaming rate due to containment heat load such that flow can be reduced. 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.

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 above, the licensee plans to use portable diesel-driven pumps to provide SAWA flow. Operators will refuel the pump and DGs in accordance with Order EA-12-049 procedures using fuel oil from the installed emergency diesel generator (EDG) fuel oil storage tanks. Procedure S-DRP-OPS-004, "Refueling Portable Diesel Equipment," Revision 1, directs operators to refuel the portable FLEX equipment from the onsite EDG fuel oil storage tanks. The licensee states in its FIP that refueling will be accomplished in areas that are shielded and protected from the radiological conditions during a severe accident scenario. Additionally, the licensee states in the FIP that S-DRP-OPS-004 contains precautions not to refuel during venting operations. The fuel tank on the SAWA pumps are sized such that the pumps can run for approximately 14 hours prior to needing to be refueled.

4.3.1.2 DG Loading Calculation for SAWA/SAWM Equipment

In its FIP, the licensee lists wetwell (suppression chamber) pressure, suppression pool level, drywell pressure, and the SAWA flow as instruments required for SAWA and SAWM implementation. The wetwell (suppression chamber) pressure and suppression pool (primary containment) level 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 from internal lithium 3.6-volt batteries with a battery life of 10 years.

The NRC staff audited licensee analysis EC-203, "Battery 2BYS*BAT2A and 2BYS*BAT2B Load Shed Coping Time for ELAP Event," Revision 0, which verified the capability of the Class 1E station batteries to supply power to the required loads (e.g. wetwell pressure, suppression pool level, and drywell pressure instruments) during the first phase of the NMP2 FLEX mitigation strategy plan for an ELAP event. The NRC staff also audited licensee calculation EC-206, which verified that the 450kW FLEX DG is adequate to support the addition of the HCVS electrical loads.

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 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.

4.4 SAWA/SAWM Instrumentation

4.4.1 Staff Evaluation

4.4.1.1 SAWA/SAWM Instruments

In Section IV.C.10 of its FIP, the licensee stated that the instrumentation used to implement the SAWA strategy are wetwell level, containment pressure and SAWA flow meter.

4.4.1.2 Describe SAWA Instruments and Guidance

In Section IV.C.10.2 of its FIP, the licensee stated that the containment 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, in part, that these instruments are used to maintain the wetwell vent in service while maintaining containment pressure and that these instruments are backed by the station 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 portable digital based electromagnetic flow meter installed on the SAWA valve distribution manifold cart and self-powered by internal batteries.

4.4.1.3 Qualification of SAWA/SAWM Instruments

Containment pressure and wetwell level are declared NMP2 PAM variables as described in Regulatory Guide 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 Regulatory Guide 1.97 variables in the NMP2 UFSAR.

The SAWA flow meter is attached to the SAWA flow manifold cart and will be deployed in the RB elevation 261' near the ROS. The licensee stated in Table 1 of its FIP that anticipated temperature at this location is 50°F-120°F and the qualification temperature range is -5°F to 140°F. The licensee stated in Table 1 of its FIP that the flow meter is qualified up to 1E3 Rad Total Integrated Dose and the anticipated radiation environment in this location is less than 1 Rad. The NRC staff determined 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 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.

4.5 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 performed a detailed radiological analysis documented as H21C-114, "Hardened Containment Vent System (HCVS) Radiological Dose Analysis as amended by ECP-17-000280-CN-001 H21C-114." This calculation analyzed the dose at different locations and times where operator actions will take place during FLEX/SAWA/SAWM activities. The analyzed locations include the POS, ROS, and travel paths for hose routing.

In its FIP, the licensee states that the SAWA pumps are stored in the FLEX Storage Building and will be operated from outside the RB behind the screenwell building. The NRC staff agrees 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 licensee also states that the SAWA flow path inside the RB consists of stainless steel piping that will be unaffected by the radiation dose and 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 reviewed the information and agrees that the SAWA flow path appears to 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 NMP2's SAWA strategy relies on three instruments: wetwell level; containment pressure; and SAWA flow. Containment pressure and wetwell level are declared NMP2 PAM variables as described in Regulatory Guide 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 stated in Section 4.5.1.1, the SAWA pump will be operated outside the RB, behind the screenwell building. This location ensures that there will be no adverse effects from radiation exposure to the flow instruments mounted on the SAWA pump trailer. The licensee has chosen low dose areas for the FLEX/SAWA manifold flowmeters to ensure that their operation will not be adversely affected by radiation exposure. Based on this information, the NRC staff concurs 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

In its FIP, the licensee indicated that accessing HCVS equipment following an external event that results in an ELAP will subject the operator to prevailing area temperatures. The majority of the operator travel path from the MCR to the ROS is outdoors. Therefore, the travel path does not pose any habitability concerns, with respect to temperature. The MCR and ROS are expected to remain habitable, with respect to temperature, during the event. Environmental conditions in the control room and the ROS were discussed previously in Section 3.1.1.2, Personnel Habitability – Environmental. Based on the above, the NRC staff agrees that the environmental conditions should not prevent operators from implementing the SAWA or SAWM strategies.

The licensee performed calculation H21C-114, "Hardened Containment Vent System (HCVS) Radiological Dose Analysis as amended by ECP-17-000280-CN-001 H21C-114," which documents the dose assessment for designated areas inside the NMP2 RB (outside of containment) and outside the NMP2 RB 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 access 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 concludes, based on an audit of the licensee's detailed evaluation that the 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 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.

4.6 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, 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.

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 reviewed 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 appears 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, 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.

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 appears to be 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, 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.

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 13], an ISE for implementation of Phase 2 requirements on August 25, 2016 [Reference 14], and an audit report on the licensee's responses to the ISE open items on October 17, 2017 [Reference 15]. The licensee reached its final compliance date on May 12, 2018 [Reference 16], and has declared that Nine Mile Point Nuclear Station, Unit 2 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, and, if implemented appropriately, should adequately address the requirements of Order EA-13-109.

6.0 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)

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Date: October 11, 2018

SUBJECT: NINE MILE POINT NUCLEAR STATION, UNIT 2 - SAFETY EVALUATION REGARDING IMPLEMENTATION OF HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS RELATED TO ORDER EA-13-109 DATED October 11, 2018

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