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Order EA-13-109

LR-N16-0148

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Hope Creek Generating Station
Renewed Facility Operating License No. NPF-57
NRC Docket No. 50-354

Subject: Supplemental Information Regarding Hope Creek Generating Station's Request for Relaxation from the Hardened Containment Vent Release Point Height Requirement of NRC Order EA-13-109

References:

1. PSEG Letter LR-N16-0041, "Hope Creek Generating Station's Request for Relaxation from the Hardened Containment Vent Release Point Height Requirement of NRC Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA-13-109)," dated June 21, 2016

2. NRC Order EA-13-109, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions," dated June 6, 2013

By letter dated June 21, 2016 (Reference 1), PSEG Nuclear LLC (PSEG) submitted a request for relaxation of Phase 1, Requirement 1.2.2, in Attachment 2 of NRC Order EA-13-109 (Reference 2), which requires the Hope Creek Generating Station Hardened Containment Vent System (HCVS) release point to be above main plant structures. The requested relaxation would enable PSEG to modify the existing HCVS by removing the piping elbow at the release point without extending the release point height. The as-left HCVS release point height would be approximately 146'-6" above plant grade and higher than adjacent plant structures with the exception of the Reactor Building dome.

On July 28, 2016, PSEG and NRC staff participated in a teleconference as part of the NRC Order EA-13-109 audit process. PSEG provided the NRC staff with supplemental information in support of the relaxation request via an electronic reading room. The purpose of this letter is to formally transmit supplemental information as requested by NRC staff in order to enable completion of their review of the relaxation request. Attachment 1 provides the requested information, which includes an overview of the safety basis for the relaxation request and addresses specific topics of discussion from the July 28, 2016 conference call. The attached information supports PSEG's assessment that the requested relaxation is the prudent course of action because extension of the vent height would have limited atmospheric dispersion benefit and negligible impact on the operator whole body submergence doses that would not outweigh the significant disadvantages (i.e., reduced containment venting capacity and constructability challenges) of extending the height.

There are no regulatory commitments contained in this letter. If you have any questions or require additional information, please do not hesitate to contact Mr. Brian J. Thomas at 856-339-2022.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on September 7, 2016
(Date)

Sincerely,

Paul J. Davison

Paul J. Davison
Site Vice President
Hope Creek Generating Station

Attachment 1: Supplemental Information Regarding Hope Creek Generating Station's Request for Relaxation from the Hardened Containment Vent Release Point Height Requirement of NRC Order EA-13-109

cc: Mr. Daniel Dorman, Administrator, Region I, NRC
Ms. Carleen J. Parker, Project Manager, NRC/NRR/DORL
Mr. Justin Hawkins, NRC Senior Resident Inspector, Hope Creek
Dr. Rajendra Auluck, Sr. Project Manager NRC/NRR/JLD
Mr. Brian Lee, Project Manager NRC/NRR/DORL
Mr. Patrick Mulligan, Chief, NJBNE
Mr. Thomas MacEwen, Hope Creek Commitment Tracking Coordinator
Mr. Lee Marabella, PSEG Corporate Commitment Coordinator

Attachment 1

Supplemental Information Regarding Hope Creek Generating Station's Request for Relaxation from the Hardened Containment Vent Release Point Height Requirement of NRC Order EA-13-109

References in this attachment are listed in Section 5.

1. Additional Information Regarding the Basis for the Relaxation Request

The primary purpose of NRC Order EA-13-109 (Reference 1) is to maintain the containment venting function during beyond-design basis conditions, including severe accidents. The Hope Creek Generating Station (HCGS) relaxation request (Reference 2) would limit the modification of the existing Hardened Containment Vent System (HCVS) release point to removal of the discharge elbow and maintaining the release point approximately at the current elevation (as-built elevation at 250'; as-left elevation at 248'-6", or height 146'-6" above grade). The basis of the relaxation request is acceptable atmospheric dispersion and improved venting performance.

Given the HCGS unique design with an oblate Reactor Building dome, extension of the release point height to a fully compliant height of elevation 307' 3" (i.e., three feet above the highest structure on the Reactor Building dome) would present distinct disadvantages:

1. It challenges the ability to meet the Order requirement for 1% Rated Core Thermal Power (RCTP) decay heat removal due to increased line resistance, reduced containment venting margin, and effluent exit velocity.
2. Constructability of a fully compliant vent is impractical due to structural limitations. For example:
   - A straight vertical extension is not feasible due to pipe support design constraints. Structural loads, including wind loads, would require long support beams to anchor the vent pipe the Reactor Building. This design would adversely affect Reactor Building design margins.
   - 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 were increased (e.g., from 12" to 16") to improve vent capacity, overall loading on the Reactor Building structure would increase. Increasing the line diameter would require major system redesign to increase the size and capacity of valves, pipe supports, etc.
   - Any option to extend the height to the compliant elevation is a significant construction impact that involves personnel safety challenges associated with working at heights and heavy load handling.

Additional details of the disadvantages associated with potential release point height extension alternatives are provided in Section 3. As demonstrated in Section 2, the proposed alternative to modify the vent for vertical release at elevation 248'- 6" results in negligible occupational dose impacts as compared to raising the vent height, which would reduce containment venting margin. The expected range of exit velocities at a given torus pressure is higher for the present vent height compared to a design change that would reduce the venting capacity and exit velocity by raising the height.

2. Response to NRC Question Regarding Radiological Conditions

The NRC staff provided the following question prior to the July 28, 2016 conference call with PSEG, and subsequently requested a docketed response.

NRC Question

The NRC staff understands that the licensee is requesting relief from Order EA-13-109, requirement 1.2.2, "The HCVS shall discharge the effluent to a release point above the main plant structures." The relief request justification is primarily based on the change in atmospheric dispersion (χ/Q) between a release point above the Reactor Building and at the new, lower, release point. Provide a discussion showing how this change in χ/Q maintains compliance with Requirement 1.1.3, "The HCVS shall also be designed to account for radiological conditions which would impede personnel actions needed for event response," and Requirement 1.1.4, "The HCVS controls and indications shall be accessible and functional under a range of plant conditions, including severe accident conditions, extended loss of AC power, and inadequate containment cooling."

During the July 28, 2016 conference call, the NRC staff also requested the following information:

- the significance of the difference in atmospheric dispersion as the vent release point height is increased
- how emergency response measures provide radiological protection of personnel.

PSEG Response

The proposed alternative to modify the vent for vertical release at elevation 248'- 6" results in negligible occupational dose impacts as compared to raising the vent height, which would reduce containment venting margin. The negligible benefit of increasing the vent height is illustrated by the following examples:

1. PSEG used the noble gas source term from NEI 13-02 (Reference 3), Table G-1, "Fission Product releases into Containment," and HCGS-specific post-LOCA dose and atmospheric dispersion information, to compare the as-built and fully compliant release height cases. These data are only used for comparative dispersion and whole body (WB) dose calculations and are not intended to represent any severe accident source term. Using design basis LOCA dose information and applying ratios of relevant HCVS χ/Q values, the operator WB submergence dose at the Control Room/Technical Support Center (CR/TSC) intake would be:

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

The difference in WB submergence dose between the two release point heights is approximately 19 mRem. Therefore, the difference in WB submergence dose is negligible. The difference in contribution of WB submergence dose to operator dose margin to the 5 Rem Total Effective Dose Equivalent (TEDE) limit (using a design basis allowable dose limit of 5.0 Rem TEDE for comparison purposes only) is negligible, i.e., 4.898 REM Rem of margin would remain for the as-left height, vs. 4.917 Rem of margin for the fully compliant height. This comparison does not include inhaled dose, which will be significantly reduced due to the use of personal protective equipment, including self-contained breathing apparatus. This example also does not calculate skyshine or pipe shine dose at this receptor location because it is only intended to illustrate the negligible benefit of raising the vent height.

2. NEI 13-02, Revision 1, Appendix J, HCVS- FAQ-04, Topic 5, provides a general "rule of thumb" of 1:5 zone of influence (5' of horizontal travel versus 1' of vertical drop) of the effluent from the release point to the potential downwind vortices / recirculation zones as a reasonable method of release point configuration determination. Using the NEI 13-02 rule of thumb, the CR/TSC air intake location is below the bottom of the effluent plume. Consequently, based on this method the CR/TSC air intake location will not be submerged in the effluent plume and there will not be any WB submergence dose.

3. Examples 1 and 2 address the CR/TSC intake as the limiting receptor location (highest χ/Q). For the FLEX diesel generators on the Hope Creek Unit 2 reactor building roof receptor location, applying the relevant HCVS χ/Q ratios (similar to the approach in Example 1) results in:

    a. 0.079 Rem from the elevation 250' release point
    b. 0.067 Rem from the elevation 307' 3" release point

    The difference in WB submergence dose between the two release point heights is approximately 12 mRem. This example illustrates that the contribution of WB submergence dose is even more negligible for receptor locations that are farther from the HCVS release point than the limiting CR/TSC receptor location.

These examples clearly illustrate that the limited improvement in dispersion associated with a fully compliant vent height is of negligible benefit and does not offset the significant disadvantages of increasing the release point height.

The potential direct WB doses to operators implementing the severe accident strategies are dominated by radiation shine from the source term confined within HCVS piping and the primary containment. The potential dose to operators is significantly reduced by the amount of direct containment concrete shielding and intercepting shadow concrete wall shielding afforded to the operators by virtue of the locations of the key operator actions (concrete shield walls and distance between the source terms and the operators).

Compliance with Order requirements 1.1.3 and 1.1.4 does not rely on χ/Q. Radiological conditions in areas inside the plant are due to the severe accident source term confined within the source volumes of vent pipe and containment that never gets dispersed through the χ/Qs. The HCVS is designed to account for radiological conditions inside the plant, which would not impede personnel actions needed for event response.

Outside of the plant, the radiological conditions that contribute occupational dose to the operator during a severe accident would be the direct shine dose from the HCVS piping and containment shine. The concrete shielding of the containment wall, the shadow shielding of surrounding structure walls, and the large source/receptor distance significantly reduce the direct dose contributions from both radioactive sources to a negligible level. Therefore, the radiological conditions inside and outside of the plant would not impede the operator actions.

For this relaxation request, the limited improvement in dispersion associated with a fully compliant vent height is of negligible radiological benefit. The relaxation request uses χ/Q as a basis for comparing the magnitude of dispersion at the as-built height to a fully compliant height and for determining the relative dose consequences. The relief request justification is primarily based on the momentum plume rise at the as-built elevation of the HCVS release point that yields an effective height which exceeds the fully compliant elevation of 307'-3."

During a severe accident, the PSEG Emergency Plan requires determination of appropriate protective measures, e.g., the use of respiratory protection and/or potassium iodide tablets to reduce the inhaled/thyroid dose to negligible level. The application of these respiratory protective and thyroid prophylactic measures are governed by the relative need which is based on air sampling and field dose measurements. The WB submergence dose is considerably small to begin with due to very low isotopic noble gas dose conversion factors. Therefore, raising the HCVS release point height would provide negligible radiological benefit while reducing the margin for venting capability and effluent exit velocity negatively impacts the limited dispersion benefits. Since the main purpose of NRC Order EA-13-109 is to maintain the containment venting function during severe accident conditions, preserving margin for containment integrity takes precedence over limited dispersion benefits and negligible radiological improvement.

3. <u>Effect of the Oblate Reactor Building Dome</u>

The HCGS Reactor Building is unique among Mark I and Mark II containment designs in that it has an oblate, reinforced concrete dome. The oblate dome has an advantage of having less significant building wake effects than a rectangular structure. However, it also results in disadvantages for constructability of a compliant vent, e.g., that would require very long horizontal supports anchored to the Reactor Building to support the extended vent pipe.

The oblate dome surface of the HCGS Reactor Building provides a smooth surface for the prevailing wind that minimizes turbulence and vortices in the recirculation zone cavity and enhances the dilution of the activity released from the HCVS in the prevailing wind direction. The oblate domed surface does not have the sharp edges of a rectangular building that would increase turbulence and vortices in the recirculation zone cavity. The oblate domed surface reduces trapping of the activity released from the HCVS in the recirculation zone and thereby improves dilution of activity compared to a rectangular structure. Therefore, the oblate surface enhances the dispersion capability of the HCVS release and reduces the wake effect.

Effluent entrainment in the roof or downstream recirculation zone cavity can be effectively prevented by maintaining the effluent velocity at a magnitude greater than the crosswind velocity. Effluent velocity and crosswind velocity used in the plume rise calculation supporting the relaxation request are 40.65 m/s and 10.9 m/s, respectively. The effluent velocity corresponds to the minimum recommended velocity of 8,000 fpm (40.65 m/s), to assure that the effluent plume will not be entrained into the roof recirculation zone of a given building (NEI 13-02, Rev 1, HCVS-FAQ-04). The effluent velocity is 3.73 times greater than the crosswind velocity, which will prevent the entrainment of effluent in recirculation zones.

4. Adverse Effects of Modifications to Extend the HCVS Release Point Height

PSEG considered several options in order to comply with NRC Order EA-13-109. All of the options include removal of the 90 degree elbow at the top of the as-built piping because of the elbow's deleterious effect on venting capacity, atmospheric dispersion, and exit velocity. PSEG considered the following modifications:

1. Extend the current HCVS to elevation 283'-5" via straight vertical extension
2. Extend the current HCVS to elevation 307'-3"(fully compliant height) via straight vertical extension
3. Extend the HCVS height to elevation 307'-3" following the curvature of the Reactor Building dome
4. Vertical Discharge at elevation 248'-6" - cut off the 90 degree elbow at elevation 250'-0"

4.1 Option 1 Extend the current HCVS to elevation 283'-5" via straight vertical extension

This option would not achieve verbatim compliance with the vent height requirement of NRC Order EA-13-109, and it would still require NRC relaxation. This option meets the 25'-0" lateral separation distance recommended by HCVS-FAQ-04 in Appendix J to NEI 13-02, Revision 1.

This option has been proven to have the capability to meet the 1% RCTP decay heat removal requirement. However, it is not a preferred option because it would result in negligible benefit in atmospheric dispersion and would not result in full compliance with NRC Order EA-13-109.

Extending the vent height vertically from elevation 250' to elevation 283'-5" would involve extensive modifications in regards to pipe supports and anchors into the Reactor Building, as shown in Figure 1. This option also involves installation challenges and personnel safety considerations due to working at heights and heavy load handling.

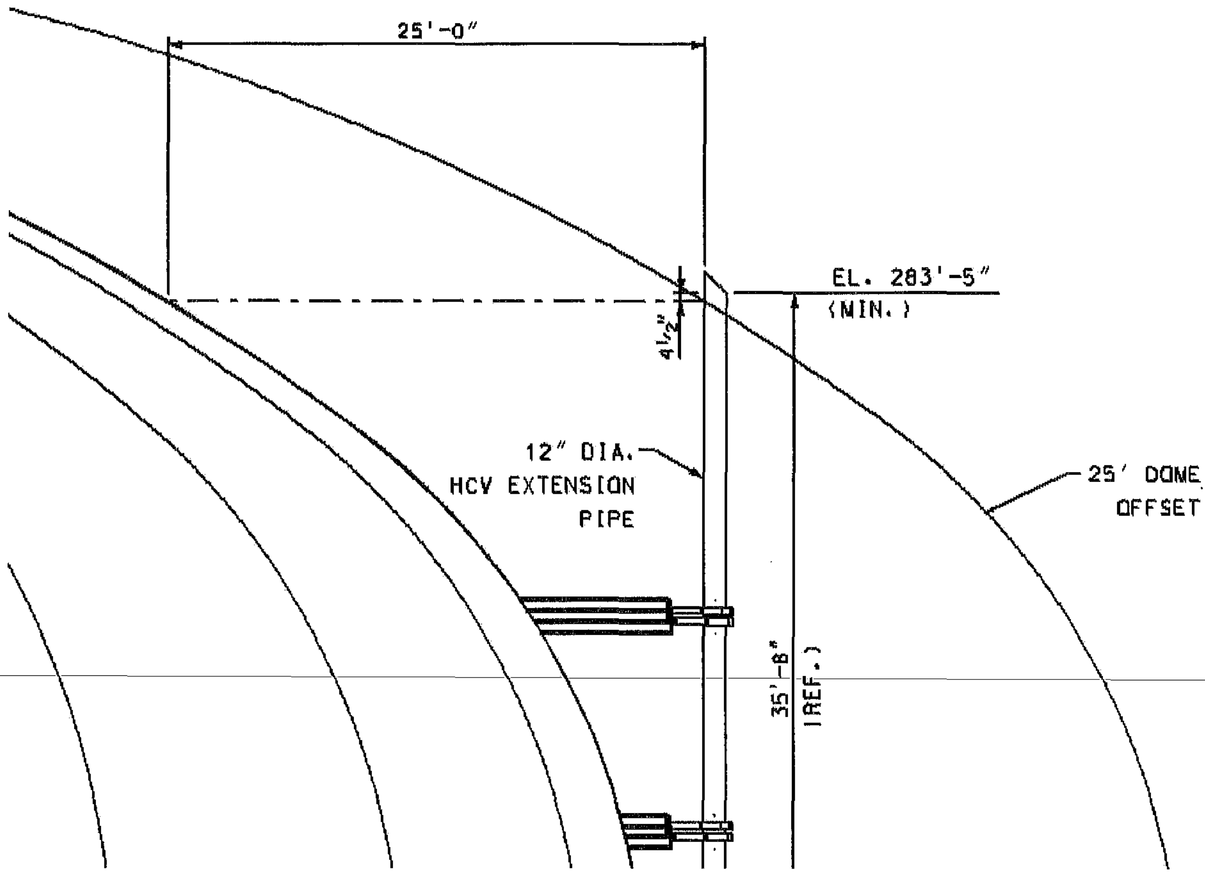

Figure 1: Option 1, 283'-5" HCVS Modifications

4.2 <u>Option 2: Extend the current HCVS to elevation 307'-3"(fully compliant height) via straight vertical extension</u>

This option would meet the height requirement of NRC Order EA-13-109 and guidance of NEI 13-02, Revision 1 verbatim ("fully compliant height"). This option has the potential to meet the required 1% RCTP decay heat flow rate. However, vertical extension of the vent height from elevation 250' to elevation 307'-3" would require pipe supports (e.g., progressively larger I-beams anchored to the reactor building dome) that would have unacceptable adverse structural impact on the Reactor Building due to structural loads including design basis wind loads. This option also involves significant installation challenges and personnel safety considerations due to working at heights and heavy load handling.

4.3 <u>Option 3: Extend the HCVS to elevation 307'-3" following the curvature of the Reactor Building dome</u>

This option would provide a fully compliant height but it would result in unacceptable challenges to vent capacity (i.e., ability to remove 1% RCTP decay heat) and reduced exit velocity.

This option would require extensive piping modifications, pipe support modifications, and would need to be routed along the oblate shape of the dome. An increase in the 12" diameter vent pipe (e.g., to 16") in order to offset the reduction in venting capacity due to line losses would involve a significant system design change, including valve replacement and increased capacity pipe supports.

This option also involves significant installation challenges and personnel safety considerations due to working at heights and heavy load handling.

4.4 <u>Option 4: Vertical Discharge at elevation 248'-6" - cut off the 90 degree elbow at elevation 250'-0"</u>

PSEG selected this option combined with the requested relaxation (Reference 1) to meet NRC Order EA-13-109 and NEI 13-02, Revision 1. As detailed in the relaxation request and supplemental information provided in this attachment, Option 4 provides acceptable atmospheric dispersion and maintains containment venting performance margin to meet the overall objectives of the Order without incurring the adverse design and installation challenges associated with fully compliant vent height.

5. References

1. NRC Order EA-13-109, "Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions," dated June 6, 2013

2. PSEG Letter LR-N16-0041, "Hope Creek Generating Station's Request for Relaxation from the Hardened Containment Vent Release Point Height Requirement of NRC Order Modifying Licenses with Regard to Reliable Hardened Containment Vents Capable of Operation Under Severe Accident Conditions (Order Number EA 13 109)," dated June 21, 2016

3. NEI 13-02, "Industry Guidance for Compliance with Order EA-13-109," Revision 1, dated April 2015