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

February 25, 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: JAMES A. FITZPATRICK NUCLEAR POWER PLANT - SAFETY EVALUATION REGARDING IMPLEMENTATION OF HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS RELATED TO ORDER EA-13-109 (CAC NO. MF4464; EPID NO. L-2014-JLD-0049)

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 (BWR) licensees with Mark I and Mark II primary containments. The order requirements are provided in Attachment 2 to the order and are divided into two parts to allow for a phased approach to implementation. The order required each licensee to submit an Overall Integrated Plan (OIP) for review that describes how compliance with the requirements for both phases of Order EA-13-109 would be achieved.

By letter dated June 30, 2014 (ADAMS Accession No. ML14181B117), Exelon Generation Company, LLC (the licensee) submitted its Phase 1 OIP for James A. FitzPatrick Nuclear Power Plant (FitzPatrick) 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 FitzPatrick, including the combined Phase 1 and Phase 2 OIP in its letter dated December 29, 2015 (ADAMS Accession No. ML15363A412). These status reports were required by the order, and are listed in the enclosed safety evaluation. By letters dated May 27, 2014 (ADAMS Accession No. ML14126A545), and August 10, 2017 (ADAMS Accession No. ML17220A328), the NRC notified all BWR Mark I and Mark II licensees that the staff will be conducting audits of their implementation of Order EA-13-109 in accordance with NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, “Regulatory Audits” (ADAMS Accession No. ML082900195). By letters dated February 12, 2015 (Phase 1) (ADAMS Accession No. ML15007A090), December 16, 2016 (Phase 2) (ADAMS Accession No. ML16343B030), and June 21, 2018 (ADAMS Accession No. ML18166A254), the NRC issued Interim Staff Evaluations (ISEs) and an audit report, respectively, on the licensee's progress. By letter dated August 28, 2018 (ADAMS Accession No. ML18240A002), the licensee reported that FitzPatrick is in full compliance with the requirements of Order EA-13-109, and submitted a Final Integrated Plan (FIP) for FitzPatrick.

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

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

Sincerely,

Brett Titus

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

Docket No. 50-333

Enclosure:
Safety Evaluation

cc w/encl: Distribution via Listserv

TABLE OF CONTENTS

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO ORDER EA-13-109

EXELON GENERATION COMPANY, LLC

JAMES A. FITZPATRICK NUCLEAR POWER PLANT

DOCKET NO. 50-333

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 James A. FitzPatrick Nuclear Power Plant (JAF, FitzPatrick) in response to Order EA-13-109. By letters dated December 19, 2014 [Reference 3], June 30, 2015 [Reference 4], December 29, 2015 (which included the combined Phase 1 and Phase 2 OIP) [Reference 5], June 30, 2016 [Reference 6], December 22, 2016 [Reference 7], June 29, 2017 [Reference 8] and December 15, 2017 [Reference 9], the licensee submitted 6-month updates to its OIP. By letters dated May 27, 2014 [Reference 10], and August 10, 2017 [Reference 11], the NRC notified all BWR Mark I and Mark II licensees that the staff will be conducting audits of their implementation of Order EA-13-109 in accordance with

NRC Office of Nuclear Reactor Regulation (NRR) Office Instruction LIC-111, "Regulatory Audits" [Reference 12]. By letters dated February 12, 2015 (Phase 1) [Reference 13], December 16, 2016 (Phase 2) [Reference 14], and June 21, 2018 [Reference 15], the NRC issued Interim Staff Evaluations (ISEs) and an audit report, respectively, on the licensee's progress. By letter dated August 28, 2018 [Reference 16], the licensee reported that full compliance with the requirements of Order EA-13-109 was achieved and submitted its Final Integrated Plan (FIP).

2.0 REGULATORY EVALUATION

Following the events at the Fukushima Dai-ichi nuclear power plant on March 11, 2011, the NRC established a senior-level agency task force referred to as the Near-Term Task Force (NTTF). The NTTF was tasked with conducting a systematic and methodical review of the NRC regulations and processes and determining if the agency should make improvements to these programs in light of the events at Fukushima Dai-ichi. As a result of this review, the NTTF developed a set of recommendations, documented in SECY-11-0093, "Near-Term Report and Recommendations for Agency Actions Following the Events in Japan," dated July 12, 2011 [Reference 17]. Following interactions with stakeholders, these recommendations were enhanced by the NRC staff and presented to the Commission.

On February 17, 2012 [Reference 18], 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 19], the NRC staff issued Order EA-12-050, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents" [Reference 20], which required licensees to install a reliable HCVS for Mark I and Mark II containments.

While developing the requirements for Order EA-12-050, the NRC acknowledged that questions remained about maintaining containment integrity and limiting the release of radioactive materials if the venting systems were used during severe accident conditions. The NRC staff presented options to address these issues for Commission consideration in SECY-12-0157, "Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments" [Reference 21]. In the SRM for SECY-12-0157 [Reference 22], the Commission directed the staff to issue a modification to Order EA-12-050, requiring licensees with Mark I and Mark II containments to "upgrade or replace the reliable hardened vents required by Order EA-12-050 with a containment venting system designed and installed to remain functional during severe accident conditions." The NRC staff held a series of public meetings following issuance of SRM SECY-12-0157 to engage stakeholders on revising the order. Accordingly, as directed by the Commission in SRM-SECY-12-0157, on June 6, 2013, the NRC staff issued Order EA-13-109.

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

2.1 Order EA-13-109, Phase 1

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

The NRC staff held several public meetings to provide additional clarifications on the order's requirements and comments on the proposed draft guidance prepared by the Nuclear Energy Institute (NEI) working group. On November 12, 2013 [Reference 23], 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 24], 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, NEI issued NEI 13-02, "Industry Guidance for Compliance with Order EA-13-109," Revision 1 [Reference 25], to provide guidance to assist nuclear power reactor licensees with the identification of measures needed to comply with the requirements of Phase 2 of Order EA-13-109. The NRC staff reviewed NEI 13-02, Revision 1, and on April 29, 2015, the NRC staff issued JLD-ISG-2015-01, "Compliance with Phase 2 of Order EA-13-109, 'Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Performing under Severe Accident Conditions'" [Reference 26], endorsing, in part, NEI 13-02, Revision 1, as an acceptable means of meeting the requirements of Phase 2 of Order EA-13-109, and on April 7, 2015, published a notice of its availability in the *Federal Register* (80 FR 26303).

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

FitzPatrick is a single unit General Electric BWR site with a Mark 1 primary containment system. To implement the Phase 1 requirements of Order EA-13-109, the licensee utilized the existing containment atmosphere dilution (CAD) penetration from the suppression chamber and attached new piping to the CAD header to route the HCVS effluent up the inside of the reactor building through the roof. The HCVS control and monitoring is accomplished from the remote

operating station (ROS). Actuation of the HCVS will be performed at the appropriate time based on procedural guidance in response to plant conditions from observed or derived symptoms. The HCVS vent operation is monitored using HCVS valve position, HCVS vent line temperature, and effluent radiation levels. The containment parameters of pressure and level are monitored from the MCR to verify the 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 will be by use of portable equipment once the installed motive force is exhausted. Venting capability will be maintained for a sustained period of up to 7 days. After that time, additional resources are expected to be available to provide alternate means to remove decay heat from the containment.

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 4 [Reference 27], 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 3-2, "HCVS Operator Actions," of the FIP. An HCVS extended loss of alternating current (ac) power (ELAP) Failure Evaluation Table (Table 3-3), which shows alternate actions that can be performed, is also provided in the FIP.

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

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

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

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

3.1.1.2 Personnel Habitability – Environmental

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

In its FIP, the licensee indicated that primary control of the HCVS is accomplished from the ROS, which is located two floors below the MCR in the administration building (located adjacent to the reactor building). FLEX actions that may be taken to maintain the habitability of the MCR and ROS were developed in response to NRC Order EA-12-049. These actions include:

- Restoring MCR ventilation via the National SAFER (Strategic Alliance for FLEX Emergency Response) Response Center (NSRC) diesel generator (DG), if required. Temperatures may increase beyond 110 degrees Fahrenheit (°F) late in the mission time of 168 hours requiring this action. Without action to restore MCR ventilation, MCR temperature will remain <120°F for the duration of the 7 days of sustained operation;
- While not specifically credited, opening of the MCR doors can also be implemented to reduce the MCR temperature; and
- Opening doors in the reactor building to establish natural circulation air flow in the reactor building.

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

The NRC staff audited the temperature response for the MCR under Order EA-12-049 compliance and documented in the NRC staff's safety evaluation [Reference 35] that the licensee has developed a plan that, if implemented appropriately, should maintain or restore equipment and personnel habitability conditions in the MCR following a BDBEE. The ROS is located in an administration control building corridor between the turbine building and reactor building. The NRC staff audited calculation JAF-CALC-15-00025, "Reactor Building Heat Up During Extended Loss of AC Power (ELAP)." This calculation indicates that, with compensatory actions of opening selected doors, the temperature in the corridor does not exceed 110°F. Furthermore, assuming a constant outdoor temperature of 93°F, the calculated maximum corridor temperature is approximately 105°F. The NRC staff noted that assuming a constant outdoor temperature of 93°F and ignoring the diurnal temperature variations is conservative. 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.

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 JAF-CALC-14-00029, "Hardened Containment Vent System: Dose Assessment," which documents the dose assessment for designated areas inside the FitzPatrick reactor building (outside of containment) and outside the FitzPatrick reactor building caused by the sustained operation of the HCVS under severe accident conditions. The licensee stated calculation JAF-CALC-14-00029 was performed using NRC-endorsed HCVS-WP-02 [Reference 28] and HCVS-FAQ-12 [Reference 29] methodologies. Consistent with the definition of sustained operations in NEI 13-02, Revision 1, the integrated whole-body gamma dose equivalent[1] due to HCVS operation over a 7-day period was determined in the licensee's dose calculation and will not exceed 10 Roentgen equivalent man (rem)[2]. The calculated 7-day dose due to HCVS operation is a conservative maximum integrated radiation dose over a 7-day period with 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 MCR and the ROS. The calculation demonstrates that the integrated whole-body gamma dose equivalent to personnel occupying defined habitability locations (resulting from HCVS operation under beyond-design-basis severe accident conditions) will not exceed 10 rem.

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

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

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

The NRC staff audited the licensee's calculation of the expected radiological conditions to ensure that operating personnel can safely access and operate controls and support equipment. Based on the expected integrated whole-body dose equivalent in the MCR and 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 monitoring of the drywell pressure and wetwell level is accomplished from the MCR. The licensee further stated that HCVS controls and indications is accomplished from the ROS, located in a corridor on the 272' elevation of the administration building, two floors below the MCR. 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 NRC staff reviewed the FIP including the response in Section 1.1.4 of the FIP and examined the information provided in Table 1. The NRC staff determined that the controls and indications appear to be consistent with the NEI 13-02 guidance. The NRC staff also confirmed the environmental qualification information in Table 1 of the FIP, as well as the seismic qualification of the controls and indications equipment through audit reviews of JAF document engineering change (EC) 52721, JAF-CALC-15-0025, "Reactor Building Heat Up During Extended Loss of AC Power, " and JAF-CALC-14-00029, "Hardened Containment Vent System: Dose Assessment," Revision 0. The NRC staff noted that the Regulatory Guide (R.G.) 1.97 instruments for drywell pressure and wetwell level did not have qualification information listed in

Table 1, but are considered acceptable, in accordance with the NEI 13-02 guidance, based on 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 stated that the HCVS wetwell path is designed for venting steam/energy at a nominal capacity of 1 percent of licensed thermal power and is able to maintain containment pressure below the primary containment design pressure.

The licensee performed calculation JAF-CALC-15-00026, "Containment Heat Up Without Water Addition," which provides verification that the wetwell is sufficient to absorb the decay heat generated during at least the first 3 hours following a loss of normal containment heat removal. The decay heat absorbing capacity of the wetwell 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 pounds per square gauge (psig)), which is lower than the primary containment pressure limit (PCPL) (62 psig).

The licensee also performed calculation JAF-CALC-14-00015, "Hardened Containment Vent Capacity," to confirm the HCVS venting capacity. The RELAP5 computer code was used to model the HCVS to perform this analysis. The RELAP5 code simulates transient two-phase flow conditions in piping systems. The RELAP5 program generates time-dependent thermal-hydraulic conditions within the piping at user-specified time increments. At the wetwell internal design pressure of 56 psig, the 1 percent rated thermal power was calculated to be equivalent to a steam flow rate of 95,369 pounds mass per hour (lbm/hr). The steady state venting capacity of the HCVS is 95,472 lbm/hr at a wetwell pressure of 51.1 psig. The FitzPatrick HCVS design was evaluated considering pipe diameter, length, and geometry as well as vendor-provided valve loss coefficients (Cv). Calculation JAF-CALC-14-00015 concludes that the design provides margin to the minimum required flow rate.

The NRC staff audited the licensee's evaluations. The NRC staff noted that a PCPL of 62 psig translates to a wetwell pressure of 51.1 psig with the wetwell water level at anticipated

maximum water level and with downcomer submergence static pressure. The calculation shows that the HCVS venting capacity based on wetwell pressure 51.1 psig is 95,472 lbm/hr steam. Calculation JAF-CALC-15-00026 indicates the required 1 percent rated thermal power flow is 95,369 lbm/hr. Based on the evaluations, the HCVS vent design appears to have the capacity to vent 1 percent of rated thermal power during ELAP and severe accident conditions with margin.

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

3.1.2.2 Vent Path and Discharge

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

The NRC staff evaluated the HCVS vent path and the location of the discharge. The HCVS exits the wetwell through the existing CAD piping (penetration X-205), through the wetwell inboard and outboard primary containment isolation valves (PCIVs), and finally through the HCVS control valve. Downstream of the HCVS control valve, the vent pipe is routed through the southwest refuel floor stairwell and up the interior of the reactor building before penetrating the roof. The discharge point was extended approximately 3 feet above the reactor building parapet wall (elevation 435'-0"). This is consistent with the guidance provided for vent height in HCVS-FAQ-04. The HCVS vent pipe release point to the outside atmosphere is at an elevation that is higher than the adjacent power block structures. The release point is on the far southwest side of the reactor building and a minimum of 25' from the reactor building and turbine building heating, venting, and air-conditioning (HVAC) exhaust ductwork. Since the effluent release velocity of the vent exceeds 8000 feet per minute, it is assured that the effluent plume will not be entrained into the recirculation zone of the turbine building, reactor building, emergency response facilities or ventilation system intakes, or open doors used for natural circulation in the BDBEE response.

Part of the guidance in HCVS-FAQ-04 is designed to ensure that vented effluents are not drawn immediately back into any ELAP emergency ventilation intake and exhaust pathways. Such ventilation intakes should be below a level of the pipe by 1 foot for every 5 horizontal feet. This intake is approximately 180 feet from the vent pipe which would require the intake to be approximately 36 feet below the vent pipe. The MCR emergency intake is at the 322' elevation which is approximately 113 feet below the HCVS pipe outlet. Therefore, the vent pipe discharge point meets the guidance of HCVS-FAQ-04 for stack discharge relative to the ELAP air intake.

Guidance document NEI 13-02, Section 5.1.1.6 provides guidance that missile impacts are to be considered for portions of the HCVS. The NRC-endorsed NEI white paper, HCVS-WP-04, "Tornado Missile Evaluation for HCVS Components 30 Feet Above Grade," Revision 0 [Reference 30], 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. The evaluation demonstrated that the pipe was robust with respect to external missiles per HCVS-WP-04 in that:

1. The HCVS piping is contained within the reactor building and first exits a tornado missile protected area at elevation 369'-6" (refuel floor). This is nearly 100 feet above the site grade at 272'-0"; there is no HCVS piping exposed to wind missile hazards below 30 feet above grade that is applicable to this assumption.

2. The exposed piping greater than 30 feet above grade has the following characteristics:
   a. The total vent pipe exposed area is 255 square feet which is less than the 300 square feet assumed in the guidance.
   b. The pipe is made of schedule 40 carbon steel and the pipe components have no small tubing susceptible to missiles.
   c. There are no obvious potential missiles or unrestrained material lay down areas in close proximity to the HCVS components because all components, except upper portions of the HCVS large bore piping and the radiation monitor, are located within the protected structure below the refuel floor. The radiation monitor, located adjacent to the vent pipe on El. 369'-6", is qualified seismically and is enclosed with a robust vendor supplied lead shield. Under the unlikely occurrence that a tornado missile strikes this component, the device within the lead shield may not remain functional; however, alternate, protected devices are available to serve the function of the radiation monitor, which is to provide an indication of vent line status (i.e., vent line open or isolated). Alternate indicators include HCVS vent line temperature and valve position indication. In addition, temporary storage of material in the area is controlled through work management procedures.

3. FitzPatrick plant will maintain the existing GL 89-16 wetwell vent capability as a contingency vent path should the HCVS vent path above 30 feet become damaged such that it restricts flow to an unacceptable level.

4. Hurricanes are not screened in for JAF.

The licensee's evaluation determined that the HCVS pipe is adequately protected from the tornado missile assumptions identified in HCVS-WP-04. The NRC staff audited the information provided and agrees that supplementary protection is not required for the HCVS piping and components.

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

3.1.2.3 Unintended Cross Flow of Vented Fluids

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

In its FIP, the licensee stated that JAF is a single unit plant so there is no potential of cross flow of vented fluids between units. The standby gas treatment system (SGTS) is the only interfacing mechanical system on the HCVS flow path for which there could be unintended cross flow of vented fluids. The SGTS is separated from the HCVS by boundary valves (27MOV-120 and 27MOV-121) between the two systems.

The migration of flow to the SGTS is minimized through the use of existing Class VI motor operated valves (MOVs). Valve 27MOV-120 remains closed for plant modes 1-3; therefore, it could not be in the open position prior to a BDBEE when the HCVS is required to be functional. A new permanent access platform is used to access 27MOV-121 should it be open prior to the BDBEE. Per the guidance given in NEI 13-02, leak rate testing is suggested for the HCVS system boundary valves (27MOV-120 and 27MOV-121). Per HCVS-FAQ-05, "HCVS Control and Boundary Valves" the allowable leakage was set equal to the allowable leakage for the PCIV of the valve pair associated with the HCVS containment penetrations which exhibits the highest accepted leakage rate during a 10 CFR 50, Appendix J, "Primary Reactor Containment Leakage Testing for Water-Cooled Power Reactors", Program [Reference 31] testing cycle. In this way, expectations set for boundary valves will not be set higher than those for the existing safety related PCIVs.

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 audited the information provided and agrees that the use of boundary valves with the testing criteria described is acceptable for prevention of inadvertent cross-flow of vented fluids and meets 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 that the primary control station is located at the ROS, which is located in the administration building, two levels below the MCR and is accessible from the MCR by a local stairway. The ROS has a direct travel path to and from the MCR and is protected by intervening structures. Both locations are protected from adverse natural phenomena and are sufficiently shielded. The MCR only has indications for containment pressure and wetwell level which must be relayed to the operator at the ROS. All the remaining instrumentation and controls are provided at the ROS. The NRC staff 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, and, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

3.1.2.5 Manual Operation

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

In its FIP, the licensee stated that the controls available at the ROS 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. 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. This provides a diverse method of valve operation and improves system reliability.

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

Table 2 in 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. These evaluations demonstrate that the design meets the requirement to be manually operated from a remote but readily accessible location during sustained operation. The NRC staff audited the pertinent plant drawings and evaluation documents. The NRC staff's audit confirmed that the actions appear to be consistent with the guidance.

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

3.1.2.6 Power and Pneumatic Supply Sources

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

Pneumatic Sources Analysis

For the first 24 hours following the event, the motive supply for the HCVS valves will be from the two nitrogen bottles that will be pre-installed and operated from the ROS in the administration building corridor. The nitrogen bottles have been sized such that they can provide motive force for at least eight venting cycles, which includes opening for each of the two PCIVs (27AOV-117 and 27AOV-118). The licensee performed calculation JAF-CALC-15-00013, "Hardened Containment Vent System: N2 Bottle and Venting Capacity," Revision 0. The calculation provided the required pneumatic supply storage volume and supply pressure set point required to operate PCIVs 27AOV-117 and 27AOV-118 for 24 hours following a loss of normal pneumatic supplies during an ELAP. The licensee's calculation determined that two nitrogen bottles set at a minimum pressure of 1158 psig each can provide sufficient capacity for operation of the HCVS valves for 24 hours following an ELAP. The nitrogen bottles contain the maximum capacity of 2640 psig, which provide more than adequate margin to support the twelve venting cycles in the first 24 hours. The NRC staff audited the calculations in JAF-CALC-15-00013 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.

Power Source Analysis

In its FIP, the licensee stated that during the first 24 hours of an ELAP event, FitzPatrick would rely on the new HCVS battery and battery charger to provide power to HCVS components. The 24 volt (V) direct current (dc) HCVS battery and battery charger are located in the dc 'A' equipment room in the administration building where they are protected from applicable hazards. EnerSys manufactured the HCVS battery.

The HCVS battery is model Genesis XE30 with a nominal capacity of 112 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 on their ePortal an evaluation for the HCVS battery/battery charger sizing requirements including incorporation into the FLEX diesel generator (DG) loading calculation.

The NRC staff audited licensee engineering change EC 9000052721, "Phase 1 Hardened Containment Vent System (Parent EC)," Revision 1, Attachment 6.003, 24VDC Battery Sizing Requirements, which verified the capability of the HCVS battery to supply power to the required loads during the first phase of the FitzPatrick 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 evaluation identified the required loads and their associated ratings (watts (W) and minimum system operating voltage). The licensee's battery sizing calculation showed that, based on a continuous 1.72 amperes of loading for a 24-hour duty period, a 67 Ah battery is required to satisfy the necessary battery duty cycle and end-of-cycle battery terminal voltage requirements. The battery selected by the licensee has a capacity of 112 Ah, which is more than the minimum required (67 Ah). Therefore, the FitzPatrick HCVS battery appears to have sufficient capacity to supply power for at least 24 hours.

The licensee's strategy includes repowering the HCVS battery charger within 24 hours after initiation of an ELAP. The licensee's strategy relies on one of two 200 kilowatt (kW) 600 Volt alternating current (Vac) FLEX DGs. Only one of the FLEX DGs is required for the HCVS

electrical strategy. The 600 Vac FLEX DG would provide power to the HCVS load in addition of loads addressed under Order EA-12-049.

The NRC staff also audited licensee calculation JAF-CALC-15-00031, "FLEX Strategy – Portable Generator System Sizing," Revision 0, which incorporated the HCVS load battery charger on the FLEX DG. The total Phase 2 DIV I load on the FLEX DG including the HCVS is 137 kW. Based on the NRC staff's audit of calculation JAF-CALC-15-00031, it appears that the FLEX DGs should have sufficient capacity and capability to supply the necessary loads during an ELAP event.

Electrical Connection Points

The licensee's strategy to supply power to HCVS components requires using a combination of permanently installed and portable components. Staging and connecting the 200 kW FLEX DG was addressed under Order EA-12-049 compliance and documented in an NRC staff safety evaluation [Reference 35]. Licensee procedures FSG-001, "Initial Assessment and FLEX Equipment Staging," Revision 0, and FSG-002, "ELAP DC Bus Load Shed and Management," Revision 0A, provide guidance to power 600 Vac buses from the FLEX DGs. Licensee procedure FSG-101, "Beyond Design Basis External Events EP Communications," Revision 2, provides guidance to power the HCVS battery charger from a 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 (EOPs) provide clear guidance to operators that the HCVS is not to be used to defeat containment integrity during any design basis transients and accidents. In addition, the HCVS was designed to provide features to prevent inadvertent actuation due to equipment malfunction or operator error. Also, these protections are designed such that any credited containment accident pressure (CAP) that would provide net positive suction head to the emergency core cooling system (ECCS) pumps will be available (inclusive of a design basis loss-of-coolant accident). However, the ECCS pumps will not have normal power available because of the ELAP.

The wetwell PCIVs must be opened to permit vent flow. The physical features that prevent inadvertent actuation are locked closed, manual nitrogen supply valves and normally open vent valves at the ROS. The NRC staff's review of the HCVS confirmed that the licensee's design is consistent with the guidance and appears to preclude inadvertent actuation.

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

3.1.2.8 Monitoring of HCVS

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

The NRC staff reviewed the following channels documented in Table 1 of the FIP which support HCVS operation: HCVS effluent temperature, HCVS effluent radiation, HCVS valve position, HCVS components (ROS includes dc voltage, pneumatic and purge pressure), drywell pressure, and wetwell level. The NRC staff notes that drywell pressure, wetwell level are declared FitzPatrick 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 agrees 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 supports monitoring of HCVS effluent, HCVS effluent temperature, and HCVS effluent radiation. The NRC staff confirmed 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 detector installed at 369'-6" elevation of the reactor building. The process and control module is installed at the ROS (administration building 272') with local indication. The licensee stated the detector is qualified for the anticipated environment at the vent pipe during accident conditions. The licensee further stated that the process and control module is qualified for the expected conditions at the ROS. The NRC staff reviewed the qualification summary information provided in Table 1 of the FIP and finds that it appears to meet 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 fire pumps (DDFP) are permanently installed in the screenwell where they are protected from all applicable hazards. Environmental conditions in the DDFP room were addressed under Order EA-12-049. The 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 performed calculation JAF-CALC-15-00025, which predicts the temperature profile at the ROS following an ELAP. The licensee determined that the peak temperature in the area of the ROS will be maintained less than 110°F by performing compensatory actions of opening selected doors. Licensee procedure FSG-001 provides guidance to open doors to the reactor building to maintain the administration building corridor temperatures within acceptable limits.

The HCVS batteries and battery charger are permanently installed in the dc 'A" equipment room in the administration building on the 272' elevation. The NRC staff reviewed licensee calculation JAF-CALC-14-00027, "Temperature Evaluation of Battery Room and DC Equipment Room During Extended Loss of Offsite Power (FLEX)," Revision 0, which predicts the temperature profile in the battery rooms and dc equipment rooms following an ELAP. The licensee determined that the peak temperature in dc 'A' equipment room will reach 109°F at 120 hours after loss of ac power. The licensee plans to implement passive cooling actions such as opening specified doors within 10 hours of the event. Plant procedure FSG-001 provides guidance to open doors in the battery rooms and dc equipment rooms.

The licensee sized the HCVS batteries considering a minimum operating temperature of 65°F. This is the minimum ambient temperature of the area under ELAP conditions where the HCVS batteries are located as specified in calculation JAF-CALC-14-00027. The manufacturer's maximum design limit for the HCVS batteries is 176°F. Therefore, the HCVS batteries appear to be adequate to perform their design function under event temperatures. The operating temperature of the battery charger is -40°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 calculation that show the dc 'A' equipment room will remain within the maximum temperature limit of 176°F and 122°F for the HCVS batteries and battery charger, respectively. Furthermore, based on temperatures remaining below 120°F (the temperature limit for electronic equipment to be able to survive indefinitely, identified in NUMARC-87-00, "Guidelines and Technical Bases for NUMARC Initiatives Addressing Station Blackout at Light Water Reactors," Revision 1, as endorsed by NRC R.G 1.155), the NRC staff believes that 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

dc 'A' equipment room and at the ROS in the administration building should not be adversely impacted by the loss of ventilation as a result of an ELAP event.

Radiological

The licensee's calculation JAF-CALC-14-00029, "Hardened Containment Vent System: Dose Assessment," documents the dose assessment for both personnel habitability and equipment locations associated with event response to a postulated ELAP condition. The NRC staff audited calculation JAF-CALC-14-00029 and noted that the licensee used conservative assumptions to bound the peak dose rates for the analyzed areas. For the sources considered and the methodology used in the dose calculation, the timing of HCVS vent operation or cycling of the vent will not create higher doses at personnel habitability and equipment locations (i.e., maximum doses determined in the calculation bound operational considerations for HCVS vent operation). The NRC staff's audit confirmed that the anticipated severe accident radiological conditions appear to not impact 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 32], 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 (and other combustibles) from the pipe with nitrogen after a period of venting. The supply for the purge system is nitrogen bottles mounted at the ROS. The nitrogen purge system is charged by opening manual valve 27CAD-317 and initiated by opening manual valve 27CAD-319 to inject nitrogen into the HCVS pipeline downstream of the HCVS control valve 27AOV-142. Calculation JAF-CALC-15-00038 determined that a 31-second purge time is required to purge the combustibles after a vent cycle. The calculation assumes 12 purges in the first 24 hours when determining the minimum quantity of installed nitrogen bottles. The use of this purge system is designed to ensure the flammability limits of gases passing through the vent pipe will not be reached. The NRC staff confirmed that the licensee's design appears to be consistent with Option 3 of white paper HCVS-WP-03. The NRC staff also audited the licensee's analysis and confirmed the installed purge system capacity is sufficient. The NRC staff confirmed that the licensee's design appears to be consistent with Option 3 and that the use of the argon purge system in conjunction with

the HCVS venting strategy meets the requirement to prevent a detonable mixture from developing in the pipe.

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

As discussed in Section 3.2.1.3, the SGTS is the only interfacing mechanical system on the HCVS flow path for which there 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 (27MOV-120 and 27MOV-121) between the two systems. Valves 27MOV-120 and 27MOV-121 will be leak 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 review confirmed that the design appears to be consistent with the guidance and meets the design requirements to minimize the potential of hydrogen gas migration into other buildings.

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

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

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

3.2 HCVS QUALITY STANDARDS

3.2.1 Component Qualifications

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

In its FIP, the licensee stated that the HCVS upstream of and including the second containment isolation valve 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 NRC staff noted that the JAF final safety analysis report (FSAR) classifies the primary containment as safety-related. At FitzPatrick, safety-related functions, structures, systems, and components, based on the NRC definition, are required for major accidents, are classified as quality assurance category SR, and must meet Class I design requirements.

During the audit process, the licensee provided a discussion on the operations of the existing primary containment isolation valves (27AOV-117 and -118) relied upon for the HCVS. The licensee performed calculation 14620.9011-US(N)-004, "Suppression Chamber (20") & Drywall (24") Vent & Purge Butterfly Valves based on RELAP 5/MOD2 56 psig and 62 psig Results," to determine actuator capability and margin calculations for these PCIVs. The NRC staff audited the licensee's calculation and confirmed that the PCIVs can open under the maximum expected differential pressure during BDB and severe accident wetwell venting. The licensee did not have to provide any modifications or operational changes to the functionality of these PCIVs.

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

3.2.2 Component Reliability and Rugged Performance

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

In its FIP, the licensee stated that the HCVS components downstream of the outboard containment isolation valve and components that interface with the HCVS are routed in seismically qualified structures or supported from seismically qualified structure(s). The HCVS downstream of the outboard containment isolation valve, including piping and supports,

electrical power supply, valve actuator pneumatic supply, and instrumentation (local and remote) components, 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 evaluation 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 reliability and rugged performance, if implemented appropriately, appears to be consistent with NEI 13-02 guidance, as endorsed by JLD-ISG-2013-02 and JLD-ISG-2015-01, and should adequately address the requirements of the order.

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

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

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

As stated above in Section 2.2, Order EA-13-109 provides two options to comply with the Phase 2 order requirements. FitzPatrick 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 one of two permanently installed diesel driven fire pumps (DDFP) which take suction from Lake Ontario to provide SAWA flow. Installation of temporary pipe adapters and fire hoses, combined with completion of local valve alignments enables either one

of the plant DDFPs to inject water into the RPV, via the residual heat removal (RHR) system, to maintain RPV level. Backflow prevention is provided by an existing containment isolation check valve. Cross flow into other portions of the RHR system is prevented using normally closed valves. In its FIP, the licensee states 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 organization exposure guidelines. Once SAWA flow is initiated, operators will have to monitor and maintain SAWA flow and ensure refueling the DDFP pump as necessary.

4.1.1 Staff Evaluation

4.1.1.1 Flow Path

The SAWA injection flow path starts from either of the two DDFP, which takes suction from Lake Ontario. The licensee indicated that a new permanent plant hose quick connection at the discharge of the DDFP is connected through a portable hose and attached to the new throttling valve cart where SAWA flow indication and control is provided. The outlet of the new throttling valve cart is connected through a portable hose to new permanent firehose quick connections downstream of the RHR service water (RHRSW) 'B' strainer. The connection to RHRSW provides a hard pipe connection to the RPV. Backflow prevention is provided by containment isolation check valve 10AOV-68V installed in the RHR system. Cross flow into other portions of the RHR system is prevented using normally closed valves. Drywell pressure and suppression pool level will be monitored and flow rate will be adjusted by use of the SAWA pump control location in the screenwell, which also contains the SAWA flow indication.

4.1.1.2 SAWA Pump

In its FIP, the licensee states that the strategy is to use one primary and one alternate DDFP pump (both are existing and permanently installed) for FLEX and SAWA. In its FIP, the licensee described the hydraulic analysis performed to demonstrate the capability of one of the two DDFP pumps to provide the required 361 gallons per minute (gpm) of SAWA flow in an ELAP scenario. Both DDFP pumps are stated to be protected from all applicable external hazards.

The NRC staff audited calculation JAF-CALC-17-00104, "HCVS Phase 2 SAWA Hydraulic Analysis," Revision 0, which determined that the required SAWA flow rate of 361 gpm was within the capacity of either DDFP pump in the screenwell. 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 FitzPatrick, as described in the above hydraulic analysis and the FIP, it appears that the licensee has demonstrated that its DDFP pump 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 FitzPatrick 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 implementing procedures are integrated into the JAF severe accident operating guidelines (SAOGs). 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 SAOG flow charts direct the use of the hardened vent as well as SAWA/SAWM when the appropriate plant conditions have been reached.

The licensee used the validation guidance in Appendix E to NEI 12-06, Revision 1, to demonstrate that the FLEX/SAWA portable pump can be deployed and commence injection in less than 8 hours. The studies referenced in NEI 13-02, Revision 1, demonstrate that establishing flow within 8 hours will protect containment. Guidance document NEI 13-02, Appendix I, establishes an initial water addition rate of 500 gpm based on EPRI Technical Report 3002003301, "Technical Basis for Severe-Accident Mitigating Strategies." The initial SAWA flow rate at FitzPatrick will be approximately 361 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, information from EPRI Technical Report 3002003301, and JAF specific parameters to demonstrate that SAWA flow could be reduced to 71 gpm after 4 hours of initial SAWA flow rate and containment would remain protected. At some point, if wetwell level begins to rise, indicating that the SAWA flow is greater than the steaming rate due to containment heat load, SAWA flow can be further reduced as directed by SAOG guidelines.

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. FitzPatrick will follow the guidance (flow rate and timing) for SAWA/SAWM described in BWROG-TP-15-008, "Severe Accident Water Addition Timing," [Reference 33] and BWROG-TP-15-011 "Severe Accident Water Management" [Reference 34]. The wetwell be opened prior to exceeding the PCPL value of 62 psig. The licensee also referenced analysis included in BWROG-TP-15-008, which demonstrates adding water to the reactor vessel within 8 hours of the onset of the event will limit the peak containment drywell temperature, significantly reducing the possibility of containment failure due to temperature. Drywell pressure can be controlled by venting the containment from the suppression chamber.

The NRC staff audited the information referenced above. Guidance document NEI 13-02, uses an initial SAWA flow of 500 gpm reduced after four hours to 100 gpm. The NRC staff noted that FitzPatrick determined plant-specific flow rates by scaling using the ratio of FitzPatrick licensed thermal power (2,536 megawatts thermal (MWt)) to that of the reference plant (3,514 MWt) used in the EPRI Technical Report 3002003301, "Technical Basis for Severe-Accident Mitigating Strategies." This is consistent with NEI 13-02, Section 4.1.1.2.

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 JAF, to preclude the necessity for installing a hardened drywell vent, is to implement the containment venting strategy utilizing SAWA and severe accident water management (SAWM). This strategy consists of the use of the Phase 1 wetwell vent and SAWA hardware to implement a water management strategy that will preserve the wetwell vent path until alternate reliable containment heat removal can be established. The SAWA system consists of a FLEX (SAWA) pump injecting into the RPV. The overall strategy consists of flow control at the FLEX (SAWA) valve distribution manifold in the screenwell basement along with instrumentation and procedures to ensure that the wetwell vent is not submerged (SAWM). Water from the SAWA (FLEX) pump will be routed through the FLEX (SAWA) valve distribution manifold to the RHR system. This RHR connection allows the water to flow into the RPV. Portable throttling valve manifolds, which each include a flow meter, will be installed to support controlling the SAWA flow rates in order to maintain wetwell availability. Procedures have been issued to implement this strategy including SAOGs. The BWROG generic assessment, BWROG-TP-15-008 [Reference 33], provides the principles of SAWA to ensure protection of containment. This strategy has been shown via Modular Accident Analysis Program 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 243'-9" and 257'-6" (27.5' above the bottom of the wetwell) elevation in the wetwell provides approximately 813,012 gallons of water volume before the level instrument would be off scale high. An additional 51,586 gallons is available prior to reaching the elevation of the wetwell vent penetration. Generic assessment BWROG-TP-15-011 [Reference 34], 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 FitzPatrick, the SAWA/SAWM design flow rates (361 gpm at 8 hours followed by 71 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. As shown in plant design document EC 620605, Attachment 6.004, "Hardened Containment Vent (HCVS) System Phase 2," the wetwell level will not reach the wetwell vent for at least seven days. The NRC staff audited the information provided and agrees that starting water addition at a higher rate of flow and throttling after approximately 4-hours will not increase the suppression pool level to a point that could block the suppression chamber HCVS.

4.2.1.2 Strategy Time Line

As noted above in Section 4.1.1.3, "SAWA Analysis of Flow Rates and Timing," the SAWA flow is based on the site-specific, scaled flow rate of 361 gpm to start at about 8 hours and will be reduced to 71 gpm after 4 hours. The NRC staff concurs that the SAWM approach will provide operators sufficient time to reduce the water flow rate and to maintain wetwell venting capability.

The strategy is based on BWROG generic assessments in BWROG-TP-15-008 and BWROG-TP-15-011.

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

4.2.2 Conclusions

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

4.3 SAWA/SAWM Motive Force

4.3.1 Staff Evaluation

4.3.1.1 SAWA Pump Power Source

As described in Section 4.1, the licensee plans to use one of two DDFP pumps located in the screenwell to provide SAWA flow. The pumps are diesel-driven by an engine mounted on the skid with the pump. Operators will refuel the pump and DGs in accordance with Order EA-12-049 procedures using fuel oil from the installed underground DG fuel oil storage tanks. In its FIP, the licensee states that refueling will be accomplished in areas that are shielded and protected from the radiological conditions during a severe accident scenario. The fuel tanks on the DDFP pumps are sized such that the pumps can run for approximately 24 hours prior to needing to be refueled. The pumps will be refueled by the FLEX refueling equipment that has been qualified for long-term refueling operations per EA-12-049.

4.3.1.2 DG Loading Calculation for SAWA/SAWM Equipment

In its FIP, the licensee lists drywell pressure, wetwell level, and the SAWA flow meter as instruments required for SAWA and SAWM implementation. The drywell pressure and wetwell level instruments are used for HCVS venting operation. These instruments are powered by the Class 1E station batteries until the FLEX DG is deployed and available. The licensee also stated that the SAWA flow meter is self-powered from internal batteries with a battery life of 2.5 years.

The NRC staff audited licensee calculation JAF-CALC-15-00045, "Station Service Batteries A and B Discharge Capacity during Extended Loss of AC Power," Revision 0, which verified the capability of the Class 1E station batteries to supply power to the required loads (e.g. drywell pressure and wetwell level instruments) during the first phase of the FitzPatrick FLEX mitigation strategy plan for an ELAP event. The NRC staff also audited licensee calculation JAF-CALC-15-00031, which verified that one 200kW FLEX DG is adequate to support the addition of the HCVS electrical loads. The NRC staff confirmed that the Class 1E batteries and 200 kW FLEX

DGs should have sufficient capacity and capability to supply the necessary SAWA/SAWM loads during an ELAP event.

4.3.2 Conclusions

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

4.4 SAWA/SAWM Instrumentation

4.4.1 Staff Evaluation

4.4.1.1 SAWA/SAWM Instruments

In Section IV.C.10.2 of its FIP, the licensee stated, in part, that the instrumentation needed to implement the SAWA/SAWM strategy is wetwell level, drywell pressure, and SAWA flow metering. The wetwell level and drywell pressure instruments are existing R.G. 1.97 instruments that were designed and qualified for severe accident conditions. The flow instrument range is 12 to 1000 gpm, which appears to be consistent with the licensee's strategy. The NRC staff reviewed Section IV.C.10.1, Section IV.C.10.2, and Table 1 of the FIP and found that the instruments appear to be consistent with the NEI 13-02 guidance.

4.4.1.2 SAWA Instruments and Guidance

In Section IV.C.10.2 of 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.10.2 of its FIP, the licensee stated that the SAWA flow meter is a portable, digital-based, electromagnetic flow meter installed on the SAWA valve manifold cart and self-powered by internal batteries.

The NRC staff reviewed the FIP, including Section IV.C.10.2 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

In Section IV.C.10.3 of its FIP, the licensee stated that the drywell pressure and wetwell level are declared FitzPatrick 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 FitzPatrick FSAR.

The SAWA flow meter is attached to the SAWA valve manifold cart and will be deployed in the screenwell basement on the opposite side of the reactor building from the vent pipe. The licensee stated in Table 1 of its FIP that anticipated temperature at this location is 11°F to 110°F and the qualification temperature range is 10°F to 130°F. The licensee stated in Table 1 of its FIP that the flow meter is qualified up to 1E3 Rad total integrated dose (TID) and the anticipated radiation environment in this location is less than 1 Rad. The NRC staff reviewed Table 1 of the FIP and confirmed the anticipated environmental conditions are within the qualified range for the flow meter.

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 JAF-CALC-14-00029, "Hardened Containment Vent System: Dose Assessment." This calculation analyzed the dose at different locations and times where operator actions will take place during FLEX/SAWA/SAWM activities. The analyzed locations include the MCR, ROS, and travel paths for hose routing.

In its FIP, the licensee states that the SAWA pump is permanently installed in the screenwell and will be operated from outside the reactor building, on the opposite side of the reactor building from the vent pipe; therefore, there will be no significant dose to the SAWA pump control location or to the SAWA pump. The NRC staff audited the radiological analysis and concurs that, if implemented correctly, there should be no significant issues with radiation dose rates at the SAWA pump control location, and there should be no significant dose to the SAWA pump.

The licensee also states in its FIP, that the SAWA flow path inside the reactor building consists of steel piping that will be unaffected by the radiation dose and that all SAWA hoses are contained in the screenwell, so they will not be subjected to a significant radiation dose. The NRC staff concurs that the SAWA flow path will not be adversely affected by radiation effects due to the severe accident conditions.

4.5.1.2 Severe Accident Effect on SAWA/SAWM Instruments

The licensee's SAWA strategy relies on three instruments: wetwell level; drywell pressure; and SAWA flow. Drywell pressure and wetwell level are declared FitzPatrick 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.

In its FIP, the licensee states that the valve manifold cart is located in the basement of the screenwell on the opposite side of the reactor building from the vent pipe. The licensee estimated that the total dose in this location over a 7-day period would be less than 1 rem. As such, there should be no concern for any effects of radiation exposure to the flow instruments. Based on this information, the NRC staff agrees that the SAWA/SAWM instruments should not be adversely affected by radiation effects due to severe accident conditions.

4.5.1.3 Severe Accident Effect on Personnel Actions

According to the FIP, thermal and radiological impacts will not impede operators from performing necessary actions for the SAWA/SAWM strategy. Key locations are the MCR, ROS, screenwell, and FLEX DG refueling locations. The most important severe accident consideration is the radiological dose as a result of the accident and operation of the HCVS. Licensee procedures FSG-001 and FSG-ELAP provide guidance for ventilation strategies at various locations to mitigate high temperature conditions. Calculation JAF-CALC-17-00105 determines the temperature profile expected in the RHR service water pump rooms during an ELAP to ensure equipment remains operational. The other locations for personnel occupancy or equipment operation including the reactor building, diesel fire pump rooms, switchgear rooms, battery rooms, and MCR were evaluated as part of the staff's safety evaluation for EA-12-049 and those evaluations remain bounding for the deployment and operation of SAWA equipment. The SAWA pump and monitoring equipment can all be operated from the MCR or from outside the reactor building below ground level. The JAF FLEX response ensures that the SAWA pump, FLEX generators, and other equipment can all be run for a sustained period by refueling.

The NRC staff audited calculation JAF-CALC-17-00105. The calculation shows that the MCR and ROS are expected to remain habitable with respect to the anticipated maximum temperature during the event. Operation of SAWA equipment will not affect the evaluation performed above in Section 3.1.1.2, "Personnel Habitability – Environmental". Ambient temperatures for equipment located outside of the buildings are not affected by operation of the HCVS.

The licensee performed calculation JAF-CALC-14-00029, "Hardened Containment Vent System: Dose Assessment," in order to document the dose assessment for designated areas inside the FitzPatrick reactor building (outside of containment) and outside the FitzPatrick reactor building caused by the sustained operation of the HCVS under the beyond-design-basis severe accident condition of an ELAP. This assessment used conservative assumptions to determine the expected dose rates in all areas that may require access during a beyond-design-basis ELAP. The NRC staff audited the licensee's evaluation and agrees that, if implemented correctly, mission doses associated with actions taken to protect the public under beyond-design-basis severe accident conditions will not subject plant personnel to an undue risk from radiation exposure.

4.5.2 Conclusions

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

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

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

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

5.0 HCVS/SAWA/SAWM PROGRAMMATIC CONTROLS

5.1 Procedures

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

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

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

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

5.2 Training

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

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

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

6.0 CONCLUSION

In June 2014, the NRC staff started audits of the licensee's progress in complying with Order EA-13-109. The staff issued an ISE for implementation of Phase 1 requirements on April 1, 2015 [Reference 13], an ISE for implementation of Phase 2 requirements on April 28, 2017 [Reference 14], and an audit report on the licensee's responses to the ISE open items on June 15, 2018 [Reference 15]. The licensee reached its final compliance date on June 29, 2018, and has declared in letter dated August 28, 2018 [Reference 16], that James A. FitzPatrick Nuclear Power Plant, 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 FitzPatrick to NRC, "James A. FitzPatrick Nuclear Power Plant – 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. ML14181B117)

3. Letter from FitzPatrick 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. ML14353A359)

4. Letter from FitzPatrick 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. ML15181A261).

5. Letter from FitzPatrick to NRC, "James A. FitzPatrick Nuclear Power Plant – 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 29, 2015 (ADAMS Accession No. ML15363A412)

6. Letter from FitzPatrick 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. ML16182A377)

7. Letter from FitzPatrick 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 22, 2016 (ADAMS Accession No. ML16357A787)

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Date: February 25, 2019

SUBJECT: JAMES A. FITZPATRICK NUCLEAR POWER PLANT - SAFETY EVALUATION REGARDING IMPLEMENTATION OF HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS RELATED TO ORDER EA-13-109 (CAC NO. MF4464; EPID NO. L-2014-JLD-0049) DATED: February 25, 2019

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