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

February 6, 2019

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 1 - SAFETY EVALUATION REGARDING IMPLEMENTATION OF HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS RELATED TO ORDER EA-13-109 (CAC NO. MF4481; 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 1 (NMP1) 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 NMP1, 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 March 26, 2015 (Phase 1) (ADAMS Accession No. ML15069A671), August 30, 2016 (Phase 2) (ADAMS Accession No. ML16231A452), and October 30, 2017 (ADAMS Accession No. ML17299A781), the NRC issued Interim Staff Evaluations (ISEs) and an audit report, respectively, on the licensee's progress. By letter dated August 20, 2018 (ADAMS Accession No. ML18232A109), the licensee reported that NMP1 is in full compliance with the requirements of Order EA-13-109, and submitted a Final Integrated Plan (FIP) for NMP1.

The enclosed safety evaluation provides the results of the NRC staff's review of NMP1's hardened containment vent design and water management strategy for NMP1. The intent of the safety evaluation is to inform NMP1 on whether or not its integrated plans, if implemented as described, appear to adequately address the requirements of Order EA-13-109. The staff will evaluate implementation of the plans through inspection, using Temporary Instruction 2515-193, "Inspection of the Implementation of EA-13-109: Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions" (ADAMS Accession No. ML17249A105). This inspection will be conducted in accordance with the NRC's inspection schedule for the plant.

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

Sincerely,

Brett Titus

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

Docket No. 50-220

Enclosure:
Safety Evaluation

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO ORDER EA-13-109

EXELON GENERATION COMPANY, INC.

NINE MILE POINT NUCLEAR STATION, UNIT 1

DOCKET NO. 50-220

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" (the Order). 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 1 (NMP1, Nine Mile Point) 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 accordance

Enclosure

with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" [Reference 12]. By letters dated March 26, 2015 (Phase 1) [Reference 13], August 30, 2016 (Phase 2) [Reference 14], and October 30, 2017 [Reference 15], the NRC issued Interim Staff Evaluations (ISEs) and an audit report, respectively, on the licensee's progress. By letter dated August 20, 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

Nine Mile Point, Unit 1 is a General Electric BWR with a Mark I primary containment system. To implement the Phase 1 requirements of Order EA-13-109, the licensee utilized existing containment vent and purge system piping from the suppression chamber and attached new piping to route the HCVS effluent outside the reactor building and up to a point above the reactor building roof. The HCVS is initiated via manual action at the remote operating station (ROS) combined with control from either the auxiliary control room (ACR) or the ROS at the appropriate time based on procedural guidance in response to plant conditions from observed or derived symptoms. The ACR is located one elevation below the main control room (MCR) and is connected to the MCR by an open stairway within the MCR envelope.

The ROS provides backup manual operation of the HCVS valves and purge system as required by the order. The HCVS performance is monitored using containment pressure and wetwell water level along with valve position and HCVS vent line temperature and effluent radiation monitoring. The HCVS motive force is monitored and has the capacity to operate for at least 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 are capable of being maintained for a sustained period of at least 7 days.

3.1 HCVS Functional Requirements

3.1.1 Performance Objectives

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

3.1.1.1 Operator Actions

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

In its FIP, the licensee stated that operation of the HCVS is initiated via manual action at the ROS combined with control from either the ACR or the ROS at the appropriate time based on procedural guidance in response to plant conditions from observed or derived symptoms. The ACR is located one elevation below the MCR and is connected to the MCR by an open stairway within the MCR envelope. After initial valve line-up at the ROS, the vent system can be operated and monitored from the ACR. The HCVS can also be operated manually from the ROS. A list of the remote manual actions for plant personnel to open the HCVS vent path is provided in Table 3-1, "Operation Actions Table," of the FIP.

The HCVS operation is monitored by HCVS valve position, vent line temperature, and effluent radiation levels. The vent utilizes containment parameters of pressure and level from the MCR instrumentation to monitor the effectiveness of the venting actions. The HCVS pneumatic motive force and electrical supply are also monitored and have the capacity to operate for 24 hours with installed equipment. Replenishment of the motive force will be by use of portable equipment once the installed motive force is exhausted. Venting actions are capable of being maintained for a sustained period of at least 7 days.

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

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

3.1.1.2 Personnel Habitability – Environmental

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

In its FIP, the licensee stated that the primary control of the HCVS is accomplished from the ACR. FLEX actions that will maintain the MCR/ACR and ROS habitable were implemented in response to NRC Order EA-12-049. These actions include:

- Blocking open selected doors;
- Opening a turbine building roof hatch; and
- Opening side wall vents.

The heat load in the MCR/ACR can also be reduced by removing the plant process computer from service by shutting down the uninterruptible power supply (UPS). 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/evaluations demonstrate that the final design meets the order requirements to minimize the plant operators' exposure to occupational hazards.

The NRC staff audited the room heat-up evaluations for the MCR/ACR under Order EA-12-049 compliance and documented in the NRC safety evaluation [Reference 34] that the licensee has developed a plan that, if implemented appropriately, should maintain or restore equipment and personnel habitability conditions following a BDBEE consistent with NEI 12-06 guidance as endorsed by JLD-ISG-2012-01. The NRC staff also reviewed FIP Table 2. No environmental conditions were identified which could inhibit operators from taking the required actions.

Alternate control of the HCVS is accomplished from the ROS located at the 261' elevation in the turbine building. The licensee performed calculation S10HVACHV11 "Turbine Building Minimum and Maximum Temperatures," Revision 1. The NRC staff audited the calculation and the Design Consideration Summary engineering change package (ECP)-13-000086-103, Revision 3. The calculated maximum ROS temperature is estimated to be 99.3 degrees Fahrenheit (°F). Based on these evaluations, the NRC staff agrees that the temperature conditions should not inhibit operator actions needed to initiate and operate the HCVS during an extended loss of ac power (ELAP) with severe accident conditions.

The FIP also states that an oxygen monitor has been installed in the ROS area, near the argon and nitrogen bottles, due to the potential to create an oxygen deficient hazard (ODH). The oxygen monitor will alert any personnel in the area when the oxygen concentration is below 19.5 percent, which is the minimum allowable oxygen concentration, as defined by the Occupational Safety and Health Administration. The monitor is equipped with a back-up power supply from the primary FLEX electrical strategy so that it will remain functional during an ELAP.

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

3.1.1.3 Personnel Habitability – Radiological

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

The licensee performed calculation H21C-115, "Hardened Containment Vent System (HCVS) Radiological Dose Analysis," which documents the dose assessment for designated areas inside the NMP1 reactor building (outside of containment) and outside the NMP1 reactor building caused by the sustained operation of the HCVS under the beyond-design-basis severe accident condition of an ELAP. Calculation H21C-115 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 and will not exceed 10 Roentgen equivalent man (rem)[2]. The calculated 7-day dose due to HCVS operation is a conservative maximum integrated radiation dose over a 7-day period with 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 in the auxiliary 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

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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

Environmental Protection Agency (EPA) Protective Action Guides (PAG) Manual, EPA-400/R-16/001, "Protective Action Guides and Planning Guidance for Radiological Incidents," provides emergency worker dose guidelines. Table 3.1 of EPA-400/R-16/001 specifies a guideline of 10 rem for the protection of critical infrastructure necessary for public welfare, such as a power plant, and a value of 25 rem for lifesaving or for the protection of large populations. The NRC staff further notes that during an emergency response, areas requiring access will be actively monitored by health physics personnel to ensure that personnel doses are maintained as low as reasonably achievable.

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

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

3.1.1.4 HCVS Controls and Indications

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

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

In its FIP, the licensee stated that primary control is accomplished from the auxiliary control room and alternate control is accomplished from the ROS. The licensee also provided, in Table 1 of its FIP, a list of the controls and indications including the locations, anticipated environmental conditions, and the environmental conditions (temperature and radiation) to which each component is qualified.

The NRC staff reviewed the information included in the FIP and examined the information provided in Table 1. The NRC staff determined that the controls and indications appear to be consistent with the NEI 13-02 guidance. The NRC staff noted that the Regulatory Guide (R.G.) 1.97 instruments for containment pressure, wetwell pressure, and wetwell level did not have qualification information listed in Table 1, but are considered acceptable for severe accident conditions, in accordance with the NEI 13-02 guidance, based on the original qualification.

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

3.1.2 Design Features

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

3.1.2.1 Vent Characteristics

Order EA-13-109, Attachment 2, Section 1.2.1 requires that the HCVS has the capacity to vent the steam/energy equivalent of one percent of licensed/rated thermal power (unless a lower value is justified by analyses), and be able to restore and then maintain containment pressure below the primary containment design pressure and the primary containment pressure limit. Relevant guidance is found in NEI 13-02, Section 4.1.1.

The licensee performed Design Consideration Summary ECP-13-000086-103, Revision 3, to address the ability of the wetwell to absorb heat from the reactor core. Attachment B of the calculation determined that the energy released for three hours following the reactor trip is 2.9×10^8 British Thermal Units (BTUs). The calculation concluded that the heat absorption capacity of the suppression pool is at least 6.3×10^8 BTUs.

The licensee also performed calculation S22.4-201.13F004, "Hardened Containment Vent Capacity," Revision 0, to verify the 1 percent power flow capacity at the wetwell design pressure (35 pounds per square gauge (psig)). The analysis was performed using a RELAP5 computer model created for the HCVS piping and fittings. The RELAP5 code simulates 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 NMP1 HCVS design was evaluated considering pipe diameter, length, and geometry as well as vendor-provided valve coefficients of flow and the losses associated with a burst rupture disc. At 1 percent reactor thermal power, the required vent capacity is 68,303 pounds mass per hour (lbm/hour). The vent capacity is 63,259 lbm/hr at a wetwell pressure of 25 psig, 71,658 lbm/hr at a wetwell pressure of 30 psig, and 79,859 lbm/hr at a wetwell pressure of 35 psig. Calculation S22.4-201.13F004 concludes that the design provides margin to the minimum required flow rate. Updated Final Safety Analysis Report (UFSAR) Section VI.B.2.1 lists the design limits for the drywell as 62 psig and 310°F and 35 psig and 205°F for the wetwell.

The FIP also notes that the decay heat absorbing capacity of the suppression pool and the selection of venting pressure were made such that the HCVS will have sufficient capacity to maintain containment pressure at or below the wetwell design pressure (35 psig), which is lower than the primary containment pressure limit (PCPL) (43 psig). The containment response calculation is contained in Modular Accident Analysis Program (MAAP) calculation N1-MISC-004, "NMP1 – MAAP Analysis to Support SAWA Strategy," Revision 2, which shows that containment is maintained below the design pressure once the vent is opened, even if it is not opened until containment pressure reaches the PCPL. The NRC staff audited the licensee's evaluations and confirmed that the HCVS vent design should support the capacity to vent one 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, if implemented appropriately, appear to be consistent with NEI 13-02 guidance,

as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.2.2 Vent Path and Discharge

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

The NRC staff evaluated the HCVS vent path and the location of the discharge. The HCVS taps into the existing containment vent and purge system piping between the wetwell and the containment vent and purge inboard primary containment isolation valve (PCIV). Two new PCIVs are provided for the HCVS. Downstream of the second isolation valve is a rupture disk which serves as a secondary containment boundary. The vent piping will exit the reactor building on the northeast side of the reactor building roof. All effluents are exhausted above the unit's reactor building. This discharge point at the 402' elevation was extended approximately 3 feet above the reactor building parapet wall. This is consistent with the guidance provided for vent height in HCVS-FAQ-04. The release point is on the northeast side of the reactor building and a minimum of 25 feet from the reactor building and turbine building HVAC exhaust ductwork. Since the effluent release velocity of the vent exceeds 8000 feet per minute, it is assured that the effluent plume will not be entrained into the ambient wind recirculation zone of the turbine building, reactor building, emergency response facilities (Technical Support Center) or ventilation system intakes, and open doors used for natural circulation in the BDBEE response. Therefore, the vent pipe discharge point meets the HCVS-FAQ-04 guidance ensuring that vented fluids are not drawn immediately back into any emergency ventilation intakes.

During the audit, the licensee provided a description of the seismic design for the HCVS stack. The HCVS vent piping system has been evaluated to Seismic Category I requirements in pipe stress calculations S22.4-201.1P002, "HCVS Piping for Torus Attached Piping," and S22.4-201.13P003, "HCVS Piping for Non-Torus Attached Piping," which is consistent with the plants seismic design basis to comply with NEI 13-02, Section 5.2, seismic design guidance.

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 in the ECP consistent with HCVS-WP-04. The conclusion of the evaluation is that NMP1 meets all of the tornado missile assumptions identified in HCVS-WP-04 and, as such, supplementary protection is not required for the HCVS piping and components.

The NRC staff audited the above referenced calculations along with ECP-13-000086-103, "Engineering Change Package Design Consideration Summary." The licensee credits the NEI 13-02, Section 5.1.1.6, approach to wind-borne missiles in that the HCVS is enclosed within a Seismic Category 1 building. The licensee also indicated that they have contingency actions

available in the event wind-borne missile block vent gas flow. Based on the audit of referenced documents, the NRC staff agrees that the evaluation appears consistent with the NEI 13-02 guidance, including the associated white paper.

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

3.1.2.3 Unintended Cross Flow of Vented Fluids

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

In its FIP, the licensee described that the HCVS for Unit 1 is fully independent from NMP, Unit 2. They are located in different structures, and have separate flow paths and discharge points. There are no shared systems between the two unit vent systems which could support unintended cross flow of vented fluids between units.

The HCVS branches off from the suppression chamber purge and vent system upstream of inboard and outboard PCIVs. These valves are normally closed and fail closed (spring and solenoid operated) 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 MCR or a remote, but readily accessible location. Relevant guidance is found in: NEI 13-02, Sections 4.2.2, 4.2.4, 4.2.5, 5.1, and 6.1; NEI 13-02, Appendices A and H; and HCVS-FAQs-01 and -08.

In its FIP, the licensee stated that the primary control station is located at the ACR, which is located one level below the MCR and is connected to the MCR by a stairway. The ROS is located in the turbine building at ground level. Both locations are protected from adverse natural phenomena. The MCR is located in a Class I structure which also provides protection from wind-borne missiles. The turbine building is a seismic Class II structure. The NMP1 UFSAR states that Class II structures and components are designed for stresses within the applicable codes relating to those structures and components when subjected to functional or operating loads. Stresses resulting from the combination of operating loads and earthquake loads or wind loads have been limited to stresses 33 1/3 percent above working stresses in accordance with applicable codes. The ROS is located in an area of the turbine building which

is protected from wind-borne missiles. The NRC staff reviewed the licensee's HCVS design and agrees that the locations for operation (ACR and ROS) of the HCVS appear to be acceptable and consistent with the guidance.

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

3.1.2.5 Manual Operation

Order EA-13-109, Attachment 2, Section 1.2.5 requires that the HCVS, in addition to meeting the requirements of Section 1.2.4, be capable of manual operation (e.g., reach-rod with hand wheel or manual operation of pneumatic supply valves from a shielded location), which is accessible to plant operators during sustained operations. Relevant guidance is found in: NEI 13-02, Section 4.2.3 and in HCVS-FAQs-01, -03, -08, and -09.

In its FIP, the licensee 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 which may be operated to provide pneumatic power/venting to the HCVS flow path valve actuators so that these valves may be opened when power is not available to the valve actuator solenoid valves. This provides a diverse method of valve operation and improves 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 ACR 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, 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 at the ROS. These bottles have been sized such that they can provide motive force for at least eight cycles of a vent path, which includes opening each of the two PCIVs (IV-201.13-74 & IV-201.13-71) and at least eight more cycles of the downstream isolation valve (IV-201.13-71). In its FIP, the licensee stated that, based on its evaluation, only 3 venting cycles are needed in the first 24 hours.

The licensee also determined the required pneumatic supply storage volume and supply pressure set point required to operate the HCVS AOVs for 24 hours following a loss of normal pneumatic supplies during an ELAP in calculation S22.4-201.13M002, "HCVS Valve Motive Gas Supply Sizing," Revision 1. The licensee's calculation determined that two nitrogen bottles filled to a pressure of 2,640 psig provide sufficient capacity for operation of the HCVS valves for 24 hours following an ELAP and that the bottles should be changed out at 766 psig. This pressure includes an allowance for leakage. The NRC staff audited the calculation and confirmed that there should be sufficient pneumatic supply available to provide motive force to operate the HCVS AOVs for 24 hours following a loss of normal pneumatic supplies during an ELAP. Following the initial 24 hours, the licensee states that replacement nitrogen bottles or a diesel driven air compressor, which will be stored in the FLEX storage building, will be used to provide motive force.

Power Source Analysis

In its FIP, the licensee stated that during the first 24 hours of an ELAP event, NMP1 would rely on the new HCVS battery and battery charger to provide power to HCVS components. The 125 volt (V) direct current (dc) HCVS battery and battery charger are located in the turbine building auxiliary equipment area 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 (Ah). The HCVS battery has a minimum capacity capable of providing power for 24 hours without recharging.

The NRC staff audited licensee engineering change package ECP-13-000086-103, "Battery Sizing Calculation, Attachment M," Revision 0E (January 09, 2017)," which verified the capability of the HCVS battery to supply power to the required loads during the first phase of the NMP1 venting strategy for an ELAP. The HCVS battery was sized in accordance with 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 1.5 amperes of loading for a 24-hour duty period, a 65 Ah 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 Ah, which is more than the minimum required (65 Ah). Therefore, the NMP1 HCVS battery appears to have sufficient capacity to supply power for at least 24 hours.

The licensee's strategy includes repowering the HCVS battery charger within 24 hours after initiation of an ELAP. The licensee's strategy relies on one of two portable 450 kilowatt (kW) 600 volt ac FLEX diesel generators (DGs). Only one of the FLEX DGs is required for the HCVS electrical strategy. The primary strategy is to provide power to safety related 600Vac/125Vdc Static Battery Charger 171A or 171B for the #12 Battery and the alternate strategy is to connect

the FLEX DG to the portable National Fire Protection Association (NFPA) 805 battery charger to power battery board 11 or 12. The 600 Vac FLEX DG would provide power to the HCVS loads in addition of loads addressed under Order EA-12-049. In addition, a connection point that utilizes a standard 120 Vac electrical connection has been provided locally for a small portable generator to support sustained operation of the HCVS.

The NRC audited licensee calculation 600VACDGES-FLEX-BDB, "Fukushima 600VAC FLEX-BDB 450 kW/563 kVA Diesel Generator Sizing," Revision 0, under Order EA-12-049 which includes the HCVS loads on the FLEX DG. The NRC staff also audited licensee calculation 125VDCSCES-FLEX-BDB, "Fukushima/NFPA-805 125VDC Portable Battery Charger Equipment Sizing," Revision 0 (minor), which incorporated the addition of the HCVS loads on the FLEX portable battery charger. The HCVS panel load addition of 1.5A (total of 195.5 A) is still within the 400 ampere rating of the portable battery charger.

Based on its review and audit of calculations 600VACDGES-FLEX-BDB and 125VDCSCES-FLEX-BDB, the NRC staff confirmed that the FLEX DGs and FLEX portable battery charger 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 and FLEX portable battery charger was addressed under Order EA-12-049. Licensee procedure N1-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 charger. Procedure N1-DRP-FLEX-ELEC also provides guidance to power the HCVS battery charger 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) 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.

Inadvertent actuation prevention of the HCVS is accomplished by means of a locked closed manual nitrogen supply valve and an open vent valve at the ROS, along with key lock switches

for the HCVS valve actuator solenoid valves located at the primary control station. The NRC staff's audit of the HCVS confirmed that the licensee's design appears to be consistent with the guidance and should preclude inadvertent actuation.

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

3.1.2.8 Monitoring of HCVS

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

In its FIP, the licensee stated that the HCVS includes indications for HCVS valve position, vent pipe temperature, purge supply pressure, and effluent radiation levels in the ACR HCVS panel. Information on the status of supporting systems (125 Vdc battery voltage indication and radiation from the ROS HCVS panel and nitrogen and argon pressure) is available from the ROS HCVS panel and gauges at the ROS. The NRC staff noted that MCR indications for wetwell pressure and level and drywell pressure are previously existing R.G. 1.97 channels. The licensee also stated that HCVS power is provided by a dedicated HCVS battery for the first 24 hours followed by the FLEX diesel generator or optionally by a smaller portable generator. The NRC staff's evaluation of the power supply is in Section 3.1.2.6. Finally, the licensee stated that HCVS instrumentation performance (e.g., accuracy and range) need not exceed that of similar plant installed equipment. Additionally, radiation monitoring instrumentation accuracy and range is sufficient to confirm flow of radionuclides through the HCVS. The NRC staff also noted that HCVS effluent temperature indication provides alternate indication of vent pipe flow.

The NRC staff audited the following channels documented in Table 1 of the FIP which support HCVS operation; HCVS effluent temperature, HCVS effluent radiation, HCVS valve position, HCVS control panel (ACR), HCVS components (ROS includes dc voltage, pneumatic and purge pressure), drywell pressure, wetwell pressure and wetwell level. The NRC staff notes that drywell pressure, wetwell pressure and wetwell level are declared NMP1 post-accident monitoring (PAM) variables as described in R.G. 1.97. 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 FIP Section III.B.1.2.8 and determined that the HCVS instrumentation appears to be adequate to support HCVS venting operations and is capable of performing its intended function during ELAP and severe accident conditions. The NRC staff found the range of the wetwell and drywell pressure indications appears to be sufficient based on a comparison to the PCPL. Wetwell level indication appears to be sufficient because the range covers nearly the full height of the wetwell.

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.

In Section III.B, Subsection 1.2.9 of the NMP1 FIP, the licensee described the ion chamber detector installed at the 340' elevation of the reactor building. The process and control module is installed at the ROS (turbine building 261') with local indication and a remote indicator in the ACR on panel PNL-1S90. The licensee stated the detector is qualified for the anticipated environment at the vent pipe during accident conditions. The licensee further stated that the process and control module is qualified for the expected conditions at the ROS. The NRC staff audited the qualification summary information provided in Table 1 of the FIP and found that it appears to be consistent with the guidance. The NRC staff also audited the instrumentation channels documented in Table 1 of the FIP, which support monitoring of HCVS effluent, HCVS effluent temperature, and HCVS effluent radiation. The NRC staff confirmed that the effluent radiation monitor provides sufficient range to adequately indicate effluent discharge radiation levels.

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 in HCVS-WP-02.

Environmental

The FLEX diesel driven pump and FLEX DG will be staged outside so they will not be adversely impacted by a loss of ventilation.

In its FIP, the licensee stated that the HCVS batteries and battery charger are permanently installed at the ROS in the turbine building at the 261' elevation. As discussed in Section 3.1.1.2, the licensee performed calculation S10-HVAC-HV11, "Turbine Building Minimum and Maximum Temperatures," Revision 1, which predicts the temperature profile in the turbine building following an loss of offsite power/loss of coolant accident (LOOP/LOCA). The licensee determined that the peak temperature on the 261' elevation will reach 99.3°F. The calculation bounds the ELAP scenario temperature due to higher 7-day LOOP/LOCA heat up loads assumed in the calculation. The licensee plans to implement passive cooling actions such as opening specified doors in the reactor building and turbine building, the turbine building hatch and side wall vents. These actions are expected to create a natural circulation vent path

through the upper levels of the reactor building and turbine building, which would help to minimize the temperature rise within the buildings. Licensee procedures N1-SOP-33A.2, "Station Blackout/ELAP," Revision 15, and N1-DRP-FLEX-MECH, "Emergency Damage Repair – BDB/FLEX Pump Deployment Strategy," Revision 7, provide guidance to open doors in the reactor building and turbine building.

The licensee further stated that the HCVS batteries are sized considering a minimum operating temperature of 60°F. This is the minimum ambient temperature of the area under ELAP conditions where the HCVS batteries are located as specified in engineering change ECP-13-000086-103. The manufacturer's maximum design limit for the HCVS batteries is 122°F. Therefore, the HCVS batteries should continue to perform their design function under event temperatures. The operating temperature of the battery charger as specified by the vendor is 0°C to 50°C (32°F to 122°F). Therefore, the battery charger should continue to perform its design function under event conditions.

Based on the above, the NRC staff concurs with the licensee's calculations that show the ROS temperature will remain within the maximum temperature limit (122°F) for the HCVS batteries and battery charger. Furthermore, based on temperatures remaining below 120°F (the temperature limit for electronic equipment to be able to survive indefinitely, identified in NUMARC-87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," Revision 1, as endorsed by NRC R.G. 1.155), the NRC staff expects that other electrical equipment in the ROS should not be adversely impacted by the loss of ventilation as a result of an ELAP event with the HCVS in operation. The NRC staff audited the information and agrees that the HCVS equipment located at the ROS in the turbine building should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

Radiological

The licensee's calculation H21C-115, "Hardened Containment Vent System (HCVS) Radiological Dose Analysis," documents the dose assessment for both personnel habitability and equipment locations associated with event response to a postulated ELAP condition. The NRC staff audited calculation H21C-115 and noted that the licensee used conservative assumptions to bound the peak dose rates for the analyzed areas. For the sources considered and the methodology used in the dose calculation, the timing of HCVS vent operation or cycling of the vent will not create higher doses at personnel habitability and equipment locations (i.e., maximum doses determined in the calculation bound operational considerations for HCVS vent operation). The NRC staff's audit confirmed that the anticipated severe accident radiological conditions will not preclude the operation of necessary equipment or result in an undue risk to personnel from radiation exposure.

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

3.1.2.11 Hydrogen Combustible Control

Order EA-13-109, Attachment 2, Section 1.2.11 requires that the HCVS be designed and operated to ensure the flammability limits of gases passing through the system are not reached; otherwise, the system shall be designed to withstand dynamic loading resulting from hydrogen

deflagration and detonation. Relevant guidance is found in: NEI 13-02, Sections 4.1.7, 4.1.7.1, and 4.1.7.2; NEI 13-02, Appendix H; and in 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 is 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 per procedure N1-EOP-4.1, "Primary Containment Venting." Once aligned, purge operations can be performed from ACR panel PNL-1890 using SOV-201.13-14. There is a locked bypass valve which can be used for purge operation when power is not available to SOV-201.13-14. The argon purge system is utilized to provide the pressure needed to burst the rupture disc. The licensee performed calculation S22.4-201.13F001, "HCVS Purge System Design," which computes the number of purge cycles that can be achieved per installed bank of argon bottles, as well as the purge rate required to adequately prevent a combustible mixture of air and hydrogen. The calculation determined that an approximate 8-second purge time is required to burst the rupture disc. For purging the combustibles after a vent cycle, a 67-second purge time has been calculated. The use of a purge system meets the requirement to ensure the flammability limits of gases passing through the vent pipe will not be reached. The NRC staff audited the licensee's analysis and confirmed the installed purge system capacity is sufficient. The NRC staff confirmed that the licensee's design appears to be consistent with Option 3 of white paper HCVS-WP-03 and that the use of the argon purge system in conjunction with the HCVS venting strategy meets the requirement to prevent a detonable mixture from developing in the pipe.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design 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 reactor building or other buildings. Relevant guidance is found in: NEI 13-02, Section 4.1.6, NEI 13-02, Appendix H; HCVS-FAQ-05; and in HCVS-WP-03.

As discussed in Section 3.2.1.3, the HCVS for NMP1 is fully independent from the HCVS for NMP, Unit 2. They are located in different structures, and have separate flow paths and discharge points.

In its FIP, the licensee stated that the HCVS piping is part of the containment purge and vent system. The HCVS branches off from the containment (suppression chamber) purge and vent system upstream of that systems inboard and outboard PCIVs IV-201-16 and IV-201-17. Valves PCIV IV-201-16 and IV-201-17 are normally closed and automatically close upon receipt

of a containment isolation signal from the reactor protection system or a high radiation signal from the off-gas system monitors. The containment purge and vent system PCIVs are routinely tested for leak tightness in accordance with 10 CFR 50, Appendix J. The NRC staff's review confirmed that the design appears to be consistent with the guidance and meets the design requirements to minimize the potential of hydrogen gas migration into other buildings.

Based on the evaluation above, the NRC staff concludes that the licensee's HCVS design 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 NMP1 FIP, Table 3-3 includes testing and inspection requirements for HCVS components. The NRC staff reviewed Table 3-3 and found that it is consistent with Section 6.2.4 of NEI 13-02, Revision 1. Implementation of these testing and inspection requirements for the HCVS will ensure reliable operation of the systems.

In its FIP, the licensee stated that the maintenance program was developed using the guidance provided in NEI 13-02, Sections 5.4, and 6.2 and utilizes the standard Electric Power Research Institute (EPRI) industry preventive maintenance process for the maintenance calibration and testing for the HCVS components. The NRC staff audited 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 the 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 design considerations of the Phase 1 HCVS installed at NMP1 complies with the requirements specified in the order and described in NEI 13-02, Revision 1, and has been installed in accordance with the station design control process. The HCVS penetration and containment isolation valves are designed and installed consistent with the design basis of primary containment including pressure, temperature, radiation, and seismic loads along with quality standards.

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

3.2.2 Component Reliability and Rugged Performance

Order EA-13-109, Attachment 2, Section 2.2 requires that all other HCVS components be designed for reliable and rugged performance, capable of ensuring HCVS functionality following a seismic event. These items include electrical power supply, valve actuator pneumatic supply and instrumentation (local and remote) components. Relevant guidance is found in NEI 13-02, Sections 5.2 and 5.3.

In its FIP, the licensee stated that the HCVS components downstream of the outboard containment isolation valve and components that interface with the HCVS are routed in seismically qualified structures or supported from seismically qualified structure(s). The HCVS downstream of the outboard containment isolation valve, including piping and supports, electrical power supply, valve actuator pneumatic supply, and instrumentation (local and remote) components, have been designed and analyzed to conform to the requirements consistent with the applicable design codes for the plant and to ensure functionality following a design-basis earthquake. This includes environmental evaluation consistent with expected conditions at the equipment location.

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.

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

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

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

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

As stated above in Section 2.2, Order EA-13-109 provides two options to comply with the Phase 2 order requirements. Nine Mile Point, Unit 1 has elected the option to develop and implement a reliable containment venting strategy that makes it unlikely the licensee would need to vent from the containment drywell before alternate reliable containment heat removal and pressure control is reestablished.

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

- The strategy making it unlikely that a licensee would need to vent from the containment drywell during severe accident conditions shall be part of the overall accident management plan for Mark I and Mark II containments,
- The licensee shall provide supporting documentation demonstrating that containment failure as a result of overpressure can be prevented without a drywell vent during severe accident conditions; and,
- Implementation of the strategy shall include licensees preparing the necessary procedures, defining and fulfilling functional requirements for installed or portable equipment (e.g. pumps and valves), and installing the needed instrumentation.

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

4.1 Severe Accident Water Addition (SAWA)

The licensee plans to use the portable, diesel-driven FLEX pump to provide SAWA flow. The pump discharge is routed through the (SAWA) manifold, which will direct the flow to the feedwater system and then into the reactor pressure vessel (RPV). The operators will use manual valves to isolate the flow path and ensure that cross flow to other portions of the feedwater system does not occur. To minimize operator exposure to hazardous radiological conditions, the alternate FLEX RPV injection path is used. It injects into the feedwater system in the turbine building rather than the reactor building. The other SAWA actions take place outside the reactor building and are in locations shielded from the severe accident radiation by the thick concrete walls of the reactor building. Once SAWA flow is initiated, operators will have to monitor and maintain SAWA flow and ensure refueling of the diesel-driven equipment as necessary. Operators may also have to reduce flow as part of the severe accident water management (SAWM) strategy, if necessary, using one of the manifolds described below.

4.1.1 Staff Evaluation

4.1.1.1 Flow Path

The SAWA injection flow path starts at the intake structure for the plant ultimate heat sink (UHS) and goes through the SAWA (FLEX) pump to the FLEX/SAWA manual manifold. The manifold has 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 point located on the inside of the turbine building located on the firewater to feedwater Storz connection located on the turbine building elevation 261'. Once the SAWA components are deployed and connected, the SAWA flow path is controlled at the valve manifold. Backflow prevention is provided by

existing safety-related check valves installed in the feedwater system, which are leak tested using the existing leakage testing programs. Drywell pressure and wetwell level will be monitored and flow rate will be adjusted by use of the FLEX (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.

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 263 gallons per minute (gpm) of SAWA flow to the unit while simultaneously providing required flow to the spent fuel pool (SFP). The NRC staff audited calculation S0-FLEX-F001, "NMP1 FLEX and SAWA Hydraulic Flow Evaluation," Revision 1, which determined that the required SAWA flowrate of 263 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. 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 states that NMP1 will follow the guidance of NEI 13-02 and the guidance (flow rate and timing) for SAWA described in BWR Owners Group (BWROG) generic assessment, BWROG-TP-15-008, "Severe Accident Water Addition Timing," [Reference 32]. The generic assessment provides the principles of severe accident water addition to ensure protection of containment. This SAWA injection path is stated to be qualified for all screened in hazards in addition to severe accident conditions.

Nine Mile Point, Unit 1 will deploy and commence SAWA injection in less than 8 hours. The initial SAWA flow rate will be at least 263 gpm. After a period of time, estimated to be about 4 hours, in which the maximum flow rate is maintained, the SAWA flow will be reduced. The reduction in flow rate and the timing of the reduction will be based on stabilization of the containment parameters of drywell pressure and wetwell level. Calculation N1-MISC-004, "NMP1 MAAP Analysis to Support SAWA Strategy," demonstrated that the SAWA flow could be reduced to 54 gpm after four hours of initial SAWA flow rate and containment would be protected. The NMP1 FIP noted that at some point 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. While this is expected to be 4 to 6 hours, no time is specified in the procedures because the NMP1 severe accident procedures (SAPs) are symptom-based guidelines.

The NRC staff audited the referenced calculation along with FLEX Strategy Validation Plan No. NMP1-VP-008. Guidance document NEI 13-02, uses an initial SAWA flow of 500 gpm reduced after 4 hours to 100 gpm. The NRC staff noted that NMP1 determined the flow rates by scaling using the ratio of NMP1 licensed thermal power (1,850 megawatts thermal (MWt)) to that of the reference plant (3,514 MWt) used in the EPRI Technical Report 3002003301, "Technical Basis for Severe-Accident Mitigating Strategies." This is consistent with NEI 13-02, Section 4.1.1.2.

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

4.2 Severe Accident Water Management (SAWM)

The NMP1 SAWM strategy consists of flow control at the FLEX (SAWA) valve cart along with instrumentation and procedures to ensure that the wetwell vent is not submerged. Procedures have been issued to implement this strategy including revision 3 to the Severe Accident Management Guidelines (SAMGs) and Emergency Procedures Committee Generic Issue 1314. This strategy has been shown via MAAP analysis (N1-MISC-004) to protect containment without requiring a drywell vent for at least 7 days which is consistent with the guidance provided in NEI 13-02 for the period of sustained operation.

The SAWA system consists of a SAWA pump injecting water into the RPV. The SAWM consists of flow control at the FLEX (SAWA) valve distribution manifold in the turbine building elevation 261' 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 firewater to feedwater Storz connection located on the turbine building elevation 261'. This Storz connection allows the water to flow into the RPV via the feedwater system. Throttling valves and flow meters will permit water flow to maintain wetwell availability. BWROG generic assessment, BWROG-TP-15-008 [Reference 32], provides the principles of SAWA to ensure protection of containment.

4.2.1 Staff Evaluation

4.2.1.1 Available Freeboard Use

As stated in the FIP, the freeboard between normal wetwell water level of 11.5 feet and 27 feet elevation (wetwell vent opening) in the wetwell provides approximately 862,288 gallons of water volume before the water level reaches the bottom of the wetwell vent pipe. The BWROG generic assessment BWROG-TP-15-011, "Severe Accident Water Management" [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. The MAAP analysis for NMP1 shows, if no additional reduction is made to SAWA, the wetwell water level will reach approximately 15.7 feet over the course of the 7-day event, resulting in approximately 11 feet of margin to the inlet of the HCVS vent pipe at 27 feet. The NRC staff audited 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

Calculation N1-MISC-004 demonstrated that the SAWA flow could be reduced to 54 gpm after 4 hours of initial SAWA flow rate and containment would be protected. At some point, 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 FIP also notes that while this time line is expected to be 4 to 6 hours, no time is specified in the procedures because the NMP1 SAPs are symptom-based guidelines.

4.2.2 Conclusions

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

4.3 SAWA/SAWM Motive Force

4.3.1 Staff Evaluation

4.3.1.1 SAWA Pump Power Source

As described in Section 4.1, the licensee plans to use 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 its FIP that S-DRP-OPS-004 contains precautions to alternatively refuel when not performing 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 containment wetwell pressure, wetwell level, drywell pressure, and the SAWA flow meter as instruments required for SAWA and SAWM implementation. The containment wetwell pressure and wetwell 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 125DCTRAIN11/12LFVD, "125 VDC Power Systems 11 and 12 Load Flow Voltage Drop," Revision 1, under Order EA-12-049 which verified the capability of the Class 1E station batteries to supply power to the required loads (e.g. containment wetwell pressure, wetwell level, and drywell pressure instruments) during the first phase of the NMP1 FLEX mitigation strategy plan for an ELAP event. The NRC staff also audited licensee calculation 600VACDGES-FLEX-BDB, which verified that the 450 kW FLEX DG is adequate to support HCVS electrical loads.

Based on its audit, the NRC staff agrees that the Class 1E batteries and 450 kW FLEX DGs appears to have sufficient capacity and capability to supply the necessary SAWA/SAWM loads during an ELAP event.

4.3.2 Conclusions

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

4.4 SAWA/SAWM Instrumentation

4.4.1 Staff Evaluation

4.4.1.1 SAWA/SAWM Instruments

In Section IV.C.10.2 of its FIP, the licensee stated that the instrumentation needed to implement the SAWA/SAWM strategy are wetwell level, drywell pressure and SAWA flow meter. The wetwell level and drywell pressure are existing R.G. 1.97 instruments that were designed and qualified for severe accident conditions. The flow instrument range is 2 to 544 gpm, which appears to be consistent with the licensee's strategy. The NRC staff reviewed the FIP including Section IV.C.10.1, Section IV.C.10.2, and Table 1 and agrees that the proposed instruments appear to be consistent with the NEI 13-02 guidance.

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 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 also 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. In Section IV.C.10.2 of its FIP, the licensee stated, in part, that drywell temperature may be repowered by FLEX generators and may provide information for the operations staff to evaluate plant conditions under a severe accident and to provide confirmation for adjusting SAWA flow rates.

The NRC staff reviewed the FIP, including Section IV.C.10.2, and agrees that the licensee's response appears to be consistent with the guidance. The NRC staff notes that NEI 13-02, Revision 2, Section C.8.3, clarifies that drywell temperature is not required, but may provide further information for the operations staff to evaluate plant conditions under severe accident and provide confirmation to adjust SAWA flow rates.

4.4.1.3 Qualification of SAWA/SAWM Instruments

Drywell pressure and wetwell level are declared NMP1 PAM variables, as described in R. G. 1.97 and the existing qualification of these channels is considered acceptable for compliance with Order EA-13-109 in accordance with the guidance in NEI 13-02, Appendix C, Section C.8.1. The NRC staff verified the R.G. 1.97 variables in the NMP1 UFSAR.

The SAWA flow meter is attached to the SAWA flow manifold cart and will be deployed in the turbine building elevation 261' near the ROS. The licensee stated in Table 1 of its FIP that anticipated temperature at this location is 43°F to 98°F and the qualification temperature range is -4°F to 140°F. The licensee stated in Table 1 of the FIP that the flow meter is qualified up to 1E3 Rad total integrated dose (TID) and the anticipated radiation environment in this location is 5.25E2 Rad. The NRC staff concurs that the SAWA flow meter appears to be qualified for the anticipated environment.

4.4.2 Conclusions

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

4.5 SAWA/SAWM Severe Accident Considerations

4.5.1 Staff Evaluation

4.5.1.1 Severe Accident Effect on SAWA Pump and Flowpath

To address SAWA/SAWM severe accident dose considerations the licensee performed a detailed radiological analysis documented as H21C-115, "Hardened Containment Vent System (HCVS) Radiological Dose Analysis." 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 (ACR), ROS, and travel paths for hose routing.

In its FIP, the licensee stated that the SAWA pumps are stored in the FLEX storage building and will be operated from outside the reactor building behind the screenhouse building; therefore, there will be no significant dose to the SAWA pump. 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 reactor building consists of stainless/carbon 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 audited the information and agrees that the SAWA flow path will not be adversely affected by radiation effects due to the severe accident conditions.

4.5.1.2 Severe Accident Effect on SAWA/SAWM Instruments

The NMP1 SAWA strategy relies on three instruments: wetwell level; containment pressure; and SAWA flow. Containment pressure and wetwell level are declared NMP1 PAM variables as described in R.G. 1.97 and the existing qualification of these channels is considered acceptable for compliance with Order EA-13-109 in accordance with the guidance in NEI 13-02, Appendix C, Section C.8.1.

As stated in FIP Section 4.5.1.1, the SAWA pump will be operated from outside the reactor building, behind the screenhouse building. This location ensures that there will be no adverse effects from radiation exposure to the flow instruments mounted on the SAWA pump cart. 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 agrees that the SAWA/SAWM instruments should not be adversely affected by radiation effects due to severe accident conditions.

4.5.1.3 Severe Accident Effect on Personnel Actions

The licensee performed calculations of the temperature response in the reactor and turbine buildings and of the MCR/ACR during the station blackout/ELAP event. During a severe accident the core materials are contained inside the primary containment. The temperature response of the reactor building, ACR/MCR, and turbine building are driven by the loss of ventilation and ambient conditions and, therefore, will not change. Thus, the reactor building heat-up calculations which includes the heat from the HCVS vent pipe are acceptable for severe accident use. Deployment of SAWA equipment will be completed before building temperatures become untenable. In the FIP, Table 2 provides a list of SAWA/SAWM operator actions, as well as an evaluation of each for suitability during a severe accident.

The NRC staff audited the temperature response calculations. The MCR, ACR, and ROS are expected to remain habitable, with respect to temperature, during the event. Environmental conditions in the MCR, ACR, and the ROS were discussed previously in Section 3.1.1.2, Personnel Habitability – Environmental. Operation of the flow meter and throttle valve cart in the turbine building will not be impeded by area temperatures. 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-115, "Hardened Containment Vent System (HCVS) Radiological Dose Analysis," which documents the dose assessment for designated areas inside the NMP1 reactor building (outside of containment) and outside the NMP1 reactor building caused by the sustained operation of the HCVS under the beyond-design-basis severe accident condition of an ELAP. This assessment used conservative assumptions to determine the expected dose rates in all areas that may require access during a beyond-design-basis ELAP. As stated in Section 3.1.1.3, Personnel Habitability – Radiological, the NRC staff agrees, based on the audit of the licensee's detailed evaluation, that mission doses associated with actions taken to protect the public under beyond-design-basis severe accident conditions will not subject plant personnel to an undue risk from radiation exposure.

4.5.2 <u>Conclusions</u>

Based on this evaluation, the NRC staff concludes that the licensee has considered the severe accident effects on the water management strategy and that the operation of components and

instrumentation should not be adversely affected, and the performance of personnel actions should not be impeded, during severe accident conditions following an ELAP event, 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 audited the overall procedures and programs developed, including the list of key components included, and noted that they appear to be consistent with the guidance found in NEI 13-02, Revision 1. The NRC staff determined that procedures developed appear to be in accordance with existing industry protocols. The provisions for out-of-service requirements appear to reflect consideration of the probability of an ELAP requiring severe accident venting and the consequences of a failure to vent under such conditions.

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

5.2 Training

Order EA-13-109, Attachment 2, Section 3.2 requires that the licensee train appropriate personnel in the use of the HCVS. Furthermore, Order EA-13-109 requires that the training

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 systematic approach to training process. The NRC staff audited the information provided in the FIP and confirmed that the training plan is consistent with the established systematic approach to training process.

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

6.0 CONCLUSION

In June 2014, the NRC staff started audits of the licensee's progress in complying with Order EA-13-109. The staff issued an ISE for implementation of Phase 1 requirements on March 26, 2015 [Reference 13], an ISE for implementation of Phase 2 requirements on August 30, 2016 [Reference 14], and an audit report on the licensee's responses to the ISE open items on October 30, 2017 [Reference 15]. The licensee reached its final compliance date on June 21, 2018, and has declared in letter dated August 20, 2018 [Reference 16], that Nine Mile Point Nuclear Station, Unit 1, is in compliance with the order.

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

7.0 REFERENCES

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

2. Letter from NMP1 to NRC, "Nine Mile Point, Unit 1 – Phase 1 Overall Integrated Plan in Response to June 6, 2013, Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions Phase 1 (Order Number EA-13-109)," dated June 27, 2014 (ADAMS Accession No. ML14184B340)

3. Letter from NMP1 to NRC, "First Six-Month Status Report For Phase 1 Overall Integrated Plan in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated December 16, 2014 (ADAMS Accession No. ML14356A192)

4. Letter from NMP1 to NRC, "Second Six-Month Status Report For Phase 1 Overall Integrated Plan in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated June 30, 2015 (ADAMS Accession No. ML15181A017)

5. Letter from NMP1 to NRC, "Nine Mile Point, Unit 1 – Phase 1 (Updated) and Phase 2 Overall Integrated Plan in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order EA-13-109)," dated December 15, 2015 (ADAMS Accession No. ML15364A075)

6. Letter from NMP1 to NRC, "Fourth Six-Month Status Report For Phases 1 and 2 Overall Integrated Plan in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated June 30, 2016 (ADAMS Accession No. ML16182A013)

7. Letter from NMP1 to NRC, "Fifth Six-Month Status Report For Phases 1 and 2 Overall Integrated Plan in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated December 14, 2016 (ADAMS Accession No. ML16349A033)

8. Letter from NMP1 to NRC, "Sixth Six-Month Status Report For Phases 1 and 2 Overall Integrated Plan in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated June 30, 2017 (ADAMS Accession No. ML17181A033)

9. Letter from NMP1 to NRC, "Seventh Six-Month Status Report For Phases 1 and 2 Overall Integrated Plan in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation

Under Severe Accident Conditions (Order Number EA-13-109)," dated December 15, 2017 (ADAMS Accession No. ML17349A031)

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

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

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

13. Letter from NRC to NMP1, "Nine Mile Point Nuclear Station, Unit 1 – Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Phase 1 of Order EA-13-109 (Severe Accident Capable Hardened Vents)," dated March 26, 2015 (ADAMS Accession No. ML15069A671)

14. Letter from NRC to NMP1, "Nine Mile Point Nuclear Station, Unit 1 – Interim Staff Evaluation Relating to Overall Integrated Plan in Response to Phase 2 of Order EA-13-109 (Severe Accident Capable Hardened Vents)," dated August 30, 2016 (ADAMS Accession No. ML16231A452)

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Date: February 6, 2019

SUBJECT: NINE MILE POINT NUCLEAR STATION, UNIT 1 - SAFETY EVALUATION REGARDING IMPLEMENTATION OF HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS RELATED TO ORDER EA-13-109 (CAC NO. MF4481; EPID NO. L-2014-JLD-0043) DATED: February 6, 2019

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