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

September 30, 2016

Mr. Peter P. Sena, III, President
PSEG Nuclear LLC – N09
P.O. Box 236
Hancocks Bridge, NJ 08038

SUBJECT: HOPE CREEK GENERATING STATION – REQUEST FOR RELAXATION OF THE RELEASE POINT HEIGHT REQUIREMENT OF NRC ORDER EA-13-109, ORDER MODIFYING LICENSES WITH REGARD TO RELIABLE HARDENED CONTAINMENT VENTS CAPABLE OF OPERATION UNDER SEVERE ACCIDENT CONDITIONS (CAC NO. MF4458)

Dear Mr. Sena:

On June 6, 2013, the Nuclear Regulatory Commission (NRC) issued Order EA-13-109, "Issuance of Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13143A321). By letter dated June 21, 2016 (ADAMS Accession No. ML16174A086), as supplemented by letter dated September 7, 2016 (ADAMS Accession No. ML16251A309), PSEG Nuclear LLC (PSEG, the licensee) requested a relaxation from the hardened containment vent release height requirement of Order EA-13-109 at Hope Creek Generating Station (Hope Creek). Specifically, the licensee requested a relaxation from compliance with the Phase 1 Requirement 1.2.2 in Attachment 2 to NRC Order EA-13-109, which states: "The [Hardened Containment Vent System] HCVS shall discharge the effluent to a release point above main plant structures."

The NRC staff has completed its review of the licensee's request and concludes that the relaxation from the hardened containment vent release height requirement of Order EA-13-109 is appropriate. Accordingly, based upon the authority granted to the Director, Office of Nuclear Reactor Regulation, the Phase 1 Requirement 1.2.2 in Attachment 2 of NRC Order EA-13-109 is relaxed to Hope Creek's current Hardened Torus Vent release point elevation, with a modification to orient the discharge in the vertical, upward direction. The staff's safety evaluation is enclosed.

If you have any questions, please contact Brian E. Lee, Project Manager, at 301-415-2916 or at Brian.Lee@nrc.gov.

Sincerely,

William M. Dean, Director
Office of Nuclear Reactor Regulation

Docket No.: 50-354

Enclosure:
Safety Evaluation

cc w/encl: Listserv

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION
REQUEST FOR RELAXATION OF THE RELEASE POINT HEIGHT REQUIREMENT
OF NRC ORDER EA-13-109
HOPE CREEK GENERATING STATION, UNIT 1
DOCKET NUMBER 50-354

1.0 INTRODUCTION

On June 6, 2013, the Nuclear Regulatory Commission (NRC) issued Order EA-13-109, "Issuance of Order to Modify Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML13143A321). By letter dated June 21, 2016 (ADAMS Accession No. ML16174A086), as supplemented by letter dated September 7, 2016 (ADAMS Accession No. ML16251A309), PSEG Nuclear LLC (PSEG, the licensee) requested a relaxation from the hardened containment vent release height requirement of Order EA-13-109 at Hope Creek Generating Station (Hope Creek). Specifically, the licensee requested a relaxation from compliance with the Phase 1 Requirement 1.2.2 in Attachment 2 to NRC Order EA-13-109, which states: "The [Hardened Containment Vent System] HCVS shall discharge the effluent to a release point above main plant structures."

2.0 REGULATORY REQUIREMENTS

The NRC issued an order on March 12, 2012, requiring all U.S. nuclear power plants with the Fukushima-style containment design to install a reliable, hardened vent that can remove heat and pressure before potential damage to a reactor core occurs. This not only helps preserve the integrity of the containment building, but can also help delay reactor core damage or melting. After issuing the order, additional NRC evaluations examined the benefits of venting after reactor core damage occurs. On June 6, 2013, the NRC issued Oder EA-13-109, which modified and superseded the March 12, 2012, order, to ensure those vents will remain functional in the conditions following reactor core damage. Section IV of Order EA-13-109 states that licensees proposing to deviate from requirements of the order may request that the Director, Office of Nuclear Reactor Regulation, relax or rescind certain requirements upon demonstration of good cause.

Regulatory guidance for the NRC staff's review of compliance with Order EA-13-109 is provided in the NRC Japan Lessons-Learned Project Directorate (JLD) Interim Staff Guidance (ISG) document JLD-ISG-2013-02, "Compliance with Order EA-13-109, Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation under Severe Accident Conditions," Revision 0, dated November 2013 (ADAMS Accession No. ML13304B836). JLD-ISG-2013-02 endorsed, in part, the Nuclear Energy Institute (NEI) document 13-02, "Industry Guidance for Compliance with Order EA-13-109," Revision 0, November 7, 2013 (ADAMS Accession No. ML13316A53). Furthermore, NRC Interim Staff Guidance document 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 Operation under Severe Accident Conditions," Revision 0, dated April 2015 (ADAMS Accession No. ML15104A118), endorsed, in part, the NEI document 13-02, "Industry Guidance for Compliance with Order EA-13-109," Revision 1, April 23, 2015 (ADAMS Accession No. ML15113B318). NEI 13-02, Appendix J, HCVS-FAQ [frequently asked question]-04 provides specific guidance on the release point, recommending a minimum release point of at least 3 feet above the roof of adjacent structures.

This is to reduce the possibility of the HCVS effluent cross-flow between plant units and/or into other systems.

3.0 TECHNICAL EVALUATION

3.1 Background

In response to NRC Generic Letter 89-16, "Installation of a Hardened Vent," dated September 1, 1989, (ADAMS Accession No. ML031140220), the licensee installed an HCVS, known at Hope Creek as a Hardened Torus Vent (HTV). The existing HTV release point is approximately at elevation 250' (148' above grade elevation) at the Hope Creek reactor building, which is approximately 54' below the top of the reactor building dome elevation of 304' 3". The release point is above adjacent plant structures with the exception of the reactor building dome. The licensee is requesting to limit the modification of the existing HTV release point to removing the horizontal discharge elbow and maintaining the release point approximately at the current elevation (the release point is 250' with the elbow and approximately 248' without the elbow).

3.2 NRC Staff Technical Review

During the response to a beyond-design basis event, protection of personnel from radiological releases from the HCVS is achieved through ensuring adequate distance between the effluent discharge point and the operators such that the plume is diluted or dispersed in the atmosphere. Atmospheric dispersion can be affected by local disturbances in atmospheric air flow. The atmospheric flow can be disrupted by aerodynamic forces in the immediate vicinity of structures or obstacles imposed by the surrounding terrain. Wind passing over a large flat-roofed structure will have a roof wake starting at the leading edge of the roof parapet and a building wake on the side of the structure opposite from the wind. Recirculation zones will occur within these wakes. The criteria established in the NRC-endorsed guidance for the release point, the 3 foot minimum stack height above the structure combined with a minimum stack exit velocity of 8,000 feet- per- minute (fpm), was determined to be sufficient to assure the effluent plume would not become entrained into the roof or building recirculation zone of a given building. These guidelines help protect workers responding to the event by reducing the potential for HCVS radiological releases from being captured in the building wake or being entrained in the building wake recirculation zone.

The licensee looked at the plume rise from the current configuration of the HCVS discharge to determine whether the effective release point would be in the roof recirculation zone. The licensee indicated that, during severe accident conditions, the exit velocity is expected to be much greater (approx. 14,000 fpm) than the minimum of 8,000 fpm, assumed in the NEI guidance. In addition, the increase in plume rise from plume buoyance was conservatively not credited in the licensee's calculation. Based on an 8,000 fpm HCVS exit velocity, the licensee calculated the effective release point to be approximately 74 feet above the top of the stack. This release point is 20 feet above the elevation of the top of the reactor building dome and therefore above the roof recirculation zone.

Hope Creek has a unique design among Mark I and II Boiling Water Reactors (BWRs) in that its reactor building has a cylindrical body and an oblate concrete dome. When wind strikes normal to flat building surfaces, the air flow path changes to flow parallel to the building surface. The vertical flow of the air deflected off flat surfaces and the momentum of the air flowing vertically to the roof influence the height of the recirculation zone above the roof. With a cylinder, only a

small portion of the air flow will be directed vertically. Most of the air flow will strike the cylinder surface at an angle and will be deflected horizontally, around the cylinder. Similarly, the dome roof provides a smoother aerodynamic shape than a flat building surface. The air flow strikes the dome at an angle, flowing around the dome curvature and minimizing the vertical flow component. As the wind strikes further up the dome the vertical deflection of the wind is minimized, due to the increased dome curvature, further reducing the height of the recirculation zone above the dome. Based on this discussion, it is the staff's engineering judgement that the height of the recirculation zone will be at or slightly above the dome surface. Therefore, with an additional 20 feet height above the dome elevation, the staff agrees that the effective release point is above the roof recirculation zone.

In addition to the release point height justification, in its supplement dated September 7, 2016, PSEG stated that they performed calculations to determine the dose impact on plant operators responding to the event. The licensee used the ARCON96 (Atmospheric Relative Concentration in Building Wakes[1]) computer program and calculated effluent releases with conservative assumptions including grade level release and straight line release to receptor points. Two calculations were performed: one for the current HCVS height (elevation 250') and the other for the HCVS height required by the order, which is 3 feet above the top of the reactor building roof (elevation 307' 3").

The licensee used the noble gas source term from the NRC-endorsed guidance in NEI 13-02, Table G-1, "Fission Product Releases into Containment," and plant-specific post-LOCA [loss- of- coolant accident] dose and atmospheric dispersion information, to perform the comparison. This data was used for comparative dispersion and whole body (WB) dose calculations only. Using design-basis LOCA dose information and applying ratios of relevant HCVS x/Q values, the licensee calculated the operator WB submergence dose at the Control Room/Technical Support Center intake to be:

a. 0.102 Rem from the elevation 250' release point
b. 0.083 Rem from the elevation 307' 3" release point

Based on this calculation, the licensee stated that the difference in WB submergence dose between the two release point heights is minimal, approximately 19 millirem or 0.4 percent of the 5 Rem limit, and does not warrant the extensive modifications to raise the vent height by approximately 57 feet.

The staff acknowledges that the elevation of 250' used in the dose calculation is slightly higher than the elevation of 248', which would be the height of the vent after removing the horizontal discharge elbow. However, this small height difference should have a negligible impact on the dose results. The staff also recognizes that the above licensee's comparison did not include inhaled dose, which will be negligible due to the use of personal protective equipment. The evaluation also did not calculate dose from skyshine or pipe shine at this receptor location, because the example was a simplified calculation only intended to illustrate the negligible dose benefit of raising the vent height. Furthermore, the minimal dose savings is contingent upon the occurrence of an accident, which is a very rare event. In contrast to the potential contingent dose savings, there would be an actual dose expenditure in making the modifications to increase the size of the vent (cutting into containment, etc.) that could potentially negate the dose saving from the vent height increase.

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[1] J.V. Ramsdell, Jr., and C.A. Simonen, "Atmospheric Relative Concentrations in Building Wakes," NUREG/CR-6331, Revision 1, USNRC, May 1997.

Further, the licensee indicated that extending the current release point height to a fully-compliant release point height at elevation 307' 3" would present distinct disadvantages. If the current HCVS release point was extended to meet the physical height requirements of the order, this would challenge the ability to meet the order requirement for one percent Rated Core Thermal Power decay heat removal due to increased line resistance, resulting in reduced containment venting margin and effluent exit velocity. In addition, constructability of a fully- compliant vent atop of the reactor building is impractical due to structural limitations. A straight vertical extension would require significant structural support arrangements for the vent to address the various loading conditions, and it could potentially add significant loads to the reactor building roof. These loads would adversely affect the current reactor building design margin. If the extension were designed to match the curvature of the dome, it would still have a significant impact on the reactor building structure and would have worse venting performance due to line resistance. If the piping diameter for the HCVS system were increased (e.g., from 12" to 16") to improve vent capacity, not only would the overall loading on the reactor building structure increase, but also the larger line diameter would require major system redesign to increase the size and capacity of valves, pipe supports and penetration, etc. As such, options to extend the vent height to the compliant elevation are likely to have significant construction impacts on the reactor building and the containment system.

The staff recognizes the significant construction modifications needed to extend the vent up to 57 feet above its current height and the associated potential negative impacts on the reactor building's design margin and containment capability. Such modifications are not warranted considering the minimal increase in estimated dose to plant personnel as a result of maintaining the current vent height and the fact that the current effective effluent release point is above the elevation of the top of the reactor building dome and therefore above the roof recirculation zone.

4.0 CONCLUSION

In light of the facts presented in the licensee's June 21, 2016, and September 7, 2016, letters and the staff's evaluation documented in Section 3.2 of this report, the NRC staff has determined that the licensee has presented good cause for a relaxation of Phase 1 Requirement 1.2.2 in Attachment 2 of NRC Order EA-13-109. The NRC staff's acceptance is based principally on the following:

- The minimal difference of approximately 19 millirem in the WB submergence dose between the two release point heights (i.e., 250' current elevation and 307' 3" required by the order). The staff attributes this small difference in part to the cylindrical walls and domed design of the Hope Creek reactor building roof as opposed to the flat building surfaces of most Mark I and Mark II reactor buildings.

- The potential significant negative construction impacts on the reactor building and containment of options to extend the height of the HTV release point.

The small doses calculated for a LOCA event coupled with the small difference in dose between the current vent configuration (modified for vertical release) and a hypothetical fully-compliant vent indicate that the Hope Creek HTV, as modified, meets the intent of Requirement 1.2.2 of the Order. Therefore, the significant modifications to fully comply with this provision are not warranted.

If you have any questions, please contact Brian E. Lee, Project Manager, at 301-415-2916 or at Brian.Lee@nrc.gov.

Sincerely,

/RA/

William M. Dean, Director
Office of Nuclear Reactor Regulation

Docket No.: 50-354

Enclosure:
Safety Evaluation

cc w/encl: Listserv

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