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

March 11, 2019

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

SUBJECT: PEACH BOTTOM ATOMIC 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. MF4416 AND MF4417; EPID NO. L-2014-JLD-0053)

Dear Mr. Hanson:

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

By letter dated June 30, 2014 (ADAMS Accession No. ML14181A301), Exelon Generation Company, LLC (the licensee) submitted its Phase 1 OIP for Peach Bottom Atomic Power Station, Units 2 and 3 (Peach Bottom) 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 Peach Bottom, including the combined Phase 1 and Phase 2 OIP in its letter dated December 15, 2015 (ADAMS Accession No. ML15364A015). These status reports were required by the order, and are listed in the enclosed safety evaluation. By letters dated May 27, 2014 (ADAMS Accession No. ML14126A545), and August 10, 2017 (ADAMS Accession No. ML17220A328), the NRC notified all Boiling Water Reactor Mark I and Mark II licensees that the staff will be conducting audits of their implementation of Order EA-13-109 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" (ADAMS Accession No. ML082900195). By letters dated February 12, 2015 (Phase 1) (ADAMS Accession No. ML15026A469), August 2, 2016 (Phase 2) (ADAMS Accession No. ML16099A272), and November 30, 2017 (ADAMS Accession No. ML17328A163), the NRC issued Interim Staff Evaluations and an audit report, respectively, on the licensee's progress. By letter dated September 28, 2018 (ADAMS Accession No. ML18271A008), the licensee reported that Peach Bottom is in full compliance with the requirements of Order EA-13-109, and submitted a Final Integrated Plan for Peach Bottom.

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

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

Sincerely,

Brett Titus

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

Docket Nos. 50-277 and 50-278

Enclosure:
Safety Evaluation

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO ORDER EA-13-109

EXELON GENERATION COMPANY, LLC

PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3

DOCKET NOS. 50-277 AND 50-278

1.0 INTRODUCTION

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

On June 6, 2013 [Reference 1], the NRC issued Order EA-13-109, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions". This order requires licensees to implement its requirements in two phases. In Phase 1, licensees of boiling-water reactors (BWRs) with Mark I and Mark II containments shall design and install a venting system that provides venting capability from the wetwell during severe accident conditions. In Phase 2, licensees of BWRs with Mark I and Mark II containments shall design and install a venting system that provides venting capability from the drywell under severe accident conditions, or, alternatively, those licensees shall develop and implement a reliable containment venting strategy that makes it unlikely that a licensee would need to vent from the containment drywell during severe accident conditions.

By letter dated June 30, 2014 [Reference 2], Exelon Generation Company, LLC (the licensee) submitted a Phase 1 Overall Integrated Plan (OIP) for Peach Bottom Atomic Power Station, Units 2 and 3 (PBAPS, Peach Bottom) in response to Order EA-13-109. By letters dated December 19, 2014 [Reference 3], June 30, 2015 [Reference 4], December 15, 2015 (which included the combined Phase 1 and Phase 2 OIP) [Reference 5], June 30, 2016 [Reference 6], December 15, 2016 [Reference 7], June 30, 2017 [Reference 8], December 15, 2017 [Reference 9], and June 29, 2018 [Reference 10], the licensee submitted 6-month updates to its OIP. By letters dated May 27, 2014 [Reference 11], and August 10, 2017 [Reference 12], 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 13]. By letters dated February 12, 2015 (Phase 1) [Reference 14], August 2, 2016 (Phase 2) [Reference 15], and November 30, 2017 [Reference 16], the NRC issued Interim Staff Evaluations (ISEs) and an audit report, respectively, on the licensee's progress. By letter dated September 28, 2018 [Reference 17], 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 18]. Following interactions with stakeholders, these recommendations were enhanced by the NRC staff and presented to the Commission.

On February 17, 2012 [Reference 19], the NRC staff provided SECY-12-0025, "Proposed Orders and Requests for Information in Response to Lessons Learned from Japan's March 11, 2011, Great Tohoku Earthquake and Tsunami", to the Commission. This paper included a proposal to order licensees to implement the installation of a reliable hardened containment venting system (HCVS) for Mark I and Mark II containments. As directed by the Commission in staff requirements memorandum (SRM)-SECY-12-0025 [Reference 20], the NRC staff issued Order EA-12-050, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents" [Reference 21], 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 22]. In the SRM for SECY-12-0157 [Reference 23], the Commission directed the staff to issue a modification to Order EA-12-050, requiring licensees with Mark I and Mark II containments to "upgrade or replace the reliable hardened vents required by Order EA-12-050 with a containment venting system designed and installed to remain functional during severe accident conditions." The NRC staff held a series of public meetings following issuance of SRM SECY-12-0157 to engage stakeholders on revising the order. Accordingly, as directed by the Commission in SRM-SECY-12-0157, on June 6, 2013, the NRC staff issued Order EA-13-109.

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

2.1 Order EA-13-109, Phase 1

For Phase 1, licensees of BWRs with Mark I and Mark II containments are required to design and install a venting system that provides venting capability from the wetwell during severe accident conditions. Severe accident conditions include the elevated temperatures, pressures, radiation levels, and combustible gas concentrations, such as hydrogen and carbon monoxide, associated with accidents involving extensive core damage, including accidents involving a breach of the reactor vessel by molten core debris.

The NRC staff held several public meetings to provide additional clarifications on the order's requirements and comments on the proposed draft guidance prepared by the Nuclear Energy Institute (NEI) working group. On November 12, 2013 [Reference 24], NEI issued NEI 13-02, "Industry Guidance for Compliance with Order EA-13-109," Revision 0, to provide guidance to assist nuclear power reactor licensees with the identification of measures needed to comply with the requirements of Phase 1 of Order EA-13-109. The NRC staff reviewed NEI 13-02, Revision 0, and on November 14, 2013 [Reference 25], issued Japan Lessons-Learned Project Directorate (JLD) interim staff guidance (ISG) JLD-ISG-2013-02, "Compliance with Order EA-13-109, 'Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Performing under Severe Accident Conditions'", endorsing, in part, NEI 13-02, Revision 0, as an acceptable means of meeting the requirements of Phase 1 of Order EA-13-109, and on November 25, 2013, published a notice of its availability in the *Federal Register* (78 FR 70356).

2.2 Order EA-13-109, Phase 2

For Phase 2, licensees of BWRs with Mark I and Mark II containments are required to design and install a venting system that provides venting capability from the drywell under severe accident conditions, or, alternatively, to develop and implement a reliable containment venting strategy that makes it unlikely that a licensee would need to vent from the containment drywell during severe accident conditions.

The NRC staff, following a similar process, held several meetings with the public and stakeholders to review and provide comments on the proposed drafts prepared by the NEI working group to comply with the Phase 2 requirements of the order. On April 23, 2015 [Reference 26], NEI issued NEI 13-02, "Industry Guidance for Compliance with Order EA-13-109," Revision 1 to provide guidance to assist nuclear power reactor licensees with the identification of measures needed to comply with the requirements of Phase 2 of Order EA-13-109. The NRC staff reviewed NEI 13-02, Revision 1, and on April 29, 2015 [Reference 27], the NRC staff issued JLD-ISG-2015-01, "Compliance with Phase 2 of Order EA-13-109, 'Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Performing under Severe Accident Conditions'", endorsing, in part, NEI 13-02, Revision 1, as an acceptable means of meeting the requirements of Phase 2 of Order EA-13-109, and on April 7, 2015, published a notice of its availability in the *Federal Register* (80 FR 26303).

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

Peach Bottom is a two unit General Electric BWR site with Mark I primary containment systems. To implement the Phase 1 requirements of Order EA-13-109, the licensee modified the existing containment vent piping from the suppression pool/torus air space and routed the HCVS effluent outside the reactor building and up to a point above the reactor building. The HCVS is initiated via manual action at the remote operating station (ROS) combined with control from either the main control room (MCR) or from the ROS at the appropriate time based on procedural guidance in response to plant conditions from observed or derived symptoms. The vent operation is monitored by HCVS valve position, temperature and effluent radiation levels. The vent utilizes containment parameters of pressure and level from the MCR instrumentation to monitor effectiveness of the venting actions. The HCVS motive force is monitored and has the capacity to operate for 24 hours with installed equipment. Replenishment of the motive force, electric or pneumatic, will be by use of portable equipment once the installed motive force is exhausted. Venting actions are capable of being maintained for a sustained period of at least 7 days.

3.1 HCVS Functional Requirements

3.1.1 Performance Objectives

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

3.1.1.1 Operator Actions

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

In its FIP, the licensee stated that operation of the HCVS was designed to minimize the reliance on operator actions in response to hazards identified in NEI 12-06, "Diverse and Flexible Coping Strategies (FLEX) Implementation Guide," Revision 0 [Reference 28], which are applicable to the plant site. Operator actions to initiate venting through the HCVS vent path can be completed by plant personnel, and the system includes the capability for remote-manual initiation from the HCVS control station. A list of the remote-manual actions performed by plant personnel to open the HCVS vent path are listed in Table 3-1, "HCVS Operator Actions," of the FIP.

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, compared it with the information contained in NEI 13-02, and determined that these actions should minimize the reliance on operator actions. The actions are consistent with the types of actions described in NEI 13-02, Revision 1, as endorsed, in part, by JLD-ISG-2013-02 and JLD-ISG-2015-01, as an acceptable means of implementing applicable requirements of Order EA-13-109. The NRC staff also reviewed the HCVS Failure Evaluation Table (FIP Table 3-2, "Failure Evaluation") and determined that the actions described adequately address all the failure modes listed in NEI 13-

02, Revision 1, which include: loss of normal alternating current (ac) power, long-term loss of batteries, loss of normal pneumatic supply, loss of alternate pneumatic supply, and solenoid operated valve failure.

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

3.1.1.2 Personnel Habitability – Environmental

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

In its FIP, the licensee stated that primary control of the HCVS is accomplished from the MCR. Alternate control of the HCVS is accomplished from the ROS located at the 135' elevation in the radwaste building. FLEX actions that may be taken to maintain the habitability of the MCR and ROS were evaluated and developed in response to NRC Order EA-12-049. FLEX actions specified in procedure FSG-30, "Establishing Control Room Ventilation and Lighting," include:

1. Restoring MCR ventilation using the FLEX Generator. The MCR ventilation loads were included in FLEX Generator load calculations.
2. Opening MCR doors to the outside (if required).
3. Operating portable generators and fans to move outside air through the MCR (if required).

In the FIP, Table 2 contains a thermal evaluation of all the operator actions that may be required to support HCVS operation. The relevant ventilation calculations are included in ECR 15-00148 (EC 556049) Attachments 46A and 46B, which demonstrate that the final design meets the order requirements to minimize the plant operators' exposure to occupational hazards.

The NRC staff reviewed the information in Table 2, audited the calculations referenced in the FIP, and used NUMARC 87-00 as a basis for the habitability temperature limit as referenced in NEI 12-06. The acceptance criteria in NUMARC 87-00 for the habitability temperature limit is 110°F for personnel performing light work as being acceptable. The NUMARC guidance states that "a drybulb temperature of 110°F is tolerable for light work for a four-hour period while dressed in conventional clothing." The licensee's ventilation calculations in ECR 15-00148 predicts that the maximum temperature in the ROS (Room #241) to be 120°F and 90% relative humidity during an accident. The evaluation noted that during the first 4 hours after the start of a severe accident, access to the room will be unaffected due to the mass of concrete between the containment and the ROS. Operators will access the room for system alignment during that period. If ROS re-entry is required after the area heats up, operators will have ice vests and limited stay times per plant procedures. The NRC staff also noted that the stay times in the ROS are limited and strenuous physical work is not required to accomplish needed tasks. As such, the temperatures in the MCR and ROS should not inhibit operators from performing their required tasks.

Access to other areas has been addressed under NRC Order EA-12-049 compliance and is documented in the NRC staff's safety evaluation [Reference 36] that the licensee has developed a plan that, if implemented appropriately, should maintain or restore equipment and personnel habitability conditions in these area following a BDBEE.

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

3.1.1.3 Personnel Habitability – Radiological

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

The licensee performed calculation PM-1190, "[Hardened Containment Vent System] HCVS Dose Assessment," which documents the dose assessment for designated areas inside the PBAPS reactor buildings (outside of containment) and outside the PBAPS reactor buildings caused by the sustained operation of the HCVS under severe accident conditions. The licensee stated calculation PM-1190 was performed using NRC-endorsed HCVS-WP-02 [Reference 29] and HCVS-FAQ-12 [Reference 30] 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 Roentgen equivalent man (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 an ELAP and fuel failure starting at reactor shutdown. For the sources considered and the methodology used in the calculation, the timing of the HCVS vent operation or cycling of the vent will not create higher doses at personnel habitability and equipment locations (i.e., maximum doses determined in the calculation bound operational considerations for HCVS vent operation).

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

The licensee calculated the maximum dose rates and 7-day integrated whole-body gamma dose equivalents for the primary operating station (POS), which is the MCR, and the ROS, which is located in the radwaste building. The calculation demonstrates that the integrated whole-body gamma dose equivalent to personnel occupying defined habitability locations,

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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

resulting from HCVS operation under beyond-design-basis severe accident conditions, will not exceed 10 rem.

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

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

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

3.1.1.4 HCVS Controls and Indications

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

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

In its FIP, the licensee stated that following a manual valve line-up performed at the ROS, primary control of the HCVS is accomplished from the MCR and alternate control of the HCVS is accomplished from the ROS on the 135' elevation of the radwaste building. The licensee also provided, in Table 1 of the FIP, a list of the controls and indications including the locations, anticipated environmental conditions, and the environmental conditions (temperature and radiation) to which each component is qualified. The licensee stated that the evaluation contained in Table 1 in the FIP demonstrates that the controls and indications are functional during a severe accident with a loss of ac power and inadequate containment cooling.

The NRC staff reviewed the information included in the FIP and examined the information provided in Table 1. The NRC staff determined that the controls and indications appear to be consistent with the NEI 13-02 guidance. The NRC staff also confirmed the environmental qualification information in Table 1 of the FIP, as well as the seismic qualification of the controls and indications equipment through an audit review of PBAPS document ECR 15-00148, Sections 3.2, 3.5, 3.14, 3.15 and 3.39 and the ROS temperature evaluation in Attachments 46A and 46B. Peach Bottom determined that the drywell pressure instrument is not Regulatory Guide (R.G.) 1.97 qualified; however, the licensee performed an evaluation in EC 618957 that demonstrated the severe accident qualifications of this instrument are appropriate for the expected severe accident conditions. The NRC staff found the instruments for drywell pressure and wetwell level to be acceptable, in accordance with the NEI 13-02 guidance, based on the original qualification for severe accident conditions.

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

3.1.2 Design Features

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

3.1.2.1 Vent Characteristics

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

The licensee performed calculation PM-0546, "Torus Hardened Vent-Flow Calculation," Revision 6, to evaluate the capability of the torus hardened vent for Units 2 and 3. The results of this analysis show that the torus hardened vent remains capable of its design function of removing 1 percent of decay heat at 4016 megawatts thermal (MWt) while maintaining primary containment pressures below both the containment design pressure (56 pounds per square inch gauge (psig)) and primary containment pressure limit (PCPL) (60 psig). The required minimum flow (1 percent rated thermal power) is $1.375x10^8$ British Thermal Units per hour (BTU/hr) or 42,100 pounds mass per second (lbm/sec) at 56 psig.

The decay heat absorbing capacity of the suppression pool and the selection of venting pressure were made such that the HCVS will have sufficient capacity to maintain containment pressure at or below the containment design pressure (56 psig), which is lower than the PCPL (60 psig). This calculation of containment response is contained in PB-MISC-010, "Peach Bottom MAAP Analysis to Support FLEX Initial Strategy," and was addressed in the Peach Bottom FLEX FIP, dated January 5, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18005A701), in response to Order EA-12-049, which shows that containment is maintained below the design pressure once the vent is opened, even if it is not opened until containment pressure reaches the PCPL.

Additionally, Modular Accident Analysis Program (MAAP) calculation PB-MISC-025 was developed using MAAP 4.0.6 to investigate the response of Peach Bottom, Unit 2 and Unit 3 containment venting using the HCVS vent parameters and the use of RPV alternate injection with assumed immediate reactor core isolation cooling (RCIC) failure. The MAAP analysis demonstrates that the suppression pool and the HCVS together are able to absorb and reject decay heat, such that following a reactor shutdown from full power containment pressure is restored and then maintained below the primary containment design pressure and the primary containment pressure limit.

The NRC staff reviewed the information provided and audited the calculations referenced. The NRC staff confirmed that the primary containment design pressure is 56 psig (Updated Final Safety Analysis Report (UFSAR) Section 5.2.3.1) and the PCPL is 60 psig (UFSAR Section 5.2.3.6). Calculation PM-0546, Revision 6, shows that the HCVS capacity exceeds 1 percent of licensed/rated thermal power at the lower of these values. The calculation conservatively assumes 4030 MWt as rated thermal power. The minimum required flow for 1 percent power is 42,100 lbm/sec (at 56 psig). The calculation results show the maximum vent capacity is 74,300 lbm/sec at choked flow which occurs at a torus pressure of 50.8 psig for Unit 2 and at 49.2 psig for Unit 3, which is a greater flow than the minimum flow required at the design pressure of 56 psig.

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

3.1.2.2 Vent Path and Discharge

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

The licensee in its FIP stated that the primary containment wetwell vent path taps off of the 18" wetwell purge exhaust piping between inboard primary containment isolation valve (PCIV) (A0-2(3)511 and standby gas treatment (SBGT) isolation valve (A0-2(3)512), which serves as an outboard PCIV. The 16" wetwell vent piping continues through the HCVS outboard PCIV (A0-8(9)0290) and the rupture disc (PSD-8(9)0293). Downstream of the rupture disc, the vent piping exits the reactor building through the torus room roof which is at grade level on the west side of the reactor building at elevation 135'. The downstream side of the rupture disc and the piping between the rupture disc and the torus room roof are part of secondary containment. The vent traverses up the exterior of the reactor building to above the reactor building roof. The vent pipe extends approximately 6 ft. above the parapet wall of the reactor building roof. This is consistent with the guidance provided in HCVS-FAQ-04. The torus vent pipe discharge point is positioned above all buildings in the PBAPS protected area. The reactor building roof parapet is at elevation 294'. The torus vent discharge point is at elevation 300'. The only higher structure in the protected area is the reactor building ventilation exhaust discharge point at elevation 305', on the east side of the reactor building, approximately 150 feet away (east-west). The reactor building ventilation exhaust fans are not powered during an ELAP; however, chimney effect would preclude an inward pressure gradient. The PBAPS main stack is positioned at a higher elevation and is not located in the PBAPS protected area.

Part of the guidance in HCVS-FAQ-04 is provided to ensure that vented effluents are not drawn immediately back into any ELAP emergency ventilation intake and exhaust pathways. Such ventilation intakes should be below a level of the pipe by 1 foot for every 5 horizontal feet. This intake is approximately 73 feet from the Unit 2 vent pipe (farther than Unit 3), which would require the intake to be approximately 15 feet below the vent pipe. The MCR emergency intake in the ELAP event is below the 190 feet elevation which is approximately 110 feet below the HCVS pipe outlet. Therefore, the vent pipe discharge point appears to be consistent with the guidance of HCVS-FAQ-04 for stack discharge relative to the ELAP air intake.

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 31], 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.

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

1. For the portions of exposed piping below 30 feet above grade: On each unit, the exposed vent pipe rises from the torus room roof at elevation 135' to elevation 300' along the west side of the respective reactor building, which faces a steeply rising slope of exposed bedrock. The slope base begins at approximate elevation 135' and the top of the slope is at approximate elevation 270'; therefore, the entire exposed portion of vent pipe is considered to be below 30 feet above grade.

   A TORMIS analysis (ARA-002611) was performed as a "reasonable protection evaluation" which calculated the damage probabilities to the external vent piping that would crimp the pipe to a point of not being able to perform as expected under SA conditions following an ELAP event. The damage probabilities are less than the numerical criterion stated in the NRC staff established position in the (TORMIS) SER dated May 7, 1983.

2. No portion of the exposed vent pipe is considered to be 30 feet above grade per Item 1 above.

3. Compensatory measures are available in the event the external vent piping becomes crimped.

4. PBAPS screens in for hurricanes. Exelon has severe weather and natural disaster procedure guidance in place for responding to a potential hurricane impacting the plant site. Site specific preparation for severe weather procedures include consideration of a plant shutdown.

The NRC staff audited the above information including the TORMIS analysis and audited the design packages. The NRC staff noted that the licensee developed a spectrum of the type, size, quantity, and distribution of potential tornado generated missiles. The licensee also performed a missile impact analysis to determine the impact damage certain missiles could impose on the stack. In the event the stack is struck with enough force to crimp it, the licensee has compensatory actions planned to re-establish the HCVS vent path.

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

3.1.2.3 Unintended Cross Flow of Vented Fluids

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

In its FIP, the licensee described that the HCVS for Units 2 and 3 for Peach Bottom are fully independent of each other with separate discharge points. The only interfacing system with the HCVS is the standby gas treatment system (SGTS) system, which is common to both units.

The interface valve is A0-2(3)512, which is a normally closed/fail closed outboard primary containment isolation valve. During venting, the torus vent pipe is isolated from the SGTS by A0-2(3)512, which remains closed. Inflation of the boot seal prevents potential leakage across the valve seat to the SGTS. The HCVS nitrogen supply, which is unit specific, is connected to the A0-2(3)512 actuator tubing to maintain the boot seal inflated. These valves are tested, and will continue to be tested, for leakage under 10 CFR Part 50 Appendix J, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors", Program [Reference 32]. The NRC staff reviewed the information provided and agrees that the use of primary containment isolation valves appears to be acceptable for prevention of inadvertent cross-flow of vented fluids and consistent with the guidance provided in NEI 13-02, HCVS-FAQ-05, "HCVS Control and Boundary Valves."

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

3.1.2.4 Control Panels

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

In its FIP, the licensee stated, in part, that following a manual valve line-up performed at the ROS, primary control of the existing wetwell vent is accomplished from the MCR and alternate control of the HCVS is accomplished from the ROS on the 135' elevation of the radwaste building. The NRC staff reviewed Section III.B.1.2.4 and confirmed these statements by comparing the instrumentation and controls component locations provided in Table 1 of the FIP.

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

3.1.2.5 Manual Operation

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

In its FIP, the licensee stated that 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 and improves system reliability.

The ROS is located on elevation 135' in the radwaste building and is common to both units. The ROS is readily accessible from the MCR. The controls available at the ROS location are accessible and functional under a range of plant conditions, including severe accident conditions with due consideration to source term and dose impact on operator exposure, ELAP, inadequate containment cooling, and loss of reactor building ventilation. Table 1 of the FIP contains an evaluation of all the required controls and instruments that are required for severe accident response and demonstrates that all these controls and instruments will be functional during a loss of ac power and severe accident.

Table 2 of the FIP contains a summary of thermal and radiological evaluations of all the operator actions that may be required to support HCVS operation during a loss of ac power and severe accident. The licensee's calculations conclude that these actions will be possible without undue hazard to the operators. In the FIP, Attachment 6 contains a site layout sketch showing the location of these HCVS actions. The NRC staff reviewed the pertinent information provided and audited procedures T-200J-2(3) "Containment Venting via the Torus Hardened Vent." The NRC staff's review and audit confirmed that the actions appear to be consistent with the guidance.

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

3.1.2.6 Power and Pneumatic Supply Sources

Order EA-13-109, Attachment 2, Section 1.2.6 requires that the HCVS be capable of operating with dedicated and permanently installed equipment for at least 24 hours following the loss of normal power or loss of normal pneumatic supplies to air operated components during an ELAP. Relevant guidance is found in: NEI 13-02, Sections 2.5, 4.2.2, 4.2.4, 4.2.6, and 6.1; NEI 13-02, Appendix A; HCVS-FAQ-02; and HCVS-WPs-01 and -02.

<u>Pneumatic Sources Analysis</u>

For the first 24 hours following the ELAP event, the motive supply for the HCVS valves will be supplied by the HCVS nitrogen backup system. The HCVS nitrogen backup system is located and operated from the ROS in the radwaste building. The nitrogen bottles have been sized such that they can provide motive force for at least eight cycles of the vent path, which includes opening two valve actuators (A0-2(3)511 and A0-8(9)0290). The licensee performed a calculation for the amount of nitrogen needed in PM-1188, "HCVS Compressed Nitrogen Bottle Sizing Calculation," Revision 2. The calculation provided the required pneumatic supply storage volume and supply pressure set point required to operate valve actuators A0-2(3)511 and A0-8(9)0290 for 24 hours following a loss of normal pneumatic supplies during an ELAP.

The licensee's calculation determined that two nitrogen bottles can provide sufficient capacity for operation of the HCVS valves for 24 hours following an ELAP. The NRC staff audited the calculation in PM-1188 and confirmed that there is sufficient pneumatic supply available to provide motive force to operate the HCVS valves for 24 hours following a loss of normal pneumatic supplies during an ELAP.

<u>Power Source Analysis</u>

In its FIP, the licensee stated that during the first 24 hours of an ELAP event, Peach Bottom would rely on the new HCVS battery and battery charger which is common to both Units 2 and 3 to provide power to HCVS components. The 125 volt (V) direct current (dc) HCVS battery is located in the turbine building on the 135' elevation in the 3A/3C battery room. The HCVS battery charger is located in the turbine building on elevation 135' in the E33 switchgear room. The HCVS battery and battery charger are installed where they are protected from applicable hazards. Exide Technologies manufactured the HCVS battery.

The HCVS battery is model GNB Absolyte GP 6-90G07 with a nominal capacity of 256 ampere hours (Ah). The HCVS battery has a minimum capacity capable of providing power for 24 hours without recharging. During the audit process, the licensee provided the NRC staff the evaluation for the HCVS battery/battery charger sizing requirements including incorporation into the FLEX diesel generator (DG) loading calculation.

The NRC staff audited licensee calculation PE-0308, "HCVS Battery Sizing and Selection," Revision 1, which verified the capability of the HCVS battery to supply power to the required loads during the first phase of the Peach Bottom venting strategy for an ELAP. The HCVS battery was sized in accordance with Institute of Electrical and Electronics Engineers (IEEE) Standard 485-2010, "IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications," which is endorsed by R.G. 1.212, "Sizing of Large Lead-Acid Storage Batteries," published in 2015. The licensee's calculation identified the required loads and their associated ratings (watts (W) and minimum system operating voltage). The licensee's battery sizing calculation showed that, based on a continuous 1.79 (3.58 for Units 2 and 3) amperes of loading for a 24-hour duty period, a 153.37 Ah (with correction factors applied) 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 256 Ah, which is more than the minimum required (153.37 Ah). Therefore, it appears that the Peach Bottom HCVS battery should have sufficient capacity to supply power for at least 24 hours.

The licensee's strategy includes repowering the HCVS battery charger within 24 hours after initiation of an ELAP. The licensee's strategy relies on one of two 500 kilowatt (kW) 480 Volt alternating current (Vac) FLEX DGs. Only one of the FLEX DGs is required for the HCVS electrical strategy. The 480 Vac FLEX DG would provide power to the HCVS load in addition to loads addressed under Order EA-12-049.

The NRC staff also audited licensee calculation PE-0301, "FLEX Electrical Loading and Voltage Drop," Revision 0C, which incorporated the HCVS battery charger load on the FLEX DG. The total Phase 2 DIV I load on the FLEX DG for Unit 2 and 3, including the HCVS, is 186 kW and 114 kW, respectively. Based on the NRC staff's audit of calculation PE-0301, it appears that either one of the two FLEX DGs should have sufficient capacity and capability to supply the necessary loads during an ELAP event.

Electrical Connection Points

The licensee's strategy to supply power to HCVS components requires using a combination of permanently installed and portable components. Staging and connecting the 500 kW FLEX DG was addressed under Order EA-12-049 compliance and documented in an NRC staff safety evaluation [Reference 36]. A manual transfer switch provides primary and alternate power sources to the HCVS battery charger from its normal source (Unit 3 motor control center (MCC)) and alternate source (Unit 2 MCC). Licensee procedures FSG-010-2, "Aligning FLEX Generator to Panel 2AS1061 and for Fuel Oil Transfer," Revision 1, FSG-010-3, "Aligning FLEX Generator to Panel 3BS1061," Revision 1, FSG-011-2, "Aligning FLEX Generator to Panel 2BS1061 and for Fuel Oil Transfer," Revision 0, and FSG-011-3, "Aligning FLEX Generator to Panel 3BS1061," Revision 1, provide guidance to place the HCVS battery charger in service and power them from the FLEX DG.

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

3.1.2.7 Prevention of Inadvertent Actuation

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

In its FIP, the licensee stated that emergency operating procedures provide clear guidance that the HCVS is not to be used to defeat containment integrity during any design basis transients and accidents. In addition, the HCVS was designed to provide features to prevent inadvertent actuation due to equipment malfunction or operator error.

The containment isolation valves must be open to permit vent flow. The physical features that prevent inadvertent actuation are the key lock switches for SV-2(3)-07K-2(3)3472 in the MCR and locked closed valves at the ROS. The NRC staff's audit of the HCVS confirmed that the licensee's design is consistent with the guidance and appears to preclude inadvertent actuation.

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

3.1.2.8 Monitoring of HCVS

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

In its FIP, the licensee stated that the HCVS includes indications for HCVS valve position, vent pipe temperature, effluent radiation levels, and argon supply pressure in the MCR. Information on the status of supporting systems (HCVS 125 VDC battery voltage and backup nitrogen pressure) is available in the E33 switchgear room and at the ROS, respectively.

The licensee further clarified that In the event that the FLEX generators do not energize the emergency busses, the wetwell HCVS will be supplied by the HCVS 125 VDC battery for 24 hours and sustained operation during an ELAP event can be accomplished using manual operations at the ROS. Containment pressure and wetwell level instrumentation may be read by portable measuring equipment using FSG-045-2(3) if the FLEX generators do not energize the emergency buses.

The NRC staff audited the following channels documented in Table 1 of the FIP, which support HCVS operation: HCVS effluent temperature, HCVS effluent radiation (wetwell vent line radiation), N2 (nitrogen) supply pressure, argon supply pressure, drywell pressure, and wetwell level, as well as, HCVS 125 VDC voltage and HCVS valve position noted in FIP Section III.B.1.2.8. The NRC staff notes that drywell pressure and wetwell level are declared PBAPS post-accident monitoring (PAM) variables as described in R.G. 1.97. The existing qualification of these channels is considered acceptable for compliance with Order EA-13-109 in accordance with the guidance in NEI 13-02, Appendix C, Section C.8.1. The NRC staff also reviewed FIP Section III.B.1.2.8 and determined that the HCVS instrumentation appears to be adequate to support HCVS venting operations and is capable of performing its intended function during ELAP and severe accident conditions.

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

3.1.2.9 Monitoring of Effluent Discharge

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

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

In Section III.B.1.2.9 of its FIP, the licensee described the ion chamber detectors installed at the 195' elevation of the Unit 2 reactor building and the 165' elevation of the Unit 3 reactor building. The process and control module is installed at the ROS (radwaste building 135') with local indication. The licensee stated in Table 1 that the detector is qualified for the anticipated environment at the vent pipe during accident conditions. The licensee further stated that the process and control module is qualified for the expected conditions at the ROS (radwaste building 135'). The NRC staff reviewed the qualification summary information provided in Section III.B.1.2.9 and Table 1 of the FIP and finds that it appears to be consistent with the guidance.

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

3.1.2.10 Equipment Operability (Environmental/Radiological)

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

Environmental

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

As discussed in Section 3.1.1.2, the licensee's evaluation in ECR 15-00148 predicts the temperature profile at the ROS (radwaste building elevation 135') following an ELAP. The licensee determined that the peak temperature in the area of the ROS will be maintained less than 120°F for the first seven days following in ELAP event.

The HCVS batteries are permanently installed in the 3A/3C battery room in the turbine building on the 135' elevation. The NRC staff audited licensee calculation PM-1186, "Division 1 Battery Room Transient Temperature Profile During ELAP," Revision 1, under Order EA-12-049. This calculation predicts the temperature profile in the 3A/3C battery room following an ELAP. The licensee determined that the peak temperature in 3A/3C battery room will reach 108°F. The licensee plans to restore battery room ventilation after the FLEX DG is placed in service or establish portable ventilation and open doors if battery room ventilation can't be restored.

Licensee procedure FSG-031, "Establishing Battery Room and Switchgear Room Ventilation," Revision 0, provides guidance for restoring battery room ventilation.

The licensee conservatively sized the HCVS batteries considering a minimum operating temperature of 50°F. This is below the minimum ambient temperature of the area under ELAP conditions where the HCVS batteries are located as specified in calculation PM-1186. The manufacturer's maximum design limit for the HCVS batteries is 122°F. Therefore, the HCVS batteries appears to be adequate to perform their design function under event temperatures.

The HCVS battery charger is permanently installed in E33 switchgear room in the turbine building on the 135' elevation. Licensee calculation PM-1186 also predicted the temperature profile in the E33 switchgear room following an ELAP. The licensee determined that the peak temperature in the E33 switchgear room will reach 114°F. The licensee plans to implement passive cooling actions such as opening specified doors within 6 hours and establishing portable ventilation. Licensee procedure FSG-031 provides guidance to open doors and establishing portable ventilation. The operating temperature of the battery charger is 32°F to 122°F. Therefore, the battery charger appears to be adequate to perform its design function under event conditions.

Based on the above, the NRC staff concurs with the licensee's calculations that show the 3A/3C battery room and the E33 switchgear room will remain within the maximum temperature limit of 122°F for the HCVS batteries and battery charger. Furthermore, based on temperatures remaining below 120°F (the temperature limit for electronic equipment to be able to survive indefinitely, identified in NUMARC-87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," Revision 1, as endorsed by NRC R.G. 1.155), the other electrical equipment located at the ROS should not be adversely impacted by the loss of ventilation as a result of an ELAP event with the HCVS in operation. Therefore, the NRC staff concurs that the HCVS equipment located in the 3A/3C battery room, the E33 switchgear room, and at the ROS should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

Radiological

The licensee's calculation, PM-1190, documents the dose assessment for both personnel habitability and equipment locations associated with event response to a postulated ELAP condition. The NRC staff's audit of PM-1190 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 audit confirmed that the anticipated severe accident radiological conditions will not preclude the operation of necessary equipment or result in an undue risk to personnel from radiation exposure.

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

3.1.2.11 Hydrogen Combustible Control

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

In NEI 13-02, Section 4.1.7 provides guidance for the protection from flammable gas ignition for the HCVS system. The NEI issued a white paper, HCVS-WP-03, "Hydrogen /Carbon Monoxide Control Measures," Revision 1, endorsed by the NRC [Reference 33], which provides methods to address control of flammable gases. One of the acceptable methods described in the white paper is the installation of an active purge system (Option 3), which ensures the flammability limit of gases passing through the system is not reached.

In its FIP, the licensee stated that to prevent a detonable mixture from developing in the pipe, a purge system is installed to purge hydrogen from the pipe with argon after a period of venting.

The purge system is described in EC 556049 for Unit 2 and EC 556318 for Unit 3. After an initial line-up of locked valve HV-2(3)-07K-2(3)3478 in the ROS and opening argon bottle manifold valves, the system can be operated from the MCR by energizing the solenoid valve SV-2(3)-07K-2(3)3472. Calculation PM-1189, "Hardened Containment Vent System Purge System Design Calculation," determined that an 8-second purge time is required to burst the rupture disc (for anticipatory venting at a pressure lower than the rated pressure for the rupture disk). The calculation also determined that for purging the combustibles after a vent cycle, a 33-second purge time has been calculated to purge the hydrogen from the vent pipe. The NRC staff's audit confirmed that the licensee's design appears to be consistent with Option 3 of white paper HCVS-WP-03. The NRC staff also audited the licensee's analysis and confirmed the installed purge system capacity is sufficient. The NRC staff confirmed that the licensee's design appears to be consistent with Option 3 of white paper HCVS-WP-03 and that the use of the argon purge system in conjunction with the HCVS venting strategy should meet the requirement to prevent a detonable mixture from developing in the pipe.

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

3.1.2.12 Hydrogen Migration and Ingress

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

As discussed in Section 3.2.1.3, the SGTS is the primary interfacing mechanical system on the HCVS flow path that could lead to the potential for hydrogen gas migration and ingress into the reactor building or other buildings. The SGTS is separated from the HCVS by boundary valves (AO-2(3)512) between the two systems. The licensee indicated that the boundary valves are leak rate tested in accordance with 10 CFR 50, Appendix J.

The miscellaneous vent, drain, and test connections have a normally closed valve and are end-capped. The process instrumentation lines are isolated by a manual valve or the instrument. These pathways should adequately minimize the potential for cross flow or combustible migration into the reactor building or other systems. The NRC staff's audit of the information provided confirmed that the design appears to be consistent with the guidance and that the proposed design will minimize the potential of combustible gas migration into other buildings. The NRC staff also noted that audited procedures, T-200-2(3) "Primary Containment Venting," verify valves interfacing with other non-HCVS systems are closed.

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

3.1.2.13 HCVS Operation/Testing/Inspection/Maintenance

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

In the Peach Bottom 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 it utilizes the standard Electric Power Research Institute (EPRI) industry preventive maintenance process for the maintenance calibration and testing for the HCVS components. The NRC staff reviewed the information provided and confirmed that the licensee has implemented adequate programs for operation, testing, inspection and maintenance of the HCVS.

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

3.2 HCVS QUALITY STANDARDS

3.2.1 Component Qualifications

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

In its FIP, the licensee stated that the HCVS upstream of and including the second containment isolation valve (A0-8(9)0290) and penetrations are not being modified for order compliance so that they continue to be designed consistent with the design basis of primary containment including pressure, temperature, radiation, and seismic loads.

The HCVS downstream of the outboard containment isolation valve, including piping and supports, electrical power supply, valve actuator pneumatic supply, and instrumentation (local and remote) components, 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. This includes environmental qualification consistent with expected conditions at the equipment location.

Table 1 of the FIP contains a list of components, controls and instruments required to operate the HCVS, their qualification limits, and a summary of the expected environmental conditions. The NRC staff reviewed this table and confirmed that the components required for HCVS venting are designed to remain functional following a design basis earthquake.

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

3.2.2 Component Reliability and Rugged Performance

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

In its FIP, the licensee stated that the HCVS components from the torus to the outboard primary containment isolation valve are located in the reactor building which is a seismically qualified structure and provides wind-generated missile protection. HCVS components downstream of the outboard containment isolation valve and components that interface with the HCVS are routed in seismically qualified structures which provides wind-generated missile protection. Those portions of the HCVS outside of the reactor building are supported from seismically qualified structures.

As part of the audit process, the licensee provided documentation that the existing primary containment isolation valves credited are capable of opening under the maximum expected differential pressure during BDB and severe accident wetwell venting. Specification M-00117 requires that PCIV A0-2(3)-078-2(3)511 be able to operate with a 62 psig pressure differential and valve data sheet DSFP, Sheet 1161, states that the design pressure of PCIV A0-2(3)-07b-8(9)0290 is 150 psig. The NRC staff audited the licensee's documentation and confirmed that the PCIVs should open under the maximum expected differential pressure during BDB and severe accident wetwell venting.

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

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

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

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

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

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

- The strategy making it unlikely that a licensee would need to vent from the containment drywell during severe accident conditions shall be part of the overall accident management plan for Mark I and Mark II containments;

- The licensee shall provide supporting documentation demonstrating that containment failure as a result of overpressure can be prevented without a drywell vent during severe accident conditions; and,

- Implementation of the strategy shall include licensees preparing the necessary procedures, defining and fulfilling functional requirements for installed or portable equipment (e.g. pumps and valves), and installing the needed instrumentation.

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

4.1 Severe Accident Water Addition (SAWA)

The licensee plans to use the portable, diesel-driven FLEX pumps (DDFP) to provide SAWA flow. The FLEX pumps take suction from the emergency cooling tower (ECT) and discharge into the RPV. The FLEX pumps for each Unit are staged north of the Unit 3 reactor building, between the plant services building and the Unit 3 startup switchgear building. The licensee states in its FIP, that the operator locations for deployment and operation of the SAWA equipment that are external to the reactor building are either shielded from direct exposure to the vent line or are a significant distance from the vent line so that dose will be maintained below emergency response exposure guidelines.

4.1.1 Staff Evaluation

4.1.1.1 Flow Path

The SAWA injection flow path starts from the ECT, which is connected to the suction portion of the FLEX pumps. The discharge of the FLEX pump carries the SAWA flow to the residual heat removal (RHR) connection in the respective Unit's reactor building closed cooling water room to the RPV. The FLEX pump and hoses are stored in the FLEX building and are deployed within 8 hours of the ELAP event initiation. Once SAWA flow is initiated, operators will have to monitor and maintain SAWA flow and ensure refueling the diesel-driven equipment as necessary.

4.1.1.2 SAWA Pump

The licensee plans to use two portable diesel-driven pumps for FLEX and SAWA, one pump for each Unit. In its FIP, the licensee described the hydraulic analysis performed to demonstrate the capability of each FLEX pump to provide the required 500 gallons per minute (gpm) of SAWA flow to each unit for the first 4 hours in an ELAP scenario. Both FLEX pumps are stated to be protected from all applicable external hazards. The NRC staff audited calculation PM-1205, "Severe Accident Water Addition SAWA Makeup Analysis in Response to NRC Order EA-13-109," Revision 0, which determined that the required SAWA flow rate of 500 gpm was within the capacity of the FLEX pumps.

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

4.1.1.3 SAWA Analysis of Flow Rates and Timing

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

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

The licensee used the referenced plant analysis included in NEI 13-02, Revision 1, and information from EPRI Technical Report 3002003301, "Technical Basis for Severe Accident Mitigating Strategies," to demonstrate that SAWA flow could be reduced to 100 gpm after 4 hours of initial SAWA flow rate and containment would remain protected. At some point, if torus level begins to rise, indicating that the SAWA flow is greater than the steaming rate due to containment heat load, SAWA flow can be further reduced as directed by the SAMGs.

In its FIP, the licensee stated that the wetwell vent was designed and installed to meet NEI 13-02, Revision 1, guidance and is sized to prevent containment overpressure under severe accident conditions. Peach Bottom will follow the guidance (flow rate and timing) for SAWA/SAWM described in BWROG-TP-15-008, "Severe Accident Water Addition Timing," [Reference 34] and BWROG-TP-15-011 "Severe Accident Water Management" [Reference 35]. The wetwell vent will be opened prior to exceeding the design pressure value of 56 psig. The licensee also referenced analysis included in BWROG-TP-15-008, which demonstrates adding water to the reactor vessel within 8-hours of the onset of the event will limit the peak containment drywell temperature, significantly reducing the possibility of containment failure due to temperature. Drywell pressure can be controlled by venting the containment from the suppression chamber.

4.1.2 <u>Conclusions</u>

Based on this evaluation, the NRC staff concludes that the licensee has developed SAWA guidance that should ensure protection of the containment during severe accident conditions following an ELAP event, and, if implemented appropriately, appears to be consistent with NEI

13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

4.2 Severe Accident Water Management (SAWM)

The strategy for Peach Bottom, to preclude the necessity for installing a hardened drywell vent, is to implement the containment venting strategy utilizing SAWA and SAWM. This strategy consists of the use of the Phase 1 wetwell vent and SAWA hardware to implement a water management strategy that will preserve the wetwell vent path until alternate reliable containment heat removal can be established. The SAWA system consists of a FLEX (SAWA) pump injecting into the RPV. The overall strategy consists of flow control at the FLEX (SAWA) pump along with instrumentation and procedures to ensure that the wetwell vent is not submerged (SAWM). Water from the SAWA (FLEX) pump will be routed through a flexible discharge to the RHR system. This RHR connection allows the water to flow into the RPV. Throttling valves and flow meters will be used to control water flow to maintain wetwell availability. Procedures have been issued to implement this strategy including site specific implementation of the generic BWROG EPG/SAG Revision 3 with Emergency Procedures Committee Generic Issue 1314. The BWROG generic assessment, BWROG-TP-15-008 [Reference 34], provides the principles of SAWA to ensure protection of containment. This strategy has been shown via MAAP analysis to protect containment without requiring a drywell vent for at least seven days, which is consistent with the guidance from NEI 13-02 for the period of sustained operation.

4.2.1 Staff Evaluation

4.2.1.1 Available Freeboard Use

As stated in the FIP, the freeboard between 14.7' to 21' elevation in the wetwell provides approximately 525,000 gallons of water volume before the level instrument would be off scale high. Generic assessment BWROG-TP-15-011 [Reference 35], provides the principles of SAWM to preserve the wetwell vent for a minimum of 7 days. After containment parameters are stabilized with SAWA flow, SAWA flow will be reduced to a point where containment pressure will remain relatively low while wetwell level is stable or very slowly rising. For Peach Bottom, the SAWA/SAWM design flow rates (500 gpm at 8 hours followed by 100 gpm from 12 hours to 168 hours) and above available freeboard volume (described above) are bounded by the values utilized in the BWROG-TP-15-011 reference plant analysis that demonstrates the success of the SAWA/SAWM strategy. The NRC staff audited the information provided and concurs that the flow of water added to the suppression pool can be controlled such that the wetwell vent remains operational.

4.2.1.2 Strategy Time Line

As noted in Section 4.1.1.3, "SAWA Analysis of Flow Rates and Timing," the SAWA flow is based on the generic analysis flow rate of 500 gpm to start at about 8 hours and will be reduced to 100 gpm after 4 hours. The NRC staff concurs that the SAWM approach should provide operators sufficient time to reduce the water flow rate and to maintain wetwell venting capability. The strategy is based on BWROG generic assessments in BWROG-TP-15-008 and BWROG-TP-15-011.

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

4.2.2 Conclusions

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

4.3 SAWA/SAWM Motive Force

4.3.1 Staff Evaluation

4.3.1.1 SAWA Pump Power Source

As described in Section 4.1, the licensee plans to use two FLEX pumps, one for each Unit, to provide SAWA flow. The pumps are diesel-driven by an engine mounted on the skid with the pump. Operators will refuel the FLEX pumps in accordance with Order EA-12-049 refueling procedures. 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 pumps will be refueled by the FLEX refueling equipment that has been qualified for long-term refueling operations per EA-12-049.

4.3.1.2 DG Loading Calculation for SAWA/SAWM Equipment

In its FIP, the licensee lists drywell pressure, suppression pool level and the SAWA flow meter as instruments required for SAWA and SAWM implementation. The drywell pressure and suppression pool level instruments are used for HCVS venting operation. These instruments are powered by the Class 1E station batteries until the FLEX DG is deployed and available. The SAWA flow meter is powered by a local lithium ion battery pack. The life expectancy of the battery pack is dependent on the frequency that the flow meter measures flow. At sampling frequencies of 0.25 and 15 seconds, the battery pack will last 3 months and 10 years, respectively.

The NRC staff audited licensee calculation PE-0140, "Class 1E 125/250V DC System What If Cases," Revision 13, under Order EA-12-049, which verified the capability of the Class 1E station batteries to supply power to the required loads (e.g. drywell pressure and suppression pool level) during the first phase of the Peach Bottom FLEX mitigation strategy plan for an ELAP event. The NRC staff also audited licensee calculation PE-0301, which verified that the 500kW FLEX DG is adequate to support the addition of the HCVS electrical loads. The NRC staff confirmed that the Class 1E batteries and 500 kW FLEX DGs should have sufficient capacity and capability to supply the necessary SAWA/SAWM loads during an ELAP event.

4.3.2 Conclusions

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

4.4 SAWA/SAWM Instrumentation

4.4.1 Staff Evaluation

4.4.1.1 SAWA/SAWM Instruments

In Section IV.C.10 of the FIP, the licensee stated that the instrumentation needed to implement the SAWA/SAWM strategy is PT/PR/TR-4(5)805 used to measure containment pressure, LI-8(9)123A used to measure wetwell level, and SAWA/SAWM flow meters used to measure flow to the RPV. The drywell pressure and wetwell level are pressure and differential pressure detectors and qualified for post-accident use. The flow instrument range is 3.3-1100 gpm which appears to be consistent with the licensee's strategy. The NRC staff reviewed Section IV.C.10, Section IV.C.10.1, Section IV.C.10.2, and Table 1 of the FIP and found that the instruments appear to be consistent with the NEI 13-02 guidance.

4.4.1.2 SAWA Instruments and Guidance

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

In Section IV.C.10 of the FIP, the licensee stated that the SAWA flow meter is a portable, digital-based, electromagnetic flow meter stored in the FLEX storage building and self-powered by internal batteries.

The NRC staff reviewed the FIP, including Section IV.C.10, Section IV.C.10.1, Section IV.C.10.2, and Table 1 and found the licensees response appears to be consistent with the guidance. The NRC staff notes that NEI 13-02 Revision 1, Section C.8.3, clarifies that drywell temperature is not required, but may provide further information for the operations staff to evaluate plant conditions under severe accident and provide confirmation to adjust SAWA flow rates.

4.4.1.3 Qualification of SAWA/SAWM Instruments

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

In Section IV.C.10.3 of its FIP, the licensee stated that the SAWA flow meter is rated for continuous use under the expected ambient conditions and so will be available for the entire period of sustained operation. Furthermore, since the FLEX/SAWA pump is deployed outside the reactor building, and in a low dose area as analyzed by calculation PM-1190, there is no concern for any effects of radiation exposure to the flow instrument.

The licensee did not state, in Table 1 of its FIP, the anticipated temperature at this location but, did state that the qualification temperature range is -4°F to 140°F. In Section IV.C.10 of its FIP, the licensee stated that per Exelon White Paper EXC-WP-06, "Documenting ELAP Design Bases," Attachment 2, a reasonable conservative outside ambient temperature that is not exceeded more than 1 percent of the time is considered reasonably conservative for a BDBEE. Therefore, based on the ASHRAE Handbook, temperatures do not drop lower than 15.5°F more than 1 percent of the time in Lancaster, PA, and is used to establish an approximate low end ambient temperature for Peach Bottom, which is well above the -4°F lower temperature limit of the Badger M5000 flow meter. The NRC staff concurs that the SAWA flow meter appears to be qualified for the anticipated environment.

4.4.2 Conclusions

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

4.5 SAWA/SAWM Severe Accident Considerations

4.5.1 Staff Evaluation

4.5.1.1 Severe Accident Effect on SAWA Pump and Flowpath

To address SAWA/SAWM severe accident dose considerations, the licensee performed a detailed radiological analysis documented in PM-1207, "HCVS Phase II 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 POS, ROS, and travel paths for hose routing.

In its FIP, the licensee states that the SAWA pumps are stored in the FLEX storage building and will be operated from outside the reactor building north of the Unit 3 reactor building in an area that is shielded from the vent pipe. Based on an audit of the licensee's evaluations, it appears that there will be no significant issues with radiation dose rates at the SAWA pump control location, and there will be no significant dose to the SAWA pump.

The licensee also states in its FIP, that the SAWA flow path inside the reactor building consists of stainless/carbon steel piping that will be unaffected by the radiation dose and that hoses will only be run in locations that are shielded from significant radiation dose, or that have been evaluated for the integrated dose effects over the period of sustained operation. Based on an audit of the licensee's evaluations, it appears that the SAWA flow path will not be adversely affected by radiation effects due to severe accident conditions.

4.5.1.2 Severe Accident Effect on SAWA/SAWM Instruments

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

As stated in Section 4.5.1.1 of the FIP, the SAWA pump will be operated from outside the reactor building in an area north of the Unit 3 reactor building in an area that is shielded from the vent pipe. This location ensures that there will be no adverse effects from radiation exposure to the SAWA flow meter. The licensee has chosen low dose areas for the FLEX/SAWA flow meter to ensure that their operation will not be adversely affected by radiation exposure. Based on this information, it appears that the SAWA/SAWM instruments should not be adversely affected by radiation effects due to severe accident conditions,

4.5.1.3 Severe Accident Effect on Personnel Actions

The SAWA monitoring equipment can all be operated from the MCR and the SAWA pump and flow monitoring equipment can be operated from outside the reactor building at ground level; therefore, there are no unusual thermal concerns for operators. The PBAPS FLEX response ensures that the FLEX/SAWA pump, FLEX generators, and other equipment can all be run for a sustained period by refueling. All the refueling locations are located in shielded or protected areas so that there is no radiation hazard from core material during a severe accident. Environmental conditions in the MCR and the ROS were discussed previously in Section 3.1.1.2, Personnel Habitability - Environmental. Based on the above, the NRC staff agrees that, if implemented correctly, the environmental conditions should not prevent operators from implementing the SAWA or SAWM strategies.

The licensee performed calculation PM-1207, "HCVS Phase II Dose Assessment," which documents the dose assessment for designated areas inside the PBAPS reactor buildings (outside of containment) and outside the PBAPS reactor buildings caused by the sustained operation of the HCVS under the beyond-design-basis severe accident condition of an ELAP. This assessment used conservative assumptions to determine the expected dose rates in all areas that may require access during a beyond-design-basis ELAP. As stated in Section 3.1.1.3 Personnel Habitability – Radiological, based on an audit of the licensee's detailed evaluation the NRC staff concludes that mission doses associated with actions taken to protect the public under beyond-design-basis severe accident conditions should not subject plant personnel to an undue risk from radiation exposure.

4.5.2 Conclusions

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

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

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

5.0 HCVS/SAWA/SAWM PROGRAMMATIC CONTROLS

5.1 Procedures

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

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

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

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

5.2 Training

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

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

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

6.0 CONCLUSION

In June 2014, the NRC staff started audits of the licensee's progress in complying with Order EA-13-109. The staff issued an ISE for implementation of Phase 1 requirements on February 12, 2015 [Reference 14], an ISE for implementation of Phase 2 requirements on August 2, 2016 [Reference 15], and an audit report on the licensee's responses to the ISE open items on November 30, 2017 [Reference 16]. The licensee reached its final compliance date on September 28, 2018, and has declared in letter dated September 28, 2018 [Reference 17], that Peach Bottom Atomic Power Station, Units 2 and 3, is in compliance with the order.

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

7.0 REFERENCES

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

2. Letter from Peach Bottom to NRC, "Peach Bottom, Units 2 & 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. ML14181A301)

3. Letter from Peach Bottom to NRC, "First Six-Month Status Report For Phase 1 Overall Integrated Plan in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated December 19, 2014 (ADAMS Accession No. ML14353A125)

4. Letter from Peach Bottom 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. ML15181A018)

5. Letter from Peach Bottom to NRC, "Peach Bottom, Units 2 & 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 15, 2015 (ADAMS Accession No. ML15364A015)

6. Letter from Peach Bottom 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. ML16182A012)

7. Letter from Peach Bottom 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 15, 2016 (ADAMS Accession No. ML16350A265)

8. Letter from Peach Bottom to NRC, "Sixth Six-Month Status Report For Phases 1 and 2 Overall Integrated Plan in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated June 30, 2017 (ADAMS Accession No. ML17181A034)

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

Under Severe Accident Conditions (Order Number EA-13-109)," dated December 15, 2017 (ADAMS Accession No. ML17349A038)

10. Letter from Peach Bottom to NRC, "Eighth Six-Month Status Report For Phases 1 and 2 Overall Integrated Plan in Response to June 6, 2013 Commission Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated June 29, 2018 (ADAMS Accession No. ML18180A032)

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

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Date: March 11, 2019

SUBJECT: PEACH BOTTOM ATOMIC 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. MF4416 AND MF4417; EPID NO. L-2014-JLD-0053) DATED: March 11, 2019

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