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

May 29, 2018

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

SUBJECT: LIMERICK GENERATING STATION, UNITS 1 AND 2 - REPORT FOR THE AUDIT OF LICENSEE RESPONSES TO INTERIM STAFF EVALUATIONS OPEN ITEMS RELATED TO NRC ORDER EA-13-109 TO MODIFY LICENSES WITH REGARD TO RELIABLE HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS (CAC NOS. MF4418 AND MF4419; EPID L-2014-JLD-0051)

Dear Mr. Hanson:

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

By letter dated June 30, 2014 (ADAMS Accession No. ML14181A418), Exelon Generation Company, LLC (the licensee) submitted its Phase 1 OIP for Limerick Generating Station, Units 1 and 2 (LGS, Limerick). By letters dated December 17, 2014, June 30, 2015, December 15, 2015 (which included the combined Phase 1 and Phase 2 OIP), June 30, 2016, December 15, 2016, June 30, 2017, and December 15, 2017 (ADAMS Accession Nos. ML14353A110, ML15181A016, ML15364A014, ML16182A011, ML16350A266, ML17181A031, and ML17349A035, respectively), the licensee submitted its 6-month updates to the OIP. The NRC staff reviewed the information provided by the licensee and issued interim staff evaluations (ISEs) for Phase 1 and Phase 2 of Order EA-13-109 for Limerick by letters dated April 1, 2015 (ADAMS Accession No. ML15082A433), and August 2, 2016 (ADAMS Accession No. ML16116A320), respectively. When developing the ISEs, the staff identified open items where additional information was still needed to complete its review.

The NRC staff is using the audit process described in letters dated May 27, 2014 (ADAMS Accession No. ML14126A545), and August 10, 2017 (ADAMS Accession No. ML17220A328), to gain a better understanding of licensee activities being performed for compliance with the order. As part of the audit process, the staff reviewed the licensee's closeout of the ISE open

items. The NRC staff conducted a teleconference with the licensee on May 3, 2018. The enclosed audit report provides a summary of that aspect of the audit.

If you have any questions, please contact me at (301) 415-1025 or by e-mail at Rajender.Auluck@nrc.gov.

Sincerely,

R Auluck

Rajender Auluck, Senior Project Manager
Beyond-Design-Basis Engineering Branch
Division of Licensing Projects
Office of Nuclear Reactor Regulation

Docket Nos. 50-352 and 50-353

Enclosure:
Audit report

cc w/encl: Distribution via Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
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AUDIT REPORT BY THE OFFICE OF NUCLEAR REACTOR REGULATION

AUDIT OF LICENSEE RESPONSES TO INTERIM STAFF EVALUATIONS OPEN ITEMS

RELATED TO ORDER EA-13-109 MODIFYING LICENSES

WITH REGARD TO RELIABLE HARDENED CONTAINMENT VENTS CAPABLE OF

OPERATION UNDER SEVERE ACCIDENT CONDITIONS

EXELON GENERATION COMPANY, LLC

LIMERICK GENERATING STATION, UNITS 1 AND 2

DOCKET NOS. 50-352 AND 50-353

BACKGROUND

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 Condition," to all Boiling-Water Reactor (BWR) licensees with Mark I and Mark II primary containments. The order requirements are divided into two parts to allow for a phased approach to implementation.

Phase 1 of Order EA-13-109 requires license holders of BWRs with Mark I and Mark II primary containments to design and install a Hardened Containment Vent System (HCVS), using a vent path from the containment wetwell to remove decay heat, vent the containment atmosphere (including steam, hydrogen, carbon monoxide, non-condensable gases, aerosols, and fission products), and control containment pressure within acceptable limits. The HCVS shall be designed for those accident conditions (before and after core damage) for which containment venting is relied upon to reduce the probability of containment failure, including accident sequences that result in the loss of active containment heat removal capability or extended loss of alternating current (ac) power (ELAP). The order required all applicable licensees, by June 30, 2014, to submit to the Commission for review an overall integrated plan (OIP) that describes how compliance with the Phase 1 requirements described in Order EA-13-109 Attachment 2 will be achieved.

Phase 2 of Order EA-13-109 requires license holders of BWRs with Mark I and Mark II primary containments to design and install a system that provides venting capability from the containment 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 order required all applicable licensees, by December 31, 2015, to submit to the Commission for

review an OIP that describes how compliance with the Phase 2 requirements described in Order EA-13-109 Attachment 2 will be achieved.

By letter dated June 30, 2014 (ADAMS Accession No. ML14181A418), Exelon Generation Company, LLC (Exelon, the licensee) submitted its Phase 1 OIP for Limerick Generating Station, Units 1 and 2 (LGS, Limerick). By letters dated December 17, 2014, June 30, 2015, December 15, 2015 (which included the combined Phase 1 and Phase 2 OIP), June 30, 2016, December 15, 2016, June 30, 2017, and December 15, 2017 (ADAMS Accession Nos. ML14353A110, ML15181A016, ML15364A014, ML16182A011, ML16350A266, ML17181A031, and ML17349A035, respectively), the licensee submitted its 6-month updates to the OIP, as required by the order.

The NRC staff reviewed the information provided by the licensee and issued interim staff evaluations (ISEs) for Phase 1 and Phase 2 of Order EA-13-109 for Limerick by letters dated April 1, 2015 (ADAMS Accession No. ML15082A433), and August 2, 2016 (ADAMS Accession No. ML16116A320), respectively. When developing the ISEs, the staff identified open items where additional information was needed to complete its review .

The NRC staff is using the audit process in accordance with the letters dated May 27, 2014 (ADAMS Accession No. ML14126A545), and August 10, 2017 (ADAMS Accession No. ML17220A328), to gain a better understanding of licensee activities as they come into compliance with the order. The staff reviews submitted information, licensee documents (via ePortals), and preliminary Overall Program Documents (OPDs)/OIPs, while identifying areas where additional information is needed. As part of this process, the staff reviewed the licensee closeout of the ISE open items.

AUDIT SUMMARY

As part of the audit, the NRC staff conducted a teleconference with the licensee on May 3, 2018. The purpose of this audit teleconference was to continue the audit review and provide the NRC staff the opportunity to engage with the licensee regarding the closure of open items from the ISEs. As part of the preparation for the audit call, the staff reviewed the information and/or references noted in the OIP updates to ensure that closure of ISE open items and the HCVS design are consistent with the guidance provided in Nuclear Energy Institute (NEI) 13-02, Revision 1, other related documents (e.g. white papers (ADAMS Accession Nos. ML14126A374, ML14358A040, ML15040A038 and ML15240A072, respectively) and frequently asked questions (FAQs), (ADAMS Accession No. ML15271A148)) that were developed and reviewed as part of overall guidance development. The NRC staff audit members are listed in Table 1. Table 2 is a list of documents reviewed by the staff. Table 3 provides the status of the ISE open item closeout for Limerick. The open items are taken from the Phase 1 and Phase 2 ISEs issued on April 1, 2015, and August 2, 2016, respectively.

FOLLOW UP ACTIVITY

The staff continues to audit the licensee's information as it becomes available. The staff will issue further audit reports for Limerick, as appropriate.

Following the licensee's declarations of order compliance, the licensee will provide a final integrated plan (FIP) that describes how the order requirements are met. The NRC staff will evaluate the FIP, the resulting site-specific OPDs, as appropriate, and other licensee documents, prior to making a safety determination regarding order compliance.

CONCLUSION

This audit report documents the staff's understanding of the licensee's closeout of the ISE open items, based on the documents discussed above. The staff notes that several of these documents are still preliminary, and all documents are subject to change in accordance with the licensee's design process. In summary, the staff has no further questions on how the licensee has addressed the ISE open items, based on the preliminary information. The status of the NRC staff's review of these open items may change if the licensee changes its plans as part of final implementation. Changes in the NRC staff review will be communicated in the ongoing audit process.

Attachments:
1. Table 1 – NRC Staff Audit and Teleconference Participants
2. Table 2 – Audit Documents Reviewed
3. Table 3 – ISE Open Item Status Table

Table 1 - NRC Staff Audit and Teleconference Participants

Title	Team Member	Organization
Team Lead/Sr. Project Manager	Rajender Auluck	NRR/DLP
Project Manager Support/Technical Support – Containment / Ventilation	Brian Lee	NRR/DLP
Technical Support – Containment / Ventilation	Bruce Heida	NRR/DLP
Technical Support – Electrical	Kerby Scales	NRR/DLP
Technical Support – Balance of Plant	Garry Armstrong	NRR/DLP
Technical Support – I&C	Steve Wyman	NRR/DLP
Technical Support – Dose	John Parillo	NRR/DRA

Table 2 – Audit Documents Reviewed

Design Change Package (DCP) 423381, "1R17 MOD – Fukushima Hardened Vent – Online Work 16-00130/ECR-DCP," Revision 3
Design Change Package (DCP) 423333, "2R14 MOD – Fukushima Hardened Vent – Online Elect/I&C Work 16-00013/ECR-DCP," Revision 3
Calculation LE-0128, "HCVS Battery and Battery Charger Sizing S&L/ECR 16-003," Revision 0
Calculation M-81-30, "Diesel Generator Building Corridor HVAC Loads," Revision 1
Engineering Change (EC) 622673, "Temperature, Humidity and Radiological Evaluation HCVS & SAWA/SAWM," Revision 0
Calculation LM-0721, "Hardended Containment Vent System Dose Assessment," Revision 0
Calculation LM-0709, "Limerick Hardened Containment Vent Capacity," Revision 0
Design Change Package (DCP) 423331, "2R14 MOD – Fukushima Hardened Vent – Online Work 16-00011/ECR-DCP," Revision 2
Design Change Package (DCP) 422831, "Unit 2 HCVS Safeguards Room Train Bay Large Bore Piping 13-00264/ECR-DCP," Revision 3
Calculation LM-0723, "HCVS PCIV Compressed Air Bottle Requirements," Revision 1
Calculation LM-0724, "Hardened Containment Vent Purge System Design Calculation," Revision 1
Calculation LM-0725, "FLEX Activity and HCVS Phase 2 Dose Assessment," Revision 0
BWROG-TP-008, "Severe Accident Water Addition Timing"
BWROG-TP-011, "Severe Accident Water Management Supporting Evaluations"

Limerick Generating Station, Units 1 and 2
Vent Order Interim Staff Evaluation Open Items:

Table 3 - ISE Open Item Status Table

ISE Open Item Number Requested Action	Licensee Response – Information provided in 6 month updates and on the ePortal	NRC Staff Close-out notes	Safety Evaluation (SE) status Closed; Pending; Open (need additional information from licensee)
Phase 1 ISE OI 1 Make available for NRC staff audit documentation of a method to disable HCVS during normal operation to provide assurances against inadvertent operation that also minimizes actions to enable HCVS operation following an ELAP.	Unit 1 – Complete The system is designed to prevent inadvertent operation. The new control switch HS-057V-183 installed in the main control room (MCR) panel 10-C689 is a keylock switch. The switch is kept locked in "OFF" position (with key removed) to prevent inadvertent powering of the HCVS components from 125 Vdc [volts direct current] HCVS battery source. Additionally, locked valves are used with the gas bottles to prevent inadvertent operation. (Reference EC 423381 section 3.19). Unit 2 – Complete The system is designed to prevent inadvertent operation. The new control switch HS-057V-283 installed in the MCR panel 20-C689 is a keylock switch. The switch is kept locked in "OFF" position (with key removed) to prevent inadvertent powering of the HCVS components from 125 Vdc HCVS battery source. Additionally, locked valves are used with the gas bottles to prevent inadvertent operation. (Reference EC 423333 section 3.19).	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. Engineering Change (EC) 423381 and EC 423333, in part, discusses the control mechanism for HCVS during normal operation. The licensee provided details in the document on maintaining the HCVS in the "OFF" condition and only being accessible as directed by revised procedures. The new control switch installed in the MCR panel is a keylock switch. Additionally, locked valves are used with the gas bottles to prevent inadvertent operation. No follow-up questions.	Closed [Staff evaluation to be included in SE Section 3.1.2.7]

	EC 423333 and EC423381 are available in ePortal.		
Phase 1 ISE OI 2 Make available for NRC staff audit the final sizing evaluation for HCVS batteries/battery charger including incorporation into FLEX DG loading calculation.	Unit 1 – Complete The HCVS batteries have been sized to meet the requirements of the HCVS system and function for the initial 24 hours into the event. (Reference Calculation LE-0128). The FLEX diesel generator loading is acceptable and rated loading of the FLEX diesel generator will not be exceeded due to the additional HCVS loading. (Reference EC 423381 section 3.35). Unit 2 – Complete. The HCVS batteries have been sized to meet the requirements of the HCVS system and function for the initial 24 hours into the event. (Reference Calculation LE-0128) The FLEX diesel generator loading is acceptable and rated loading of the FLEX diesel generator will not be exceeded due to the additional HCVS loading. (Reference EC 423333 section 3.35). LE-0128, EC 423333 and EC 423381 are available in ePortal.	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. The licensee stated that all electrical power required for operation of HCVS components is provided by the 125 Vdc battery/battery charger. The battery sizing calculation (L-0128) confirmed that the HCVS batteries have a minimum capacity capable of providing power for 24 hours without recharging, and therefore is adequate. The licensee provided DCS Section 3.35 for EC 423333 and EC 423381, which discusses re-powering of the HCVS battery charger using a FLEX DG. No follow-up questions.	Closed [Staff evaluation to be included in SE Section 3.1.2.6]
Phase 1 ISE OI 3 Make available for NRC staff audit an evaluation of temperature and radiological conditions to ensure that operating personnel can safely	Unit 1 – Complete The primary operating station for HCVS operation is located in the MCR. A remote operating station (ROS) is located in the emergency diesel generator (EDG) Corridor, EL. 217' (Room 313). The ROS	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. MCR temperatures have been addressed as part of the FLEX	Closed [Staff evaluation to be included in SE Sections 3.1.1.2 and 3.1.1.3]

access and operate controls and support equipment	location and travel path to ROS location was evaluated for habitability and accessibility during a severe accident. (Reference EC 423382 section 3.19). Unit 2 – Complete The primary operating station for HCVS operation is located in the MCR. A remote operating station (ROS) is located in the EDG Corridor, EL. 217' (Room 317). The ROS location and travel path to ROS location was evaluated for habitability and accessibility during a severe accident. (Reference EC 423281 section 3.19). EC 423281 and 423382 are available in ePortal.	order and were found to acceptable by the NRC staff. EC 423281 and EC 423382 discusses the environmental conditions for the ROS as it relates to personnel habitability and equipment operability. The maximum expected temperature in the ROS location in the EDG corridor is 120 degrees Farenheit (°F). This temperature is expected to occur due to a non-safety-related heating steam pipe rupturing during a seismic event. To mitigate this issue, the heating steam pipe was analyzed and additional supports have been installed to ensure the piping will not rupture (EC 423333 and EC 423381). There are no additional process fluid piping or heat generating equipment that would add significant heat to this area. Therefore, the area will then be at outside ambient conditions which does not normally exceed 100 °F. In addition, operator stay time in the ROS is limited. If required, operating personnel working in high temperature areas will be protected using guidance in SA-AA-111, Heat Stress Control. Calculation LM-0721, "Hardended Containment Vent System Dose Assessment," Revision 0 was	

		performed to determine the integrated radiation dose due to HCVS operation. The NRC staff reviewed this calculation and determined that the licensee used conservative assumptions and followed the guidance outlined in NEI 13-02 Rev.1 and HCVS-WP-02 Rev. 0. Based on the expected integrated whole body dose equivalent in the MCR and ROS and the expected integrated whole body dose equivalent for expected actions during the sustained operating period, the NRC staff believes that the order requirements are met.result in low operator dose. Based on the these evaluations, the temperature and radiological conditions should not inhibit operator actions needed to initiate and operate the HCVS during an ELAP with severe accident conditions. No follow-up questions.	
Phase 1 ISE OI 4 Make available for NRC staff audit analyses demonstrating that HCVS has the capacity to vent the steam/energy equivalent of one (1) percent of licensed/rated thermal power (unless a lower value is justified), and that the suppression pool and the HCVS together are able to	Unit 1 and Unit 2 – Complete The required one percent capacity at the lower of Primary Containment Pressure Limit (PCPL) or containment design pressure will be verified using Reactor Excursion and Leak Analysis Program (RELAP). In addition, Modular Accident Analysis Program (MAAP) analyses will be credited to verify that venting can be delayed for at least three hours and that anticipatory venting can be credited to	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. Calculation LM-709 used a rated thermal power of 3,952 MWt [megawatt thermal]. The flow rate equivalent of 1% reactor power thermal energy is 147,708 lbm/hr. HCVS flow at 63.76 psia [per square inch absolute] is 149,540	Closed [Staff evaluation to be included in SE Section 3.1.2.1]

absorb and reject decay heat, such that following a reactor shutdown from full power containment pressure is restored and then maintained below the primary containment design pressure and the primary containment.	maintain Reactor Core Isolation Cooling (RCIC) functional. Unit 1 (Reference EC 423382 Section 3.33 and LM-709). Unit 2 (Reference EC 423281 Section 3.33 and LM-709). EC 423281, EC 423382, and LM-709 are available in ePortal.	lbm/hr. (Vent capacity summary table on page 24 of calculation) No follow-up questions.	
Phase 1 ISE OI 5 Make available for NRC staff audit the seismic and tornado missile final design criteria for the HCVS stack.	Complete (Reference EC 423331 section 3.2, 3.5, 3.9, and 3.38 (formally known as 16-00011) and EC 423332 section 3.38 (formally known as 16-00012), and EC 422831 section 3.24 (formally known as 13-264)) describe seismic and tornado missile design criteria for HCVS stack. EC pkgs 423331, 423332, and 422831 are available in ePortal for review.	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. EC 423331, EC 423332, and EC 422831 addresses the HCVS seismic qualification and tornado missile design. The licensee evaluated the entire HCVS system to Seismic Catergory I, which is consistent with the plants seismic design basis. For the tornado missile design the licensee relies on NRC-endorsed HCVS-WP-04. Section 3.0 of the white paper defines 30-feet above grade as the highest grade within 300 yards of the HCVS structure for potential tornado missles evaluation. HCVS is routed inside the Reactor Building until it exits to the South Stack structure. That structure also provides additional protection from wind generated missiles. No follow-up questions.	Closed [Staff evaluation to be included in SE Section 3.2.2]

Phase 1 ISE OI 6 Make available for NRC staff audit the descriptions of local conditions (temperature, radiation and humidity) anticipated during ELAP and severe accident for the components (valves, instrumentation, sensors, transmitters, indicators, electronics, control devices, and etc.) required for HCVS venting including confirmation that the components are capable of performing their functions during ELAP and severe accident conditions.	Unit 1 and Unit 2 – Complete HCVS is designed to minimize the impact of elevated temperatures, due to the potential loss of ventilation, radiation and humidity impact on the ability of operators to initiate and maintain the functionality of the HCVS. The locations of system equipment that require operator action and the travel paths to reach the controls and indications are in mild environments. Unit 1 (Reference EC 423382 section 3.19 and 3.24). Unit 2 (Reference EC 423281 section 3.19 and 3.24). EC 423281 and EC 423382 are available in ePortal for review. The loss of all general area lighting, coincident with the ELAP, does not pose a threat to the operators' ability to access and operate HCVS, since self-contained emergency lights illuminate the travel paths and handheld or portable lighting is available to manipulate HCVS equipment.	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. EC 423281 and EC 423382, and Table 1 in EC 622673, "Temperature, Humidity and Radiological Evaluation HCVS & SAWA/SAWM [severe accident water addition/ severe accident water management]," Revision 0 discusses the environmental conditions during an accident at the locations containing I&C components. The staff's review indicated that the environmental qualification met the order requirements. No follow-up questions.	Closed [Staff evaluation to be included in SE Section 3.1.1.4]
Phase 1 ISE OI 7 Make available for NRC staff audit documentation of the HCVS nitrogen pneumatic system design including sizing and location.	Unit 1 and Unit 2 – Complete HCVS is designed to operate for first 24 hours with installed independent pneumatic air supply, thereby eliminating the reliance on portable equipment. HCVS is also designed for multiple venting and purge cycles during the first 24-hour period without the need to recharge pneumatic air supply is located in the emergency diesel corridor. Unit 1 (Reference EC 423381 section 3.19 and Calculation LM-0723). Unit 2 (Reference EC 423333 section 3.19 and Calculation LM-0723).	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. EC 423333 and EC 423381 discuss the pneumatic design and sizing. Calculation LM-0723, "HCVS PCIV [primary containment isolation valve] Compressed Air Bottle Requirements," Revision 1 and Calculation LM-0724, "Hardened Containment Vent Purge System Design Calculation," Revision 1	Closed [Staff evaluation to be included in SE Section 3.1.2.6]

	EC 423333, EC 423381, and calculation LM-0723 are available in ePortal for review.	provides verification of the bottle size calculation. Two bottles at a minimum of 1500 per square inch gauge (psig) are required for temperatures below 121°F. The HCVS is based on 8 vent cycles in 24 hours. Additionally, the licensee determined that 20 argon bottles valved in has a minimum pressure of 2300 psig for temperatures at 70°F. Bottles are replaced after 4 vent cycles. No follow-up questions.	
Phase 1 ISE OI 8 Make available for NRC staff audit documentation that demonstrates adequate communication between the remote HCVS operation locations and HCVS decision makers during EI.AP and severe accident conditions.	Complete This communication method is the same as accepted in Order EA-12-049. These items will be powered and remain powered using the same methods as evaluated under EA-12-049 for the period of sustained operation, which may be longer than identified for EA-12-049. Communication will be via the plant radio system if available. If the radio system is not available, the Plant page system can be used. The page system was modified for FLEX to include a UPS [uninterruptable power supply] that can be manually aligned to repower the system. (Reference AR 2492527-42). AR 2492527-42 is available in ePortal for review.	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. The communication methods are the same as accepted in Order EA-12-049. No follow-up questions.	Closed [Staff evaluation to be included in SE Section 3.1.1.1]
Phase 1 ISE OI 9 Provide a description of the final design of the HCVS to	Unit 1 and Unit 2 – Complete HCVS has been designed to ensure the flammability limits of gases passing through the system are not reached. The	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal.	Closed [Staff evaluation to be included in SE Section 3.1.2.11]

address hydrogen detonation and deflagration.	vent piping is routed with a continuously upward slope. A purge gas (argon) supply system has been provided to displace potentially flammable/denotable mixtures of gases that may be present in the vent after system actuation. The purge gas supply system is designed for four purge cycles during the first 24-hour period without the need to recharge. Unit 1 (Reference EC 423381 section 3.19). Unit 2 (Reference EC 423333 section 3.19) EC 42333 and 423381 are available in ePortal for review.	Licensee uses argon to purge the HCVS piping of hydrogen to limit the possibility of a hydrogen deflagration/detonation. EC 423381 and EC 423333 discusses the argon purge system, including the volume of Argon to burst the rupture disk, which is designed for 4 purges in the first 24 hours. The NRC staff also noted that oxygen monitoring systems are being installed to alert personnel of oxygen deficient environment where the argon is used. The licensee's design is consistent with Option 3 of the NRC-endorsed white paper HCVS-WP-03. No follow-up questions.	
Phase 1 ISE OI 10 Provide a description of the strategies for hydrogen control that minimizes the potential for hydrogen gas migration and ingress into the reactor building or other buildings.	Unit 1 - Complete As discussed in the December 2015 OIP, the Limerick wetwell vent line for each unit has a dedicated HCVS flow path from the wetwell penetration to the outside with no interconnected system. The discharge point meets the guidance of "HCVS Release Point", HCVS-FAQ-04. Unit 2 - Complete (Reference EC 423281 and Calculation LM-0709) EC 423281 and calculation LM-0709 are available in ePortal for review.	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. The HCVS wetwell pipe in each each unit provides a dedicated HCVS flowpath from the wetwell penetration PCIVs to the outside with no interconnected downstream piping. The staff's review of the proposed system indicates that the licensee's design appears to maintain hydrogen below flammability limits. No follow-up questions.	Closed [Staff evaluation to be included in SE Section 3.1.2.12]

Phase 1 ISE OI 11 Make available for NRC staff audit documentation of a seismic qualification evaluation of HCVS components.	Unit 1 – Complete Seismic documentation has been provided EC 423381, Section 3.4, EC 423382, Section 3.4, and AR 2492527-97. Unit 2 – Complete Seismic documentation has been provided in Reference EC 423331 section 3.4 and 3.38, 423333 section 3.4, 3.38 and attachment 45, and 617568 section 3.2. EC 423331, EC 423333, EC 617568, EC 423381, EC 423382, and AR 2492527-97 are available in ePortal for review.	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. The licensee provided several qualification reports which demonstrate the seismic adequacy of the HCVS components. These seismic qualification reports indicates the HCVS piping, components, supports, and wall penetrations are classified as Seismic Class IIA but are designed to Seismic Class 1 Criteria. The NRC staff reviewed these reports and confirmed that the components required for HCVS venting remain functional following a design basis earthquake. No follow-up questions.	Closed [Staff evaluation to be included in SE Section 3.2.2]
Phase 1 ISE OI 12 Make available for NRC staff audit descriptions of all instrumentation and controls (existing and planned) necessary to implement this order including qualification methods.	Unit 1 – Complete EC 423381 installed and qualified the following components in the MCR and in the plant: - valve position indicating lights, power key-locked switch, temperature indicator displays, radiation monitoring system consisting of an element local to the HCVS vent pipe, and a monitor. (Reference EC 423381 section 3.19 and 3.36).	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. The existing plant instuments required for HCVS (i.e. wetwell level instruments and drywell pressure instruments) meet the requirements of RG 1.97. EC 423381 and EC 423333 discusses the qualifications for new HCVS I&C components. The NRC staff's review indicated that the qualification met the order requirements.	Closed [Staff evaluation to be included in SE Section 3.1.2.8]

	Existing pressure instrument PI-042-170-1 will be used to monitor containment pressure in the drywell. The transmitter (PT-042-170) has been replaced with an RG 1.97 qualified component to ensure this will remain functioning during the event. See EC 423381 for replacement and EC 423382 section 3.19 for qualification of the component. Unit 2 – Complete EC 423333 installed and qualified the following components in the MCR and in the plant: - valve position indicating lights, power key-locked switch, temperature indicator displays, radiation monitoring system consisting of an element local to the HCVS vent pipe, and a monitor. (Reference EC 423333 section 3.19 and 3.36). Existing pressure instrument PI-042-270-1 will be used to monitor containment pressure in the drywell. See EC 617568 section 3.2 for qualification of the component. EC 423333, 617568, EC 423381 and EC 423382 are available in ePortal for review.	No follow-up questions.	
Phase 1 ISE OI 13 Make available for NRC staff audit the procedures for HCVS operation.	Unit 1 – Started Unit 2 – Complete Reference the following procedures. SAMP-1 Sht 1 -7: RPV and Primary Containment Flooding Control SAMP-2	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. The Unit 2 guidelines and procedures for HCVS operation	Closed [Staff evaluation to be included in SE Section 5.1]

	Sht 1- 3: Containment and Radioactivity Release Control T-101: RPV Control T-102: Primary Containment Control SP/T, SP/L, PC/P, DW/T, PC/H T-111: RPV Level Restoration/Steam Cooling T-116: RPV Flooding T-117: Level/Power Control T-334: FLEX Generator Connection for Repowering DIV 2 Battery Charger T-341: Primary Containment Venting Via Hardened Containment Vent System RT-6-000-914-0: Inspection of FLEX Pump Storage Building Equipment RT-6-000-915-0: Inspection of FLEX Generator Storage Building Equipment RT-6-000-916-0: Routine Inspection of Spare HCVS Argon and Air Bottles RT-6-057V-400-2: HCVS PCIV Valve Exercise Test GP-19: Operator Activities ST-6-092-1 16-2 D22: Diesel Generator 4KV SFGD Loss of Power LSF-SM and Outage Testing RT-6-092-452-2: Procedure for Deenergizing and Reenergizing the D22 Safeguard Bus During a Refuel Outage ST-6-092-1 18-2: D24 Diesel Generator 4KV SFGD Loss of Power LSF-SM and Outage Testing RT-6-092-452-2: Procedure for Deenergizing and Reenergizing the D22 Safeguard BUS during a Refueling outage ST-6-060-460-2: Primary Containment Isolation Capability Check OP-LG-108-103-1 102: Limerick Generating Station Unit 2 Locked Valve List RT-6-000-360-2: Unit 2 Accessible Locked Valve Walkdown 2S57V.1.A: Equipment Alignment of the Hardened Containment Vent System for Normal Operation SE-10-1: Breaker Reset Following LOCA RT-6-057V-901-2: HCVS Battery Monthly Check RT-6-057V-902-2 HCVS Battery Quarterly Check F-	are complete and consistent with the guidance in NEI 13-02. The Unit 1 guidelines and procedures for HCVS operation will be developed and will follow the same guidance as Unit 2, consistent with the guidance in NEI 13-02. No follow-up questions.	

	R-714: South Stack Instrument Room 714 F-D-317: Unit 2 Diesel Generator Access Coordinate and Condensate Pump Rooms 317 and 318 (El 217') F-FPSB-OOI: Pre-Fire Plan Strategy for FLEX Pump Storage Building 2S92. 1 .N: Equipment Alignment for 2A Diesel Generator Operator S57V.8.A: Startup of the HCVS Battery Charger S57V.8.B: Shutdown of the HCVS Battery Charger ST-6-076-360-2: RX ENCL SEC CNTMT Integrity Verification. These procedures are in ePortal for review.		
Phase 2 ISE OI 1 Licensee to demonstrate that the HCVS components meeting reasonable protection from tornado missiles is at least 30 feet above the highest grade within 300 yards.	Unit 1 and Unit 2 – Complete Per Drawing HBD-842-01, the HCVS pipe leaves the protected structure more than 120 feet above grade elevation, which is 217 feet main sea level (MSL), as indicated on site topographical drawing C-0062 that shows grade elevation referenced to MSL within 300 yards of the HCVS components evaluated.	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. For the tornado missile design the licensee relies on NRC-endorsed HCVS-WP-04. Section 3.0 of the white paper defines 30-feet above grade as the highest grade within 300 yards of the HCVS structure for potential tornado missile evaluation. HCVS is routed inside the Reactor Building until it exits to the South Stack structure. That structure also provides additional protection from wind generated missiles. No follow-up questions.	Closed [Staff evaluation to be included in SE Section 3.2.2]
Phase 2 ISE OI 2 Licensee to confirm through analysis the temperature and radiological conditions to	Unit 1 and Unit 2 – Complete Actions taken within the first hour (prior to start of core damage) from the start of the ELAP are acceptable from an	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal.	Closed [Staff evaluation to be included in SE Sections 4.1.1.4 and 4.2.1.4]

ensure that operating personnel can safely access and operate controls and support equipment.	environmental and radiological perspective without further evaluation. For actions within the MCR are acceptable for the entire period of Sustained Operation per HCVS-FAQ-06 Assumption 049-21. For actions within the Reactor Building and between 1 and 7 hours, evaluation of expected temperatures and dose rates has been performed and determined to be acceptable. (Reference EC622673, and calculations LM-0721 and LM-0725). For locations outside the Reactor Building between 7 hours and 7 days, Limerick performed evaluations for the temperature and radiological conditions for the equipment and deployment locations, including ingress/egress paths and determined them to be acceptable. (Reference EC 622673, and calculations LM-0721 and LM-0725). EC 622673, LM-0721 and LM-0725 are available in ePortal for review.	For temperature review of the MCR and ROS, see Phase 1 ISE Open Item-3 above. As noted in Phase 1 ISE Open Item-3, above, if required, operating personnel working in high temperature areas will be protected using guidance in SA-AA-111, Heat Stress Control. The use of SA-AA-111 heat stress controls, it is reasonable to assume the operator actions required to implement the HCVS and SAWA/SAWM strategies can be accomplished. Calculation LM-0725, "FLEX Activity and HCVS Phase 2 Dose Assessment," Revision 0 was performed to determine the integrated radiation dose due to HCVS operation. Temperature and radiological conditions should not inhibit operator actions or SAWA equipment and controls needed to initiate and operate the HCVS during an ELAP with severe accident conditions. No follow-up questions.	
Phase 2 ISE OI 3 Licensee to evaluate the SAWA equipment and controls, as well as the ingress and egress paths for the expected severe accident conditions (temperature,	Unit 1 and Unit 2 – Complete Equipment and Controls Plant instrumentation for SAWA/SAWM that is qualified to RG 1.97 or equivalent is considered qualified for the sustained	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. EC 622673, "Temperature, Humidity and Radiological Evaluation HCVS &	Closed [Staff evaluation to be included in SE Sections 4.1.1.4 and 4.2.1.4]

humidity, radiation) for the sustained operating period.	operating period without further evaluation. Passive components that do not need to change state after initially establishing SAWA flow do not require evaluation beyond the first 8 hours, at which time they are expected to be installed and ready for use to support SAWA/SAWM. The following additional equipment performing an active SAWA/SAWM function is considered: - SAWA/SAWM flow instrument - SAWA/SAWM/FLEX pump - SAWA/SAWM/FLEX generator - Active valves in SAWA flow path Ingress and Egress For locations outside the Reactor Building between 7 hours and 7 days when SAWA is being utilized, Limerick performed evaluations of expected temperatures, humidity and the dose rates and determined them to be acceptable. (Reference EC 622673, and calculations LM-0721 and LM-0725). EC 622673, LM-0721 and LM-0725 are available in ePortal for review.	SAWA/SAWM," Revision 0 along with calculations LM-0721 and LM-0725 shows that temperature and radiological conditions should not inhibit operator actions or SAWA equipment and controls needed to initiate and operate the HCVS during an ELAP with severe accident conditions. No follow-up questions.	
Phase 2 ISE OI 4 Licensee to demonstrate that containment failure as a result of overpressure can be prevented without a drywell vent during severe accident conditions.	Unit 1 and Unit 2 – Complete The wetwell vent has been designed and installed to meet NEI 13-02 Rev 1 guidance, which will ensure that it is adequately sized to prevent containment overpressure under severe accident conditions.	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. The wetwell vent was designed and installed to meet NEI 13-02 Revision 1 guidance and is sized	Closed [Staff evaluation to be included in SE Sections 4.1 and 4.2]

	The SAWM strategy will ensure that the wetwell vent remains functional for the period of sustained operation. LGS will follow the guidance (flow rate and timing) for SAWA/SAWM described in BWROG-TP-15-008 and BWROG-TP-15-011. These documents have been posted to the ePortal for NRC staff review. The wetwell vent will be opened prior to exceeding the PCPL value of 60 psig. Therefore, containment over pressurization is prevented without the need for a drywell vent.	to prevent containment overpressure under severe accident conditions (see Phase 1 ISE Open Item-2 above). Limerick will follow the guidance (flow rate and timing) for SAWA/SAWM described in BWROG-TP-15-008, "Severe Accident Water Addition Timing", and BWROG-TP-15-011 "Severe Accident Water Management". The wetwell be opened prior to exceeding the PCPL value of 60 psig. The evaluations noted in 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 suppression chamber through the suppression pool. The evaluations noted in BWROG-TP-15-011 demonstrates that starting water addition at a high rate of flow and throttling after approximately 4-hours will not increase the suppression pool level to that which could block the suppression chamber HCVS.	

		As noted under Phase 1, the vent is sized to pass a minimum steam flow equivalent to 1% rated core power. This is sufficient permit venting to maintain containment below the lower of PCPL or of design pressure. No follow-up questions.	
Phase 2 ISE OI 5 Licensee shall demonstrate how the plant is bounded by the reference plant analysis that shows the SAWM strategy is successful in making it unlikely that a drywell vent is needed.	Unit 1 and 2 – Complete Using Figure 2.1.C from the combined Phases 1 and 2 OIP, compare the reference plant parameters to the plant specific parameters. Reference Plant: Torus free board volume is 525,000 gallons SAWA flow is 500 GPM at 8 hours followed by 100 GPM LGS: Suppression Pool freeboard volume is 147,670ft^3 (1,104,572 gallons) SAWA flow is 500 GPM at 8 hours followed by 100 GPM from 12 hours to 168 hours. The above parameters for LGS compared to the reference plant that determine success of the SAWM strategy demonstrate that the reference plant values are bounding. Therefore, the SAWM strategy implemented at LGS makes it unlikely that a drywell vent is	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. The reference plant has a Torus freeboard of 525,000 gallons. Limerick has a Torus freeboard of 1,104,572 gallons. Both the reference plant and Limerick assume SAWA flow of 500 gallons per minute (gpm) starting at 8 hours. Both the reference plant and Limerick reduces SAWA flow to 100 gpm at 12 hours. BWROG TP-15-011 report confirmed, that the Mark I (and Mark II) fleet is bounded by the reference plant analyses. This study addressed how suppression pool level control could be achieved in a manner that maintains long-term function of the wetwell vent, and determined if there would be adverse effects by controlling (limiting) flow rate. The study concludes that plants with Mark I and Mark II containments, with injection into the RPV, can maintain containment cooling and preserve	Closed [Staff evaluation to be included in SE Section 4.2.1.1]

	needed to prevent containment overpressure related failure	the wetwell vent without a plant specific analysis. The evaluation bounds the parameters at LGS. LGS plans to follow this strategy and is bounded by the conclusions of the BWROG evaluation. The NRC staff reviwed the parameters from the reference plant to those of Limerick. The staff concurs that it is unlikely the suppression chamber HCVS could become blocked leading to a successful SAWA/SAWM strategy. Therefore, it is unlikely a drywell vent would be required to maintain containment integrity. No follow-up questions.	
Phase 2 ISE OI 6 Licensee to demonstrate that there is adequate communication between the MCR and the operator at the FLEX pump during severe accident conditions.	Complete. This communication method is the same as accepted in Order EA-12-049. These items will be powered and remain powered using the same methods as evaluated under EA-12-049 for the period of sustained operation, which may be longer than identified for EA-12-049. Communication will be via the plant radio system if available. If the radio system is not available, the Plant page system can be used. The page system was modified for FLEX to include a UPS that can be manually aligned to repower the system. (Reference AR 2492527-42)	The NRC staff reviewed the information provided in the 6-month updates and on the ePortal. The communication methods are the same as accepted in Order EA-12-049. No follow-up questions.	Closed [Staff evaluation to be included in SE Section 4.1]
Phase 2 ISE OI 7	Unit 1 and Unit 2 – Complete	The NRC staff reviewed the information provided in the 6-	Closed

Licensee to demonstrate the SAWM flow instrumentation qualification for the expected environmental conditions.	For locations outside the Reactor Building between 7 hours and 7 days when SAWA is being utilized, Limerick Generating Station performed evaluation of expected temperatures, humidity and the dose rates and determined them to be acceptable. (Reference EC 622673). **SAWA Pump Flow Instrument Qualification** 37 to 1246 GPM, 32 to 140 °F fluid temperature, 14 to 122 °F Instrument Electronics*, 275 PSI maximum **Expected SAWA Parameter Qualification Range** 100 to 500 GPM, 32 to 95 °F fluid temperature, 0 to 100 °F Ambient air temperature, 239.7 PSI maximum *Below 14°F, the LCD may become sluggish or unresponsive; however, will continue to measure and function to at least -4°F. (Reference MS2500-DataSheet). MS2500-DataSheet and EC 622673 is available in ePortal for review.	month updates and on the ePortal. EC 622673 discusses the SAWM flow instrumentation qualification. The NRC staff found through engineering judgement that the accuracy of the flow meter and the environmental qualifications related to the performance of the flow meter meets the intent of Order EA-13-109. No follow-up questions.	[Staff evaluation to be included in SE Sections 4.1.1.3 and 4.2.1.3]

SUBJECT: LIMERICK GENERATING STATION, UNITS 1 AND 2 - REPORT FOR THE AUDIT OF LICENSEE RESPONSES TO INTERIM STAFF EVALUATIONS OPEN ITEMS RELATED TO NRC ORDER EA-13-109 TO MODIFY LICENSES WITH REGARD TO RELIABLE HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS (CAC NOS. MF4418 AND MF4419; EPID L-2014-JLD-0051) DATED May 29, 2018

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