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

April 27, 2018

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

SUBJECT: DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3 - SAFETY EVALUATION REGARDING IMPLEMENTATION OF HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS RELATED TO ORDER EA-13-109 (CAC NOS. MF4462 AND MF4463; EPID NO. L-2014-JLD-0047)

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 licensees to submit for review overall integrated plans (OIPs) that describe how compliance with the requirements for both phases of Order EA-13-109 will be achieved.

By letter dated June 30, 2014 (ADAMS Accession No. ML14184A018), Exelon Generation Company, LLC (Exelon, the licensee) submitted its Phase 1 OIP for Dresden Nuclear Power Station, Units 2 and 3 (Dresden) 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 Dresden, including the combined Phase 1 and Phase 2 OIP in its letter dated December 16, 2015 (ADAMS Accession No. ML15352A027). These status reports were required by the order, and are listed in the attached safety evaluation. By letters dated May 27, 2014 (ADAMS Accession No. ML14126A545), and August 10, 2017 (ADAMS Accession No. ML17220A328), the NRC notified all Boiling Water Reactor Mark I and Mark II licensees that the staff will be conducting audits of their implementation of Order EA-13-109 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" (ADAMS Accession No. ML082900195). By letters dated February 11, 2015 (Phase 1) (ADAMS Accession No. ML15007A491), September 30, 2016 (Phase 2) (ADAMS Accession No. ML16273A430), and December 20, 2017 (ADAMS Accession No. ML17349A926), the NRC issued Interim Staff Evaluations (ISEs) and an audit report, respectively, on the licensee's progress. By letter dated January 12, 2018 (ADAMS Accession No. ML18012A111), Exelon reported that Dresden, Units 2 and 3 are in full compliance with the requirements of Order EA-13-109, and submitted a final integrated plan for Dresden.

The enclosed safety evaluation provides the results of the NRC staff's review of Exelon's hardened containment vent design and water management strategy for Dresden. The intent of the safety evaluation is to inform Exelon 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. ML17229B295). This inspection will be conducted in accordance with the NRC's inspection schedule for the plant.

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

Sincerely,

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

Docket Nos. 50-237 and 50-249

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO ORDER EA-13-109

EXELON GENERATION COMPANY, LLC

DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3

DOCKET NOS. 50-237 AND 50-249

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 30, 2014 [Reference 2], Exelon Generation Company, LLC (Exelon, the licensee) submitted a Phase 1 Overall Integrated Plan (OIP) for Dresden Nuclear Power Station, Units 2 and 3 (Dresden) in response to Order EA-13-109. By letters dated December 17, 2014 [Reference 3], June 30, 2015 [Reference 4], December 16, 2015 (which included the combined Phase 1 and Phase 2 OIP) [Reference 5], June 30, 2016 [Reference 6], December 14, 2016 [Reference 7], and June 27, 2017 [Reference 8], the licensee submitted 6-month updates to its OIP. By letters dated May 27, 2014 [Reference 9], and August 10, 2017 [Reference 10], the NRC notified all BWR Mark I and Mark II licensees that the staff will be conducting audits of their implementation of Order EA-13-109 in accordance with NRC Office of

Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" [Reference 11]. By letters dated February 11, 2015 (Phase 1) [Reference 12], September 30, 2016 (Phase 2) [Reference 13], and December 20, 2017 [Reference 14], the NRC issued Interim Staff Evaluations (ISEs) and an audit report, respectively, on the licensee's progress. By letter dated January 12, 2018 [Reference 15], 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 16]. 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 17], 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 18], the NRC staff issued Order EA-12-050, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents" [Reference 19], 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 20]. In the SRM for SECY-12-0157 [Reference 21], 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, the NEI issued NEI 13-02, "Industry Guidance for Compliance with Order EA-13-109," Revision 0 [Reference 22] 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 23], 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, the NEI issued NEI 13-02, "Industry Guidance for Compliance with Order EA-13-109," Revision 1 [Reference 24] 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 25], endorsing, in part, NEI 13-02, Revision 1, as an acceptable means of meeting the requirements of Phase 2 of Order EA-13-109, and on April 7, 2015, published a notice of its availability in the *Federal Register* (80 FR 26303).

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

To implement the Phase 1 requirements of Order EA-13-109, the licensee utilized part of its existing Generic Letter (GL 89-16) wetwell vent system (Augmented Primary Containment Vent System) piping from the suppression chamber, and attached new piping to route the HCVS effluent outside the Reactor Building (RB) and up to a sufficient height above the RB roof. The HCVS is initiated via manual action from the Main Control Room (MCR) or Remote Operating

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

3.1 HCVS FUNCTIONAL REQUIREMENTS

3.1.1 Performance Objectives

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

3.1.1.1 Operator Actions

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

In its FIP, the licensee stated that operator actions to initiate the HCVS vent path can be completed by plant personnel and includes the capability for remote-manual initiation from the HCVS control station. After initial valve line-up at the ROS, the vent system is initiated, operated and monitored from the MCR. The vent system can also be initiated and operated from the ROS located in the Turbine Building adjacent to the RB north wall. A list of the remote manual actions to be performed by plant personnel to open the HCVS vent path are listed in Table 3-1, HCVS Operator Actions, of the FIP. A HCVS extended loss of alternating (ac) power (ELAP) Failure Evaluation table (Table 3-2), which shows alternate actions that can be performed, is provided in the FIP.

The licensee also stated that permanently installed electrical power and pneumatic supplies are available to support operation and monitoring of the HCVS for a minimum of 24 hours. No portable equipment needs to be moved in the first 24 hours. After 24 hours, available personnel will be able to connect supplemental electric power and pneumatic supplies for sustained operation of the HCVS for a minimum of 7 days. The FLEX generators and Nitrogen bottles provide this motive force. In all likelihood, these actions will be completed in less than 24 hours. However, the HCVS can be operated for at least 24 hours without any supplementation.

The NRC staff reviewed the HCVS Operator Actions Table and compared it with the information contained in the guidance document NEI 13-02, and determined that these actions should minimize the reliance on operator actions. The actions are consistent with the types of actions described in the guidance found in NEI 13-02, Revision 1 as endorsed, in part, by JLD-ISG-2013-02 and JLD-ISG-2015-01, as an acceptable means for implementing applicable requirements of Order EA-13-109. The NRC staff also reviewed the HCVS Failure Evaluation

Table and determined the actions described adequately address all the failure modes listed in the guidance provided by NEI 13-02, Revision 1, which include: loss of normal ac power, long-term loss of batteries, loss of normal pneumatic supply, loss of alternate pneumatic supply, and solenoid operated valve failure.

In its FIP, the licensee discussed communication between the remote HCVS operation locations and HCVS decision makers during ELAP and severe accident conditions. Plant Procedure FSG-39, "FLEX Communications Options," discusses the available onsite communications. Communications may be performed using the installed sound powered headset system within the power block and 800 Mhz [megahertz] radios in the talk-around mode. Public Address announcements are made by Nuclear Security Officers using hand-held bullhorns. Offsite communications will utilize hand held satellite phones staged in the Control Room and Technical Support Center (TSC). Battery chargers for the portable communications equipment are stored in a robust structure. Upon initiation of the ELAP, the FLEX Diesel Generator can power the battery chargers.

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

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design minimizes the reliance on operator actions consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses the requirements of the Order.

3.1.1.2 Personnel Habitability – Environmental

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

In its FIP, Exelon referred to Updated Final Safety Analysis Report (UFSAR) Section 9.4.4 indicating the turbine building ventilation system is designed to maintain area temperature between 65 and 120 degrees Fahrenheit (°F) with outside temperatures varying between -6 and +93 °F. Technical evaluation (EC-EVAL 403298) was performed to estimate temperatures on the turbine floor. The calculation determined that with the large volume of concrete thermal mass surrounding the ROS area the temperature in the ROS area will limit the temperature drop from 65 to 55 degrees in 24 hours, while the outside temperature is at 0 °F. The licensee did not provide a calculation evaluating the area temperatures during the hot weather. The licensee indicated that historically normal summer temperatures on the turbine deck are around 104 °F. During the audit, NRC staff requested additional clarification regarding the expected temperatures at the ROS. The licensee replied that because the ROS is in the Turbine Building and normal heat sources are shut down during an ELAP, a detailed temperature evaluation was not performed. The licensee indicated most HCVS actions will take place in the MCR. When manual actions are needed in the ROS, an operator will be dispatched from the MCR to perform the specific task. Stay time in the ROS will be limited. Existing procedures identify requirements for hot area work. Ice vests will be available as needed. Because of the use of oxygen displacing gasses, a low oxygen sensor is installed in the ROS to alarm if an argon or nitrogen leak results in deficient oxygen for personnel safety. The NRC staff finds this acceptable. The MCR temperature has been addressed as part of the safety evaluation (SE) (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17037C929) for Order EA-12-049 (mitigating strategies). The heat loads for the mitigating strategies event envelope the expected heat loads for an Order EA-13-109 event. Therefore, the mitigating strategies safety evaluation remains applicable.

The NRC staff reviewed calculation DRE17-0013, "Transient Thermal Analysis of Turbine Building for FLEX During SAWA [Severe Accident Water Addition]". The calculation results determined the temperature near the Flood Pump will peak at approximately 116 °F with ambient temperature at 95 °F. Temperature near the FLEX diesel generator (DG) will peak at approximately 120 °F with ambient temperature of 95 °F. Operators are not stationed at the DG equipment continuously. Limited stay times and existing hot area work procedures along with ice vests and other compensatory actions will permit operators to access and operate equipment as needed.

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design, with respect to personnel habitability during severe accident conditions, is consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses 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's calculation DRE16-0010, "FLEX Activity and Phase 2 Dose Assessment," documents the dose assessment for designated areas inside the Dresden RB (outside of containment) and outside the Dresden RB caused by the sustained operation of the HCVS under the beyond-design-basis severe accident condition of an ELAP. Calculation DRE16-0010 was performed using NRC-endorsed HCVS-WP-02 [Reference 26] and HCVS-FAQ-12 [Reference 27] methodologies. Consistent with the definition of sustained operations in NEI 13-02, Revision 1, the integrated whole body gamma dose equivalent[1] due to HCVS operation over a 7-day period was determined in the licensee's dose calculation to be no greater than 10 rem[2]. The 7-day dose determined in the calculation due to HCVS operation is a conservative maximum integrated radiation dose over a 7-day period with ELAP and fuel failure starting at reactor shutdown. For the sources considered and the methodology used in the calculation, the timing of HCVS vent operation or cycling of the vent will not create higher doses at personnel habitability and equipment locations (i.e., maximum doses determined in the calculation bound operational considerations for HCVS vent operation).

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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

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 MCR and the ROS. The calculation demonstrates that the integrated whole body gamma dose equivalent to personnel occupying defined habitability locations, resulting from HCVS operation under beyond-design-basis severe accident conditions, will not exceed 10 rem.

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

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

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design, with respect to personnel habitability during severe accident conditions, is consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses 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 SE, respectively.

The Dresden HCVS instrumentation components are located in the primary containment, the RB, the turbine building and the main control room. The SAWA flow instrument is portable and will be attached near the SAWA manifold either outside the RB or in the turbine building depending on the site flooding conditions. Regarding the functionality of the HCVS controls and indications, the licensee evaluated the environmental conditions and impacts for the components (switches, control devices, instrumentation sensors, transmitters and indicators, etc.) required for HCVS venting operations. Dresden engineering change packages (ECPs) EC400578 and EC401069 provide detailed design considerations for the instrumentation including the seismic, temperature and radiation environmental qualifications. The licensee also provided a complete list of the instrumentation components, their locations, the anticipated environmental conditions and summary qualification details in Table 1 of its FIP.

The NRC staff reviewed the instrumentation and controls (I&C) configuration in Dresden's FIP and confirmed the qualification summary information provided in Table 1 for each channel based on an electronic portal audit of Dresden documents EC400578 and EC401069. The NRC staff reviewed the following channels which support HCVS operation: HCVS Effluent Temperature, Wetwell Vent Line Radiation, HCVS direct current (dc) Voltage, Nitrogen Supply Pressure, Drywell Pressure, and Wetwell Level. The staff notes that Drywell Pressure and Wetwell Level are declared Dresden post-accident monitoring (PAM) variables as described in Regulatory Guide (RG) 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 reviewed the licensee's evaluation and confirmed that the HCVS instrumentation is adequate to support HCVS venting operations and is capable of performing its intended function during ELAP and severe accident conditions.

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design, with respect to the accessibility and functionality of the HCVS controls and indications during severe accident conditions, is consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses the requirements of the Order.

3.1.2 Design Features

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

3.1.2.1 Vent Characteristics

Order EA-13-109, Attachment 2, Section 1.2.1 requires that the HCVS have the capacity to vent the steam/energy equivalent of one (1) percent of licensed/rated thermal power (unless a lower value is justified by analyses), and be able to restore and then maintain containment pressure below the primary containment design pressure and the primary containment pressure limit. Relevant guidance is found in NEI 13-02 Section 4.1.1.

The HCVS wetwell path is designed for venting steam/energy at a minimum capacity of 1 percent of 2957 MW thermal power at a pressure of 47 pounds per square inch gauge (psig). The containment design pressure is 62 psig and the primary containment pressure limit (PCPL) is 53 psig. However, conservatively the steady state venting capacity of the Dresden HCVS was determined at a torus vapor space pressure of 47 psig, which corresponds to the PCPL for the torus filled with water. The size of the wetwell portion of the HCVS is 10 inches in diameter, which provides adequate capacity to meet or exceed the Order criteria, as confirmed in the vent capacity calculation discussed below.

The licensee performed Calculations DRE15-0046, "Vent Line Sizing (for Unit 3)," Revision 1 and DRE16-0019, "Vent Line Sizing for Unit 2," Revision 1 to confirm the HCVS venting capacity. The RELAP5 computer code was used to model the HCVS to perform this analysis. RELAP5 is a code to simulate transient two-phase flow conditions in piping systems. The RELAP5 program generates time-dependent thermal-hydraulic conditions within the piping at user-specified time increments. A torus vapor space pressure of 47 psig was used at Dresden. The energy for 1 percent thermal power is calculated to be equivalent to a steam flow rate of approximately 110,381 lbm/hr. The current design was evaluated considering pipe diameter, length, and geometry, as well as vendor provided valve loss of coefficients (Cv's), and the losses associated with a burst rupture disc. The licensee's RELAP5 calculation concludes that at the torus pressure of 47 psig the HCVS can vent 111,071 lbm/hr of steam for Unit 3 and 121,442 lbm/hr of steam for Unit 2, which provides margin to the minimum required flow rate. The NRC staff reviewed the licensee's evaluations and finds that the HCVS vent design will support the capacity to vent 1 percent of rated thermal power (110,381 lbm/hr) during ELAP and severe accident conditions.

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design characteristics are consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and 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 Dresden HCVS vent path consist of a separate wetwell vent for each unit. The upstream portion consists of 18-inch nominal diameter piping and the upstream primary containment isolation valve (PCIV) that is shared with the torus containment purge exhaust path. The downstream portion consists of 10-inch nominal diameter piping and includes the downstream PCIV and the rupture disc. The downstream PCIV and rupture disc are dedicated to the HCVS function. The rupture disc is credited as the secondary containment isolation barrier. The 10-inch diameter vent line is initially routed vertically within the RB and then horizontally through the RB wall at elevation 591', which is approximately 74 feet above nominal plant ground elevation. This line is then routed vertically (from elevation 591' to 665'-5") on the outside of the RB to a point approximately 5 feet above the highest point of the RB roof. This satisfies the guidance for height from HCVS-FAQ-04. Since the RB refuel floor has sheet metal siding, the 74'-5" vertical run (from elevation 591' to 665'-5") of the two vent lines is supported by a structural steel tower bolted to a structural steel platform attached to the RB south wall. The licensee performed evaluation DRE15-0038, "Evaluation of Reactor Building Exterior Structural Steel Tower," Revision 2 to design a steel tower to support the Unit 2 and Unit 3 HCVS piping outside of the RB for beyond-design-basis conditions, which includes tornado and safe shutdown earthquake (SSE) events. The NRC staff reviewed the licensee's evaluation at the HCVS steel support tower, which is shown to be structurally adequate to withstand the beyond-design-basis loads. This calculation demonstrates that the HCVS tower adds insignificant mass to the RB and will have negligible impact on the seismic analysis of the RB. Additionally, there is no seismic interaction between the RB and HCVS tower during a seismic event. There are no interconnected systems downstream of the second PCIVs and there is no sharing of any flow path between the two units.

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 28], 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, for plants that are enveloped by the assumptions in the white paper. For the missile protection of the outdoor HCVS stack, the licensee provided a site-specific missile evaluation, documented in Engineering Change (EC) 13-400578, Revision 2 consistent with HCVS-WP-04. The White Paper assumes: 1) piping and components external to any missile-protected structure and less than 30 feet above grade are evaluated and protected from large and small wind-generated missiles; 2) piping and components external to any missile-protected structure and greater than 30 feet above grade provide a target area less than 300 square feet, the size and robustness of the exposed HCVS piping and components are substantial, and there is no source of obvious potential missiles in the proximity of the exposed HCVS components; 3) the licensee considered guidance in FLEX or other procedures, to restore venting capability in the event the HCVS is damaged; 4) the licensee verified that if hurricanes are screened in for FLEX, site procedures recommend a plant shutdown prior to hurricane arrival on-site. Dresden's evaluation demonstrated that the pipe was robust with respect to external missiles per HCVS-WP-04 in that: 1) For the portions of exposed piping below 30 feet above grade, the two SAWA penetrations near plant grade level are missile protected by thick plates and the two HCVS vent lines exit the RB at elevation 591' (74' above the plant grade); 2) the exposed piping greater than 30 feet above grade has the following characteristics: a) the total vent pipe exposed area is about 152 square feet for both vent lines (about 85' long, 10.75" OD each), which is less than the 300 square feet, b) the pipe is made of schedule 40 steel and is not plastic and the pipe components have no small tubing susceptible to missiles, c) there are no obvious sources of missiles located in the proximity of the exposed HCVS components; 3) the only credible missile for Dresden above 30' elevation is a 1" diameter steel rod. Dresden HCVS pipe thickness is nominally 0.365" thick and the thickness of steel required to stop the 1" diameter steel rod missile is 1" thick steel. Therefore, the missile would penetrate the pipe section but is unlikely to crimp the vent line, thus a cutting tool is not required for Dresden; and 4) Dresden is not screened in for hurricanes. The conclusion of the evaluation is that Dresden meets all of the tornado missile assumptions identified in HCVS-WP-04. The NRC staff reviewed the information provided and finds that supplementary protection is not required for the HCVS piping and components.

Based on the evaluation above, the NRC staff finds that the licensee's location and design of the HCVS vent path and discharge are consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately address the requirements of the Order.

3.1.2.3 Unintended Cross Flow of Vented Fluids

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

In its FIP, the licensee stated that the HCVS for Units 2 and 3 for Dresden are fully independent of each other with separate discharge points. Therefore, the status at each unit is independent of the status of the other unit's HCVS. The two vent lines are supported by a common tower/platform but hydraulically there is no cross tie between them.

The existing Augmented Primary Containment Vent System has two valves, 2(3)-1601-24 and 63 downstream of the new HCVS connection point. This upstream 18-inch nominal diameter portion isolates any interconnected, non- HCVS systems in that unit through normally shut, air-operated PCIVs that, if open, will automatically shut. Both of these valves are part of the 10 CFR Part 50 Appendix J, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors", Program [Reference 29] and go through periodic surveillance testing to ensure the leak rates to be within the acceptable limits. The downstream dedicated 10-inch portion does not have any interconnected systems. 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 finds that the licensee's HCVS design limits the potential for unintended cross flow of vented fluids consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses the requirements of the Order.

3.1.2.4 Control Panels

Order EA-13-109, Attachment 2, Section 1.2.4 requires that the HCVS be designed to be manually operated during sustained operations from a control panel located in the main control room or a remote but readily accessible location. Relevant guidance is found in NEI 13-02 Sections 4.2.2, 4.2.4, 4.2.5, 5.1, and 6.1, NEI 13-02 Appendices A and H, and HCVS-FAQs-01 and -08.

In its FIP, the licensee stated that a HCVS control panel is located in the MCR, which allows for the operation and monitoring of the HCVS. In addition, a secondary location for the HCVS operation is the ROS, which is located in the Turbine Building adjacent to the RB north wall. Both locations are protected from adverse natural phenomena and are sufficiently radiologically shielded. The MCR is the normal control point for HCVS operation and plant emergency response actions. The ROS provides means to manually operate the wetwell vent in case the MCR is not accessible. The dc battery system, battery charger, and argon and nitrogen bottle racks are installed at the ROS. The seismic adequacy for the ROS location was analyzed by the licensee and is discussed in Section 3.2.2 of this SE. The NRC staff reviewed the licensee's HCVS design and finds the locations for operation of the HCVS to be acceptable and consistent with the guidance.

Based on the evaluation above, the NRC staff finds that the licensee's location and design of the HCVS control panels is consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses 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 HCVS-FAQs-01, -03, -08, and -09.

In its FIP, the licensee described the ROS as a readily accessible alternate location, with means operation of HCVS valves via pneumatic motive force. The ROS contains manually operated valves that supply pneumatics to the HCVS flow path valve actuators so that these valves may be opened without power to the valve actuator solenoids and regardless of any containment isolation signals that may be actuated. This provides a diverse method of valve operation improving system reliability.

Following alignment of the three way valve and gas isolation valves (Table 3-1 of the FIP) at the ROS, the HCVS has been designed to allow initiation, control, and monitoring of venting from the MCR and will be able to be operated from an installed ROS consistent with the requirements of the Order. Both locations minimize plant operators' exposure to adverse temperature and radiological conditions, as discussed in Sections 3.1.1.2 and 3.1.1.3 above, and 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 replenishment of pneumatic supplies and Argon purge system stored gases and recharging the electrical supply. The NRC staff's review confirmed that the actions are consistent with the guidance.

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design allows for manual operation consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses 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 Supply Analysis

For the first 24 hours following the event, the motive supply for the air-operated valves (AOVs) will be nitrogen gas bottles that will be pre-installed and available. These bottles have been sized such that they can provide motive force for at least 12 cycles of a vent path, which includes two openings for each of the two PCIVs (2(3)-1601-60) and at least 12 openings of the HCVS isolation valve, 2(3)-1601-93. In its FIP, the licensee stated that based on its evaluation, only 3 venting cycles are needed in the first 24 hours.

The licensee performed a calculation in Section 4.1.33 of ECS 400578, "Hardened Containment Vent System Modification," Revision 0, which determined the required pneumatic supply storage volume and supply pressure set point required to operate the HCVS AOVs (2(3)-1601-60 and 2(3)-1601-93) for 24 hours following a loss of normal pneumatic supplies during an ELAP. The licensee's calculation determined that two nitrogen bottles filled to a minimum pressure of 2500 psig provide sufficient capacity for operation of the HCVS valves for 24 hours following an ELAP. This minimum pressure includes an allowance for leakage. The NRC staff reviewed the calculation in EC 400578 and confirmed that there is 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.

Power Source Analysis

In its FIP, the licensee stated that during the first 24 hours of an ELAP event, Dresden would rely on the new HCVS battery to provide power to HCVS components. The 125 Volt (V) dc HCVS battery and battery chargers are located on the south side of the turbine floor (561' elevation) near the ROS where it is protected from screened in hazards. Exide Technologies manufactured the HCVS battery (GNB model MCX-9) with a nominal capacity of 1800 ampere-hours (A-H). The HCVS battery is sized such that it is capable of supplying 125 Vdc to Unit 2 and Unit 3 for 24 hours (assuming simultaneous operation of the HCVS at both units) without recharging. During the audit period, the licensee provided the NRC staff an evaluation for the HCVS battery/battery charger sizing requirements including incorporation into the FLEX diesel generator (DG) loading calculation.

The NRC staff reviewed licensee calculation DRE15-0056, "125 VDC Battery Sizing Calculation For Hardened Containment Vent System for 24 Hour Duty Cycle," Revision 1, which verified the capability of the HCVS battery to supply power to the required loads during the first phase of the Dresden venting strategy for an ELAP event. The HCVS battery was sized in accordance with Institute of Electrical and Electronics Engineers (IEEE) Standard 485-2010, "IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications," which is endorsed by RG 1.212, "Sizing of Large Lead-Acid Storage Batteries," 2015. The licensee's evaluation identified the required loads and their associated ratings (ampere (A) and minimum required voltage). The licensee's battery sizing calculation showed that based on 8.8A of loading for a 24-hour duty period, a 211.2 A-H battery is required to satisfy the necessary battery duty cycle and end-of cycle battery terminal voltage requirements. The battery selected by the licensee has a capacity of 344 A-H, which is more than the minimum required (211.2 A-H). Therefore, the Dresden HCVS battery will have sufficient capacity to supply power for at least 24 hours.

The licensee's strategy includes repowering the HCVS battery chargers within 24 hours after initiation of an ELAP. The licensee's strategy relies on a pre-staged and portable 800 kilowatt (kW) 480 Vac FLEX DG. Only one of the FLEX DGs is required for the HCVS electrical strategy. The 480 Vac FLEX DG will provide power to the HCVS load in addition to loads addressed under Order EA-12-049. The licensee also has 5.5 kW portable generators available to repower the HCVS battery chargers.

The NRC staff reviewed licensee calculation DRE14-0037, "Unit 2(3) 480 VAC FLEX Diesel Generator and Cable Sizing for Beyond Design Basis FLEX Event," Revision 1, which incorporated the HCVS loads on the FLEX DG. The loads added include an HCVS battery charger and a 60A portable distribution unit. The minimum required load for the Phase 2 800 kW FLEX DG incorporating the HCVS loads is 737 kW. Based on its review of calculation

DRE14-0037, the NRC staff finds that the FLEX DGs will have sufficient capacity and capability to supply the necessary loads during an ELAP event.

Electrical Connection Points

The licensee's strategy is to supply power to HCVS components using a combination of permanently installed and portable components. Staging and connecting the 800 kW FLEX DG was addressed under Order EA-12-049. Licensee procedure FSG-06, "FLEX Strategy for Aligning Power to U2 (3) 480 Volt Safety Related Busses 28 (38) and 29 (39)," Revision 2 provides guidance to power 480 Vac buses 29 (39) from the 480 Vac FLEX DGs to power the HCVS battery chargers. Licensee procedure DOP 8300-14, "125VDC Hardened Containment Ventilation System Battery Charger Operation," Revision 1, provides guidance to power the HCVS battery chargers from a portable generator.

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design allows for reliable operation with dedicated and permanently installed equipment consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses 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 accidents. In addition, the HCVS was designed to provide features that prevent inadvertent actuation due to equipment malfunction or operator error. The features that prevent inadvertent actuation are two PCIVs in series with a downstream rupture disc. The downstream PCIV is a normally shut, fail-shut AOV dedicated to the HCVS function. This valve is air to open; spring to shut that requires energizing a solenoid-operated valve (SOV) to allow the motive air to open the valve. This PCIV is controlled by its own key-locked switch. In addition, the dc power to its SOV and the motive air supplied will normally be disabled to prevent inadvertent operation. The containment isolation valves must be opened to permit vent flow. The physical features that prevent inadvertent actuation are the key lock switches for 2(3)-1604-1, 2(3)-1604-10A, 2(3) 1604-20A and 2(3)-1605-25A at the 902(3)-13 panel in the MCR and locked closed valves at the ROS. The NRC staff's review of the HCVS confirmed that the licensee's design is consistent with the guidance and appears to preclude inadvertent actuation.

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design, with respect to prevention of inadvertent actuation, is consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses 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 1.2.4. In addition, Order EA-13-109 requires that the monitoring system be designed for sustained operation during an ELAP. Relevant guidance is found in NEI 13-02 Section 4.2.2, and HCVS-FAQs-01, -08, and -09.

The licensee stated in its FIP that the HCVS monitoring parameters include indications for HCVS valve position, vent pipe temperature and effluent radiation levels in the MCR, HCVS dc battery voltage, and backup nitrogen pressure at the ROS. The licensee also stated in the FIP that wetwell level and containment pressure indications are R.G. 1.97 variables and these components will be powered by the FLEX DG through emergency busses for sustained operation, but may be read directly with portable hand instruments should the FLEX DGs fail.

The licensee further stated in its FIP that HCVS instruments have sufficient accuracy and range and are qualified for the environment as summarized in Table 1 of the FIP.

The NRC staff reviewed the information provided in the FIP and confirmed the details of qualification for the HCVS instruments in Dresden documents EC400578 and EC401069. The staff confirmed the RG 1.97 variables through its review of the Dresden UFSAR.

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design allows for the monitoring of key HCVS instrumentation consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses 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 1.2.4 and be designed for sustained operation during an ELAP. Relevant guidance is found in NEI 13-02 Section 4.2.4 and HCVS-FAQs-08 and -09.

The HCVS design includes radiation monitors that are sufficient to monitor the effluent discharge during the operation of HCVS including severe accident conditions. The HCVS radiation monitoring system consists of an ion chamber detector at elevation 589', coupled to a process and control module. The process and control module is mounted in the ROS at the Turbine Building 561' elevation. The MCR has a radiation indicator on the 902(3)-13 panel to verify venting operation. As discussed above in Section 3.2.1.8, the radiation monitor detector is fully qualified for the expected environment at the vent pipe during accident conditions, and the process and control module is qualified for the environment in the Turbine Building ROS. Both components are qualified for the seismic requirements. The NRC staff reviewed the information provided and finds it acceptable.

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design allows for the monitoring of effluent discharge consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses the requirements of the Order.

3.1.2.10 Equipment Operability (Environmental/Radiological)

Order EA-13-109, Attachment 2, Section 1.2.10 requires that the HCVS be designed to withstand and remain functional during severe accident conditions, including containment pressure, temperature, and radiation while venting steam, hydrogen, and other non-condensable gases and aerosols. The design is not required to exceed the current capability of the limiting containment components. Relevant guidance is found in NEI 13-02 Sections 2.3, 2.4, 4.1.1, 5.1 and 5.2, NEI 13-02 Appendix I, and HCVS-WP-02.

Environmental

During all non-flood scenarios, the FLEX diesel driven pumps and FLEX DG will be staged outside so they will not be adversely impacted by a loss of ventilation. However, during a flood scenario, the FLEX DG (only one is required) is staged on the 561' elevation of the Turbine Building and the SAWA (flood) pump barge is staged in the Turbine Building ground floor, both contributing to the heat load in the Turbine Building.

As discussed above in Section 3.1.1.2, the licensee performed technical evaluation EC-EVAL-403298 and calculation DRE17-0013 which analyzes the temperature response in the turbine building. The licensee determined that the temperature in the turbine building would remain above 55°F in extreme cold and below 120°F in extreme heat. In the FIP, the licensee stated that four doors would be open on the turbine deck at 561' elevation and two large roll-up doors at 517' elevation will be opened to establish a natural circulation of air. Procedure FSG-31, "FLEX Ventilation Strategies," Revision 3, provides guidance to open doors on the turbine deck at elevations 561' and 517'.

Based on the above, the NRC staff finds that the licensee's ventilation strategy (opening doors) should maintain the turbine building temperature below the maximum temperature limit for the HCVS battery (120°F), HCVS battery charger (122°F), FLEX DG (122°F), and diesel-driven flood pump (122°F). Therefore, the NRC staff finds that the equipment located in the turbine building should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

Radiological

As discussed above in Section 3.1.1.3, the licensee performed calculation DRE16-010 which documents the dose assessment for both personnel habitability and equipment locations associated with event response to a postulated ELAP condition. The NRC staff's review of DRE16-0010 found that the licensee used conservative assumptions to bound the peak dose rates for the analyzed areas. For the sources considered and the methodology used in the dose calculation, the timing of HCVS vent operation or cycling of the vent will not create higher doses at personnel habitability and equipment locations (i.e., maximum doses determined in the calculation bound operational considerations for HCVS vent operation). The NRC staff's review finds 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 finds that the licensee's HCVS design, with respect to equipment operability during severe accident conditions, is consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses the requirements of the Order.

3.1.2.11 Hydrogen Combustible Control

Order EA-13-109, Attachment 2, Section 1.2.11 requires that the HCVS be designed and operated to ensure the flammability limits of gases passing through the system are not reached; otherwise, the system shall be designed to withstand dynamic loading resulting from hydrogen deflagration and detonation. Relevant guidance is found in NEI 13-02 Sections 4.1.7, 4.1.7.1, and 4.1.7.2, NEI 13-02 Appendix H, and HCVS-WP-03.

NEI 13-02, Section 4.1.7 provides guidance for the protection from flammable gas ignition for the HCVS system. The NRC-endorsed NEI white paper, HCVS-WP-03, "Hydrogen /Carbon Monoxide Control Measures," Revision 1 [Reference 30], 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), which ensures the flammability limits of gases passing through the system are not reached.

In its FIP, the licensee stated that in order to prevent a detonable mixture from developing in the pipe, the HCVS design includes an Argon purge system that is connected just downstream of the second PCIV. It is designed to prevent hydrogen detonation downstream of that valve. The Argon purge system has a switch for the control valve in the MCR to allow opening the purge for the designated time, but it also allows for local operation in the ROS in case of a dc power or control circuit failure. The Argon purge will only be utilized following severe accident conditions when hydrogen is being vented. After an initial line-up of locked valve 2(3)-1605-14 in the ROS and opening argon bottle manifold valves, the system can be operated from the MCR by energizing solenoid valve 2(3)-1605-25A. The installed capacity for the Argon purge system has been designed to accommodate up to 12 purges within the first 24 hours of the ELAP. The Argon purge system can also be used to breach the rupture disc if venting is required before reaching the rupture disc setpoint. The licensee performed evaluation DRE15-0047, which computes the number of purge cycles that can be achieved per Argon bottle, as well as the purge rate required to adequately disallow a combustible mixture of air and hydrogen. DRE15-0047 determined that a 26-second purge time is required to burst the rupture disc; for purging the combustibles after a vent cycle, a 40-second purge time has been calculated. The design allows for Argon bottle replacement for continued operation past 24 hours. The MCR panel will include an indication of Argon pressure to the HCVS path to verify that the Argon purge system flow is occurring. The NRC staff confirmed that the licensee's design is consistent with Option 3 of white paper HCVS-WP-03. The staff also reviewed the licensee's analysis and confirmed the installed purge system capacity is sufficient.

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design ensures that the flammability limits of gases passing through the system are not reached consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses the requirements of the Order.

3.1.2.12 Hydrogen Migration and Ingress

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

As discussed above in Section 3.2.1.3, the downstream dedicated 10-inch portion of the HCVS does not have any interconnected systems. The existing Augmented Primary Containment

Vent System has two valves, 2(3)-1601-24 and 63, downstream of the new HCVS connection point, which isolates any interconnected, non- HCVS systems in that unit. These valves are normally-closed, fail closed (spring and solenoid operated) valves. Upon initiation of an ELAP and associated loss of instrument air, the valves would automatically shut due to spring pressure or loss of power to the solenoid. Therefore, no additional power is necessary. These boundary valves are located at a high point of the HCVS piping. When closed, the leakage is minimized. At slow leakage rates, there would be no motive force to move any accumulated hydrogen away from the high point of the piping, thereby preventing a combustible mixture in any areas of the RB. Both of these valves are part of the 10 CFR Part 50 Appendix J program and go through periodic surveillance testing to ensure the leak rates to be within the acceptable limits. Testing and maintenance will be performed to ensure that the valves remain leak-tight within established leakage criteria. The NRC staff's review confirmed that the design is consistent with the guidance and that the proposed design will minimize the potential of hydrogen gas migration into other buildings.

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design minimizes the potential for hydrogen gas migration and ingress consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses the requirements of the Order.

3.1.2.13 HCVS Operation/Testing/Inspection/Maintenance

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

Primary and secondary containment required leakage testing is covered under existing design basis testing programs. The HCVS outside the containment boundary shall be tested to ensure that vent flow is released to the outside with minimal leakage, if any, through the interfacing boundaries with other systems or units.

In the FIP, Table 3-3 includes testing and inspection requirements for HCVS components. The NRC staff reviewed Table 3-3 and found that it 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 industry preventive maintenance process for the maintenance, calibration, and testing of the HCVS components. The staff reviewed the information provided and confirmed that the licensee has implemented adequate programs for operation, testing, inspection and maintenance of the HCVS.

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design allows for operation, testing, inspection, and maintenance consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses the requirements of the Order.

3.2 HCVS QUALITY STANDARDS

3.2.1 Component Qualifications

Order EA-13-109, Attachment 2, Section 2.1 requires that the HCVS vent path up to and including the second containment isolation barrier be designed consistent with the design basis of the plant. Items in this path include piping, piping supports, containment isolation valves, containment isolation valve actuators and containment isolation valve position indication components. Relevant guidance is found in NEI 13-02 Section 5.3.

In its FIP, the licensee stated that the HCVS upstream of and including the second containment isolation valve and penetrations are not being modified for Order compliance. The design is consistent with the design basis of primary containment including pressure, temperature, radiation, and seismic loads.

During the audit period, the licensee provided a discussion if the operations of the existing containment isolation valves (2(3)-1601-24 and 63) relied upon for the HCVS. Appendix B of the Design Consideration Summary (DCS) of EC 401069 describes the Primary Containment Pressure Limit (PCPL), which is conservatively expected to be the differential pressure during Beyond Design Basis External Event (BDBEE) and severe accident wetwell venting, being less than the maximum valve differential pressure limit. The PCPL is also less than the design pressure of the line containing the existing containment isolation valve. The licensee provided valve/actuator information which shows the actuator capability and margin calculations for the two existing PCIVs. The NRC staff reviewed this information and verified the actuator can develop greater torque than the PCIVs' unseating torque.

The new HCVS primary containment isolation valve (AOV 3-1601-93) is a triple offset butterfly valve, which is torque seated, and is classified as safety-related since it forms part of the primary containment boundary. The new HCVS PCIV is also equipped with a safety-related, spring to close/gas to open (fail closed) actuator. The piping that connects this new PCIV to existing vent system piping is also classified as safety-related.

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design, with respect to component qualifications, is consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses the requirements of the order.

3.2.2 Component Reliability and Rugged Performance

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

In its FIP, the licensee states that the HCVS components downstream of the outboard containment isolation valve and components that interface with the HCVS are routed in seismically qualified structures or supported from seismically qualified structures. The HCVS downstream of the outboard containment isolation valve, including piping and supports, electrical power supply, valve actuator pneumatic supply, and instrumentation (local and remote) components, has been designed and analyzed to conform to the requirements consistent with the applicable design codes for the plant and to ensure functionality following a design-basis earthquake as required per Section 2.2 of Order EA-13-109.

New components related to HCVS operation are required to be designed to operate following a seismic event. The NRC staff reviewed Design Change Package (DCP) 401069, which states that the new PCIV and components related to the PCIV are safety-related and therefore considered Seismic Category I. Other HCVS components that have a design basis function, including the rupture disc, and the piping between the rupture disc and the RB exterior wall, are also designated Seismic Category I. All new HCVS components solely dedicated to HCVS operation, including motive air, purge, and battery systems, are designed to the seismic design requirements of the plant and evaluated as Seismic Category I systems. Table 1 of the FIP contains a list of components and instruments required to operate the HCVS, their qualification and evaluation against the expected conditions. The NRC staff reviewed this table and confirmed that the components required for HCVS venting are designed to remain functional following a design basis earthquake.

In accordance with the design requirements, the ROS components and their supports must remain functional post seismic and tornado events. For the tornado event, both tornado wind and missile impact must be considered. The licensee performed calculation DRE16-0028, "Evaluation of Ventilation Floor at El 581'-4" for the Hardened Containment Vent Remote Operation Station Modification," Revision 0, which evaluates the adequacy of the ROS location including seismic interaction of the structure above the ROS location. It was determined that stresses on the ROS components were less than the allowable stresses. The licensee also performed calculation DRE 16-0029, "Hardened Containment Vent Remote Operating System Tornado Missile Barrier," Revision 0, which evaluates the adequacy of missile barriers to protect the Unit 2 and Unit 3 ROS components from tornado generated missiles. As a result, the licensee installed missile barriers accordingly. Additionally, the in-place concrete structure was found to be adequate for load imparted by the barrier anchorage. The NRC staff reviewed the licensee's evaluation and determined that the ROS components are protected from and will not fail during an SSE or tornado missile strike.

The only portion of the HCVS system not contained within a seismic, missile protected area is the vent pipe external to the RB. However, the external piping meets the tornado reasonable protection criteria provided in HCVS-WP-04. All external components are limited to large bore piping and its supports, are located above 30' from ground level, and the piping cross section is less than 300 square feet. There are no obvious sources of missiles located in the proximity of the exposed HCVS components.

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design, with respect to component reliability and rugged performance, is consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses the requirements of the Order.

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

Based on its review, the NRC staff finds that the licensee has developed guidance and a HCVS design that, if implemented, appropriately adequately addresses the requirements of Order EA-13-109, Phase 1.

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. Dresden 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.

- 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 pumps to provide SAWA flow. The pumps discharge to a FLEX/SAWA manifold which will direct flow to the Low Pressure Coolant Injection (LPCI) system and then into the reactor pressure vessel (RPV). The licensee states in the FIP that the operator locations for deployment and operation of the SAWA equipment are either shielded from direct exposure to the vent line or a significant distance from the vent line so dose will be maintained below Emergency Response Organization (ERO) exposure guidelines. Once SAWA flow is initiated, operators will have to monitor and maintain SAWA flow and ensure refueling the diesel driven equipment as necessary. Operators may also have to reduce flow as part of the severe accident water management (SAWM) strategy, if necessary, using one of the manifolds described below.

4.1.1 Staff Evaluation

4.1.1.1 Flow Path

The SAWA injection flow path starts from the FLEX suction at the Cribhouse intake for the plant Ultimate Heat Sink (UHS) through the SAWA (FLEX) pump to the FLEX/SAWA manual manifold having connections for the SAWA pump and the hose that will deliver SAWA flow to the RPV. This valve manifold will also provide minimum flow and freeze protection for the pump. From this valve manifold, hoses will be routed to the permanent SAWA connection points located on the outside of the RB that are hard piped to the LPCI system. Once the SAWA components are deployed and connected, the SAWA flow path is controlled at the valve manifold. Backflow prevention is provided by check valves installed in the LPCI system which are leak tested using the existing leakage testing programs. Cross flow into other portions of the residual heat removal system will be isolated by ensuring closure of the motor operated valves from the MCR. Drywell pressure and Suppression Pool level will be monitored and flow rate will be adjusted by use of the FLEX (SAWA) pump control valve at the valve manifold that also contains the SAWA flow indication. Alternately, the flow indication and flow control may be from the pump discharge. Communication will be established between the MCR and the SAWA flow control location, which is discussed below in Section 4.2 of this SE.

The flow path described above applies for all BDBEEs except for river flooding. For flood conditions, Dresden will use two barge mounted diesel driven pumps (Flood Pumps) as part of the FLEX (Order EA-12-049) flood strategy. One pump will be able to provide all water make-up needs for both units under FLEX and/or Severe Accident conditions. The second pump provides redundancy. The river flood is slow developing so the site will have about 24 hours of advance warning. Dresden procedure DOA 0010-04 “Floods,” Revision 38, describes the strategy to deploy all necessary equipment if a flood is predicted. The RB will be secured by flood barriers to keep the flood waters from entering the torus basement and rendering the wetwell vent inoperable. The barge mounted flood pumps will be staged prior to flooding, so the Flood Pumps will remain functional as flood waters rise or recede. Procedure FSG-60 describes the FLEX Flood Pump Deployment-Operation. The Flood Pump will take suction from the flood water and deliver it to the FLEX/SAWA manifold located on the turbine deck at elevation 561’ with flow measuring devices staged at the Turbine Building mezzanine. Operators will route hoses from the manifold across the turbine deck to the RB where they will connect them to the LPCI system as described above.

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 421 gallons per minute (gpm) of SAWA flow to one or both units simultaneously while providing spent fuel pool (SFP) and RPV makeup for all SAWA and FLEX scenarios. During the audit, the staff reviewed calculation DRE17-0008, "HCVS Phase 2 SAWA/SAWM Hydraulic Analysis," Revision 0, which determined that the required SAWA flowrate of 421 gpm to each unit was within the capacity of the portable FLEX pumps.

The NRC staff reviewed the flow rates and pressures evaluated in the hydraulic analyses and confirmed that the equipment is capable of providing the needed flow rates. Based on the NRC staff's review of the FLEX pumping capabilities at Units 2 and 3, as described in the above hydraulic analyses and the FIP, 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

During the audit, the staff reviewed, calculation DRE 17-0008, “HCVS Phase 2 SAWA//SAWM Hydraulic Analysis”, Revision 0, which analyzed the SAWA strategy to ensure established flow injection requirements will be achieved. A SAWA flow rate of 421 gpm was determined by using the industry base case model flow of 500 gpm and prorating that flow to the Dresden licensed reactor thermal power. One pump is used to serve both Unit 2 and Unit 3. An analysis was performed assuming one unit in a severe accident (421 gpm flow for the first 4 hours, starting at 7 hours into the event, followed by 85 gpm to the RPV for 164 hours and 30 gpm to the SFP) and one unit in “FLEX” (350 gpm to the isolation condenser, 25 gpm to the standby liquid control system, and 32 gpm to the SFP).

Based on the evaluation above, the NRC staff finds that the licensee's HCVS design allows for reliable operation with dedicated and permanently installed equipment consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses 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, if implemented appropriately, will make it unlikely that the licensee would need to vent from the containment drywell during severe accident conditions following an ELAP event consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses the requirements of the Order.

4.2 SEVERE ACCIDENT WATER MANAGEMENT

The strategy for Dresden to preclude the necessity for installing a hardened drywell vent, is to implement the containment venting strategy utilizing SAWA and severe accident water management (SAWM). This strategy consists of the use of the Phase 1 wetwell vent and SAWA hardware to implement a water management strategy that will preserve the wetwell vent path until alternate reliable containment heat removal can be established. The SAWA system consists of a FLEX (SAWA) pump injecting into the RPV; SAWM consists of flow control at the FLEX (SAWA) pump along with instrumentation and procedures to ensure that the wetwell vent is not submerged (SAWM). Procedures have been issued to implement this strategy including Revision 3 to the Severe Accident Management Guidelines (SAMG) and BWR Owners' Group Emergency Procedures Committee (EPC) Issues 13-14.

The SAWA system consists of a SAWA pump injecting into the RPV (discussed above); SAWM consists of flow control at the FLEX/SAWA manifold 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 FLEX/SAWA manifold. Throttling valves and flow meters will permit throttling water flow to maintain wetwell availability. Boiling-Water Reactors Owners Group (BWROG) generic assessment, BWROG-TP-15-008 [Reference 31], provides the principles of Severe Accident Water Addition to ensure protection of containment.

In its FIP, the licensee discussed communication between the MCR and the operator at the FLEX/SAWA manual valve during ELAP and severe accident conditions. Procedure FSG-39, "FLEX Communications Options," discusses the available onsite communications. Dresden utilizes the installed sound powered headset system within the power block and 800 Mhz [megahertz] radios in the talk around mode to communicate between the MCR and the SAWA flow control location. These communication methods are consistent with FLEX communication practices at Dresden and have been previously reviewed and accepted by the NRC staff under Order EA-12-049. These items will be powered and remain powered using the same methods as evaluated under Order EA-12-049 for the period of sustained operation.

4.2.1 Staff Evaluation

4.2.1.1 Available Freeboard Use

As stated in the FIP, the torus freeboard volume (above 14.9' water level [minimum Technical Specification water level]) is 1,021,500 gallons before the water level reaches the bottom of the wetwell vent pipe. Generic assessment BWROG-TP-15-011 [Reference 32], provides the principles of SAWM to preserve the wetwell vent for a minimum of 7 days. After containment parameters are stabilized with SAWA flow, SAWA flow will be reduced to a point where containment pressure will remain low while wetwell level is stable or very slowly rising. For Dresden, the SAWA flow rate is 421 gpm for first 4 hours followed by 85 gpm until an alternate means of removing reactor decay heat can be implemented. The total SAWA and SAWM water addition will be 937,440 gallons (rounded up to 940,000 gallons) for the first 7 days. After 7 days the remaining freeboard space will be 81,500 gallons. Dresden determined that the remaining freeboard volume translates to about 2.7 feet high air space above the torus water, ensuring that the wetwell vent will remain operational as a result of implementing the SAWA/SAWM strategy for a seven-day period. The NRC staff reviewed the information provided and concurs that the flow of water added to the suppression pool can be controlled such that the wetwell vent remains operational.

4.2.1.2 Strategy Time Line

As noted above, the SAWA/SAWM strategy is based on BWROG generic assessments in BWROG-TP-15-008 and BWROG-TP-15-011. The SAWA flow is based on the industry base model plant flow prorated to the rated thermal power for Dresden. The SAWA flow of 421 gpm is modeled to start after 8 hours and will be reduced to 85 gpm after 4 hours.

4.2.2 Conclusions

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

4.3 SAWA/SAWM MOTIVE FORCE

4.3.1 Staff Evaluation

4.3.1.1 SAWA Pump Power Source

As described above, the licensee plans to use portable diesel-driven pumps to provide SAWA flow. Operators will refuel the pump and DGs in accordance with Order EA-12-049 procedures using fuel oil from the installed emergency diesel generator (EDG) fuel oil storage tanks. Procedure FSG-32, "Refueling FLEX Portable Equipment," Rev. 3, 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. The fuel tank on the SAWA pumps are sized such that the pumps can run for approximately 24 hours prior to needing to be refueled. The licensee states in Section IV.C.9.6.1 that it will have enough onsite fuel supply for more than 7 days.

4.3.1.2 DG Loading Calculation for SAWA/SAWM Equipment

In its FIP, the licensee lists drywell pressure, wetwell level, and the SAWA flow meter as instruments required for SAWA and SAWM implementation. The drywell pressure and wetwell level instruments are used to monitor containment. These instruments are powered by the Class 1E station batteries until the FLEX DG is deployed and available. The SAWA flow meter has an internal battery which will power the flow meter for 6 hours. As a backup, the SAWA flow meter can be powered by the 800 kW FLEX DG.

The NRC staff reviewed licensee engineering change 391973, "Extend 125VDC and 250VDC Battery Coping Time with Load Shedding," Revision 0, which verified the capability of the Class 1E station batteries to supply power to the required loads (e.g. drywell pressure and wetwell level instruments) during the first phase of the Dresden FLEX mitigation strategy plan for an ELAP event. The NRC staff also reviewed licensee calculation DRE14-0037, which verified that the 800 kW FLEX DG is adequate to support the addition of the HCVS electrical loads.

Based on its review, the NRC staff finds that the Class 1E batteries and 800 kW FLEX DGs will 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, and if implemented appropriately, will make it unlikely that the licensee would need to vent from the containment drywell during severe accident conditions following an ELAP event consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses the requirements of the Order.

4.4 SAWA/SAWM INTRUMENTATION

4.4.1 Staff Evaluation

4.4.1.1 SAWA/SAWM Instruments

Guidance document NEI 13-02 provides specific guidance regarding the required instrumentation necessary to perform SAWA/SAWM operations, which includes indications of containment pressure, wetwell level and water addition flow rate. In Section IV.C.10.1 of its FIP, the licensee states that Table 1 contains a listing of all the instruments needed for SAWA and SAWM implementation, including the expected environmental parameters for each instrument, its qualification, and its power supply for sustained operation. The NRC staff reviewed Table 1 and noted that Dresden's SAWA/SAWM strategy relies on three instruments: wetwell level, containment pressure and a SAWA flow meter to provide indication of the FLEX pump output flow rate. The drywell pressure and wetwell level are existing instrumentation and are declared Dresden PAM variables as described in RG 1.97. The NRC staff review determined that the proposed instruments are consistent with the guidance for SAWA/SAWM instruments.

4.4.1.2 Describe SAWA Instruments and Guidance

The wetwell level indication (LI 2(3)-1640-10 A/B) range is from 0 to 30 feet. This range extends from the bottom of the wetwell to the bottom of the wetwell vent line, covering the range of interest for SAWA operation. The wetwell level indicator is in the MCR.

The drywell pressure indication (LI 2(3)-1640-11 A/B) range is from -5 to 250 PSIG. The PCPL at Dresden is 60 psig. The drywell pressure indicator is in the MCR.

The flow meter (2/3-1570-A(B)) is a portable unit with local indication that will be deployed near the SAWA manifold outside the RB or on the turbine deck elevation 538'. The instrument range is 80 to 2,300 gpm. The anticipated range during use is 85-421 gpm.

4.4.1.3 Qualification of SAWA/SAWM Instruments

Drywell pressure and wetwell level are declared Dresden PAM variables as described in RG 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 flow meter is deployed near the SAWA manifold which will be outside the RB or on the turbine deck 538' elevation depending on site flooding conditions. Radiation is not a significant concern at either location based on the amount of shielding provided by the RB concrete walls. Both flow meter locations are subject to dose during venting operations, but there are only eight venting operations anticipated during the 7 day period, and the total radiation exposure to the flow instrument will not be significant at those locations. The maximum ambient temperature at the flow meter is expected to be 120°F. The flow meter is qualified to operate up to 120°F.

The NRC staff reviewed the environmental conditions and instrument qualification information provided in Section IV.C.10.3 and Table 1 of the FIP and determined that the qualification of the SAWA/SAWM instruments is consistent with the guidance in NEI 13-02.

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, and if implemented appropriately, will make it unlikely that the licensee would need to vent from the containment drywell during severe accident conditions following an ELAP event consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses 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

For SAWA/SAWM severe accident dose considerations, the licensee performed a detailed radiological analysis documented in DRE16-0010, Rev. 1, "FLEX Activity and Phase 2 Dose Assessment." 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 MCR, ROS, and travel paths for hose routing.

In its FIP, the licensee states that the SAWA pumps will be stored in FLEX Building B, which is protected from all applicable external hazards, and will be operated outside the RB, on the opposite side of the RB from the HCVS vent piping, so the pump and operators controlling the pump will not be exposed to significant dose. To minimize operator exposure to hazardous radiological conditions while implementing the SAWA flowpath, the licensee's procedures direct operators to deploy hoses and make connections in the RB in locations that are shielded from significant dose or have been evaluated for dose effects during a severe accident scenario over the period of sustained operation. Therefore, the NRC staff concurs that the SAWA flow path will not be adversely affected by radiation effects due to the severe accident conditions.

4.5.1.2 Severe Accident Effect on SAWA/SAWM Instruments

The licensee states that the drywell pressure and wetwell level instruments are PAM variables as described in RG 1.97 and the existing qualification of these channels is considered acceptable for compliance with Order EA-13-109 in accordance with the guidance in NEI 13-02, Appendix C, Section C.8.1.

As stated in Section 4.5.1.1 above, the SAWA pump will be operated outside the RB, on the opposite side of the RB from the vent pipe. This location ensures that there will be no adverse effects from radiation exposure to the flow instruments mounted on the SAWA pump trailer. Both flow meter locations are subject to dose during venting operations, but there are only eight venting operations anticipated during the 7 day period and the total radiation exposure to the flow instruments will not be significant. Therefore, the NRC staff concurs that the SAWA/SAWM instruments will not be adversely affected by radiation effects due to the severe accident conditions.

4.5.1.3 Severe Accident Effect on Personnel Actions

The NRC staff reviewed calculation DRE17-0013, "Transient Thermal Analysis of Turbine Building for FLEX During SAWA". The results of this analysis indicate the temperature near the Flood Pump will peak at approximately 116 °F with an ambient temperature at 95 °F. The temperature near the FLEX DG will peak at approximately 120 °F with an ambient temperature of 95 °F. Operators are not stationed at this equipment continuously. Limited stay times and existing hot area work procedures, along with ice vests and other compensatory actions, will permit operators to access and operate equipment as needed. Environmental conditions in the Control Room and the ROS were discussed previously in Section 3.1.1.2, Personnel Habitability – Environmental. Based on the above, the NRC staff concludes that environmental conditions will not prevent operators from implementing the SAWA or SAWM strategies.

The licensee performed calculation DRE16-0010, "FLEX Activity and Phase 2 Dose Assessment," which documents the dose assessment for designated areas inside the Dresden RB (outside of containment) and outside the Dresden RB caused by the sustained operation of the HCVS under the beyond-design-basis severe accident condition of an ELAP. This assessment used conservative assumptions to assess the expected dose rates in all areas that may require access during a beyond-design-basis ELAP. As stated in Section 3.1.1.3 Personnel Habitability – Radiological, the NRC staff concludes, based on a review 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 Conclusions

Based on this evaluation, the NRC staff concludes that the licensee has considered the severe accident effects on the water management strategy, and if implemented appropriately, will make it unlikely that the licensee would need to vent from the containment drywell during severe accident conditions following an ELAP event consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses the requirements of the Order.

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

Based on its review, the NRC staff finds that the licensee has developed guidance and a water management strategy that, if implemented appropriately, adequately addresses the requirements of Order EA-13-109, Phase 2.

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 compensatory measures. In the FIP, Section V.B provides specific time frames for out-of-service requirements for the HCVS functionality.

The FIP also provides a list of key areas where either new procedures were developed or existing procedures were revised. The NRC staff reviewed the overall procedures and programs developed, including the list of key components included, and noted that they appear to be consistent with the guidance found in NEI 13-02, Revision 1. The NRC staff determined that procedures developed 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 finds that the licensee's procedures for HCVS/SAWA/SAWM operation is consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and adequately addresses the requirements of the Order.

5.2 Training

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

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

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

6.0 CONCLUSION

In June 2014, the NRC staff started audits of the licensee's progress in complying with Order EA-13-109. The staff issued an ISE for implementation of Phase 1 requirements on February 11, 2015 [Reference 12], an ISE for implementation of Phase 2 requirements on September 20, 2016 [Reference 13], and an audit report on the licensee's responses to the ISE open items on December 20, 2017 [Reference 14]. The licensee reached its final compliance date on January 12, 2018 [Reference 15], and has declared that Dresden Nuclear Power Station, Units 2 and 3 are 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.

6.0 REFERNECES

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 Exelon to NRC, "Dresden, Units 2 and 3 – Phase 1 Overall Integrated Plan in Response to June 6, 2013, Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions Phase 1 (Order Number EA-13-109)," dated June 30, 2014 (ADAMS Accession No. ML14184A018).

3. Letter from Exelon 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 17, 2014 (ADAMS Accession No. ML14351A442)

4. Letter from Exelon 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. ML15181A220)

5. Letter from Exelon to NRC, "Dresden, Units 2 and 3 – 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 16, 2015 (ADAMS Accession No. ML15352A027).

6. Letter from Exelon 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. ML16182A393)

7. Letter from Exelon 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. ML17353A045)

8. Letter from Exelon 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 27, 2017 (ADAMS Accession No. ML17178A078)

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Date: April 27, 2018

SUBJECT: DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3 - SAFETY EVALUATION REGARDING IMPLEMENTATION OF HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS RELATED TO ORDER EA-13-109 (CAC NOS. MF4462 AND MF4463; EPID NO. L-2014-JLD-0047) DATED April 27, 2018

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