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United States Nuclear Regulatory Commission
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Gentlemen:

PERMANENT HYDROGEN WATER CHEMISTRY SYSTEM
HOPE CREEK GENERATING STATION
FACILITY OPERATING LICENSE NO. NPF-57
DOCKET NO. 50-354

Public Service Electric & Gas Company (PSE&G) submitted to the NRC for review and approval a Request for License Amendment to the Hope Creek Generating Station Operating License to permit operation of a Hydrogen Water Chemistry System (LCR 88-05 submitted by letter NLR-N88154 dated September 28, 1988). LCR 88-05 stated that PSE&G shall meet the requirements of EPRI Special Report NP-5283-SR-A, EPRI Guidelines for Permanent BWR Hydrogen Water Chemistry Installations, 1987 Revision without exception or deviation. In our submittal, PSE&G stated it would utilize on an interim basis two (2) DOT approved transportable tube trailers to store hydrogen onsite until an economic study could be completed to fully evaluate the best options available for a permanent storage facility. NRC Safety Evaluation Report (SER) dated April 3, 1989 provided NRC approval of LCR 88-05 (License Amendment No. 23) to allow operation of the Hydrogen Water Chemistry System (HWCS).

PSE&G has completed the economic study and decided to continue to use the DOT approved transportable tube trailers as a permanent hydrogen storage facility, and the existing Liquid Oxygen Storage (LOX) tank as a permanent oxygen storage facility. The purpose of this letter is to provide the results of PSE&G's evaluation that supports the permanent use of the transportable tube trailers and to utilize the existing LOX tank. This evaluation is contained in Attachment 1.

In response to the NRC Cost Beneficial Licensing Action (CBLA) initiative, PSE&G met with the NRR Staff on November 12, 1993, to discuss our CBLA Program. PSE&G considers this submittal a CBLA. By utilizing the existing hydrogen and oxygen storage facilities, it is estimated that the cost savings over the life of the plant is approximately \$2.0 million.

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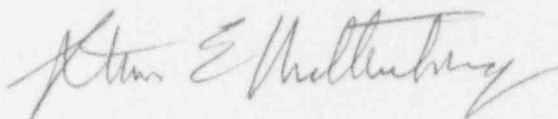
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Please contact us if there are any questions regarding this
submittal.

Sincerely,



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ATTACHMENT 1

PERMANENT HYDROGEN WATER CHEMISTRY SYSTEM
HOPE CREEK GENERATING STATION
FACILITY OPERATING LICENSE NO. NPF-57
DOCKET NO. 50-354

In order to utilize the existing hydrogen and liquid oxygen facilities as permanent storage facilities for the Hope Creek Generating Station, further evaluation was required to ensure that the requirements of the EPRI guidelines have been satisfied. The transportable tube trailers were evaluated for a seismic event, design basis tornado and tornado missile impact, and site specific flood conditions. The liquid oxygen (LOX) tank was evaluated for design basis tornado and site specific flood conditions. Certain exceptions to the EPRI Guidelines relative to design basis tornado and tornado missile impact, and site-specific flood conditions were identified. Where exception is noted to the EPRI guidelines, justification is provided or compensatory measures implemented to support the use of the storage facilities as currently installed. The following is a summary of the evaluations completed for both the hydrogen tube trailers and the LOX tank.

I. Hydrogen Storage Facility

EPRI Guidelines Section 3.1.1 allows the use of transportable hydrogen storage vessels (tube trailers) in lieu of permanent hydrogen storage vessels. The transportable tube trailers must meet the requirements of DOT specifications 3A, 3AA, 3AX or 3AAX. The NRC review and Safety Evaluation Report of the EPRI Guidelines does acknowledge the use of DOT approved transportable trailers. PSE&G has evaluated the use of the transportable trailers to ensure that the EPRI guidelines related to seismic design loadings, tornado and tornado missiles, and site specific flood conditions have been satisfied. The following is a description of the hydrogen storage facility currently installed at Hope Creek, and a summary of the potential impact to the storage facility as a result of these design basis external events. It should be noted that this information is intended to supplement the description of the hydrogen storage facility previously provided to the NRC as part of the LCR 88-05 submittal, and clarify those areas which required further evaluation to support compliance with the EPRI Guidelines.

1. Hydrogen Storage Facility Description -

The hydrogen storage facility consists of two (2) DOT approved hydrogen tube trailers that meet DOT Specification 3AAX-2400 each with a maximum capacity of approximately 132,000 scf oriented side-by-side. The trailers are located at the southern end of the Hope Creek (HC) Turbine Building at a distance of approximately 275 feet from the nearest safety related structure (the Seismic Category I dike surrounding the HC Condensate Storage Tank). The next nearest safety related structure is the HC Auxiliary Building (South Radwaste) located a distance of approximately 300 feet from the hydrogen storage facility. Each tube trailer contains a maximum of 11 tubes, each with a maximum

capacity of 12,000 scf. In accordance with the siting criteria of the EPRI Guidelines Figure 4-2, each of the vessels contained on the tube trailers must be located a minimum of 82 feet from any safety related structure (with reinforced concrete walls \geq 18 inches thick and a static capacity \geq 1.5 psi). This criteria is applicable to both Hope Creek and the Salem Generating Stations.

Collision barriers are also installed along the 3 sides of the facility (except for the gate) to prevent vehicles traveling on the nearby roadway from veering into the tube trailers.

The hydrogen storage facility is located more than 200 feet from any air intakes for either Hope Creek or Salem Generating Station. The closest air intake into a safety related structure from the hydrogen storage facility is the HC Diesel Generator Area Ventilation System which is located approximately 517 feet from the storage facility. All high pressure hydrogen piping (1" diameter) is contained at the hydrogen storage facility and passes through a pressure reducing station located at the storage facility. The minimum separation distance of approximately 40 feet from safety related structures and approximately 200 feet for safety related air intakes into a safety related structure required by the EPRI Guidelines Figure 4-3 for a 1 inch diameter pipe has been met.

2. Design Basis Earthquake -

EPRI Guidelines Section 4.1.2 requires the storage vessel to be capable of withstanding site specific seismic loadings due to horizontal and vertical accelerations acting simultaneously. The anticipated seismic Safe Shutdown Earthquake (SSE) forces with 0.20G peak ground acceleration in the horizontal and vertical direction were analyzed. The tube trailers are provided with two metal straps in addition to the front and rear bulkheads to contain the tubes on the trailer. The analysis concluded that the two metal straps alone, without consideration of the front and rear bulkheads, would be sufficient to contain the tubes on the trailer during a postulated seismic event. The analysis also concluded that the trailers with tubes would not overturn during a SSE. Therefore, the integrity of the hydrogen tube trailers would not be impacted in the event of a design basis earthquake.

3. Design Basis Tornado -

EPRI Guidelines Section 4.1.2.2 requires that the storage vessels and the foundation be designed to remain in place for the design basis tornado event. This requirement ensures that the storage vessel will not move from its specified location, and the minimum separation distance from safety related structures would be

maintained. Therefore, further evaluation was performed to ensure that the transportable tube trailers would satisfy the EPRI Guidelines for a design basis tornado as defined by Reg. Guide 1.76.

The tube trailers are provided with two metal straps in addition to the front and rear bulkheads as discussed above. For the purpose of this evaluation, it was conservatively assumed that the metal straps and bulkheads would not be able to hold the tubes in place on the trailers under design basis tornado winds. The presence of the collision barriers was also ignored. The impact of tornado missiles on the hydrogen tubes is discussed in the following section.

Based on the conservative analysis completed, the maximum travel distances for the hydrogen tube trailers due to a design basis tornado are as follows:

- Trailer with all tubes attached will tumble and move 28 feet closer to a safety related structure from the installed location.
- In the event of the tubes separating from the trailer, the trailer alone travels an additional distance of 97.5 feet. The total travel distance of the trailer alone is 28 feet + 97.5 feet = 125.5 feet. The tubes are assumed to separate and each individual tube travels a distance of 37 feet. The total travel distance of a tube separated from a trailer is 28 feet + 37 feet = 65 feet. The nearest safety related structure (the Seismic Category I dike surrounding the HC Condensate Storage Tank) is located approximately 275 feet from the hydrogen storage facility. Therefore, this would leave a separation distance of approximately 210 feet from this structure. This is still much greater than the minimum calculated separation distance of 82 feet for one tube in accordance with the EPRI Guidelines.
- In the unlikely event that a trailer with one tube attached becomes airborne, calculation has determined that the travel distance would not be any further than the travel of the trailer alone (97.5 feet + 28 feet = 125.5 feet). This would leave a separation distance of approximately 149 feet which is much greater than the minimum calculated separation distance of 82 feet for one tube in accordance with the EPRI Guidelines.

Based on the above, although the hydrogen tube trailers will not conform with the EPRI Guidelines tornado criterion to remain in place in the event of a design basis tornado, the intent of the EPRI Guidelines has been met by maintaining the minimum safe separation distance from safety related structures.

Also, the minimum safe separation distance from safety related

structures of 40 feet required in accordance with the EPRI Guidelines is also maintained for a 1 inch pipe break in the event of a design basis tornado. The minimum safe separation distance of approximately 200 feet from a safety related air intake due to a hydrogen release through a 1 inch pipe break is also maintained. The effects of a hydrogen release due to the impact of a tornado missile are discussed in the following section.

4. Tornado Missiles -

EPRI Guidelines Section 4.1.2 states that the gaseous hydrogen storage vessels (hydril tubes) shall be capable of withstanding tornado missiles in accordance with NUREG-0800 (NRC Standard Review Plan). By designing the vessels to withstand the effects of tornado missiles, the EPRI Guidelines allow the assumption that common cause failures (i.e., the simultaneous rupture of more than one hydril tube) will not occur. The safe separation distances provided in the EPRI Guidelines may then be applied. Since the ability of the DOT hydril tubes to withstand tornado missiles is uncertain, further evaluation was performed.

The credible tornado missiles considered in the Hope Creek design are described in UFSAR Section 3.5.1.4 and are listed in UFSAR Table 3.5-12. The calculation analyzed the spectrum of missiles contained in the UFSAR and determined that the most limiting missiles are a 6 inch nominal diameter and 12 inch nominal diameter section of piping. The calculation has determined that the most limiting tornado missile could perforate a maximum of two hydril tubes simultaneously. Other missiles were found not to have sufficient energy to penetrate the hydril tube walls. Therefore, PSE&G has analyzed the possibility of the simultaneous explosion of two hydril tubes to determine if the minimum safe separation distance is maintained.

The worst case scenario analyzed was based on the analysis results discussed above that the tube trailer would travel a maximum distance of 125.5 feet towards a safety related structure. (Note that the trailer with two tubes attached was conservatively assumed to travel the same distance as the trailer alone.) As stated above, a separation distance of 149 feet would still be maintained. The tube trailer would then be struck by a tornado missile causing the simultaneous explosion of the two hydril tubes. The minimum safe separation distance for two hydril tubes exploding simultaneously was calculated utilizing the EPRI Guidelines, Appendix B as allowed by Section 4.1.2.2 of the EPRI Guidelines. This calculation is valid for concrete walls at least 18 inches thick with a static capacity of ≥ 1.5 psi. Utilizing a total hydrogen volume of 24,000 scf and the TNT-equivalent explosive yield of 27.1 lbs. per 1000 scf of

hydrogen, a minimum safe separation distance of 123 feet was determined. Therefore, the minimum safe separation distance has been maintained in the unlikely event of a tornado missile strike. Furthermore, the pressure resulting from the explosion of two tubes simultaneously was evaluated to determine the potential impact to safety related structures, components, air-intakes and blowout panels. No safety concerns were identified.

The probability of a credible missile strike occurring that could cause the simultaneous explosion of two hydril tubes was calculated. The probability of a critical missile striking and damaging the hydrogen tube trailer was calculated to be $8.4E-8$ per year. The probability of a critical missile striking and damaging the two tubes simultaneously was calculated to be $4.6E-8$ per year. Based on the above it can be concluded that the probability of a tornado missile strike causing the simultaneous explosion of two hydril tubes is extremely remote.

In accordance with EPRI Guidelines Section 4.1.3, evaluation of a resultant hydrogen release due to a tornado missile striking a tube was performed to ensure the following criteria have been met:

1. Dilution of the resultant release below the lower flammability limit of 4% before reaching air pathways into safety related structures will occur.
2. Minimum separation distances for the blast damage criteria has been met.

As discussed above, the minimum safe separation distance for the simultaneous explosion of two hydril tubes is maintained. Therefore, Criterion 2 above has been met for a hydrogen release due to a tornado missile.

The impact of a hydrogen release due to a tornado missile striking a hydril tube was evaluated against Criterion 1 above. The purpose of this evaluation was to demonstrate that upon a tornado strike, the release of hydrogen does not accumulate in sufficient volume to possibly exceed the lower flammability limit of 4% before reaching air pathways into safety related structures. The nearest air intake into a safety related structure is located approximately 517 feet from the storage facility (HC Diesel Generator Area Ventilation System). For the purpose of this calculation, the separation distance to an air intake was conservatively assumed to be 350 feet from the storage facility minus the travel distance of the trailer in the event of a tornado (125.5 feet), which is equal to a separation distance of 225 feet. The atmospheric dispersions of three break sizes

(3", 6" and 12") with the hydril tubes fully pressurized at 2400 psig were modelled using the CHARM code. A lower tornado wind velocity of 209 mph was conservatively assumed to promote less dispersion of the release.

Based on the assumptions above, a release hole of 3 inches results in the maximum hydrogen concentration at the Reactor Building of 3210 ppm. A 4% hydrogen flammability limit is equivalent to a concentration of 40,000 ppm. A release hole of 12 inches results in maximum hydrogen concentration of < 200 ppm. Therefore, a hydrogen release due to a tornado missile strike will not accumulate to levels exceeding the 4% flammability limit specified in Criterion 1 above.

In summary, although the probability of a tornado missile striking the tube trailer and causing the simultaneous explosion of two hydril tubes is extremely remote, the minimum safe separation distance from safety related structures has been maintained in accordance with the EPRI Guidelines should a tornado missile strike occur. The minimum safe separation distance also ensures that hydrogen concentrations will be below the 4% flammability limit before reaching safety related air intakes in the event of a hydrogen release.

5. Flooding Analysis -

EPRI Guidelines Section 4.1.2.2 requires the hydrogen storage facility vessels and foundations be designed to withstand site-specific flood conditions. PSE&G analysis of the impact of flooding on the hydrogen tube trailers has determined that the tube trailers could be affected in the event of the most limiting site specific flood conditions that includes a probable maximum hurricane surge. Therefore, the tube trailers will be administratively controlled by removing the trailers from the protected area in the event of an impending flood. Station procedures have been revised to specify the decision criteria for removing the trailers offsite.

II. Liquid Oxygen (LOX) Facility

As stated above, PSE&G has evaluated the LOX tank to ensure that the EPRI guidelines related to tornado impact and site specific flood conditions have been satisfied. The following is a description of the liquid oxygen facility currently installed at Hope Creek, and a summary of the potential impact to the storage facility as a result of these design basis external events. It should be noted that this information is intended to supplement the description of the liquid oxygen facility and LOX tank previously provided to the NRC as part of the LCR 88-05 submittal, and clarify those areas which required further

evaluation to support compliance with the EPRI Guidelines.

1. Liquid Oxygen Facility Description -

The LOX tank is located approximately 70 feet west of the Hope Creek incomplete Unit 2 reactor building. The 3000 gallon cryogenic LOX tank is installed on a foundation capable of supporting a 6000 gallon cryogenic tank. The LOX tank is designed to ASME Section VIII, Division 1 standards. Figure 4-8 of the EPRI Guidelines was utilized to provide the basis for the minimum separation distance of the LOX tank from safety related air intakes. The LOX tank is located over 200 feet from the HC Emergency Diesel Generator air intakes located approximately 40 feet above grade. The HC Service Water Building air intakes are located approximately 750 feet from the LOX tank and located approximately 20 feet above ground level. The EPRI Guidelines require, for a 3000 gallon LOX tank, a minimum separation distance of approximately 100 feet for air intakes located a height of 20 feet above ground level or higher. Therefore, the most limiting air intake (HC Emergency Diesel Generator) satisfies the minimum safe separation distance from the LOX tank required in accordance with the EPRI Guidelines.

2. Design Basis Tornado -

EPRI Guidelines Section 4.4.3 requires the LOX tank and its foundation to remain in place in the event of a design basis tornado. This will ensure that the minimum safe separation distance between the LOX tank and safety related air intakes will be maintained. Calculations have been performed to determine that the foundation would remain in place in the event of a design basis tornado. However, the calculations indicate the tank anchors may fail under these loads. Assuming the LOX tank anchors would fail, calculation of the maximum travel distance of the LOX tank has been completed. The maximum travel distance of the tank was determined to be approximately 52 feet and would still maintain a separation distance of 148 feet. This is still well beyond the minimum separation distances (100 feet) allowed by the EPRI Guidelines, and ensures that oxygen enriched air will not reach safety related air intakes in the event the LOX tank failed or was struck by a tornado missile.

3. Flooding Analysis -

EPRI Guidelines Section 4.4.3 requires the LOX tank and its foundation to remain in place for site specific flood conditions. Calculation has determined that although the foundation of the LOX tank will remain in place for site specific flood conditions, the tank anchors may fail due to the loads associated with the most limiting flooding that includes probable maximum hurricane

surge. Therefore, the LOX tank will be administratively controlled to require the venting of the LOX tank in the event of an impending flood. Station procedures have been revised to specify the decision criteria for venting the LOX tank.

III. Conclusion

Based on the results of our analysis, PSE&G has completed a 10CFR50.59 Safety Evaluation to support the use of DOT approved tube trailers and LOX tank as currently installed for Hope Creek.

The evaluation concluded that the EPRI requirements related to a seismic event have been met for the DOT approved tube trailers. Where exceptions are noted to the EPRI Guideline requirements for design basis tornado and tornado missiles, the discussions contained in this letter have demonstrated the tube trailers meet the intent of the EPRI Guidelines by maintaining the required minimum safe separation distance. The requirements for the foundation and hydrogen storage vessel to meet site specific flood conditions have been addressed through administrative controls. The evaluation also determined that although the Liquid Oxygen Storage (LOX) tank may not remain in place in the event of a design basis tornado, the minimum safe separation distance in accordance with the EPRI guidelines will be maintained, and the requirement to meet site specific flood conditions have been addressed through administrative controls.

Therefore, the 10CFR50.59 Safety Evaluation concluded that the Hydrogen Water Chemistry System as currently installed at Hope Creek did not constitute an Unreviewed Safety Question. The Hydrogen Water Chemistry System will be incorporated into the next update of the UFSAR.

IV. Generic Letter 93-06, Research Results on Generic Safety Issue (GSI) 106, "Piping and the Use of Highly Combustible Gases in Vital Areas" -

PSE&G recently received Generic Letter 93-06 regarding the NRC resolution of GSI 106. The scope of GSI-106 for BWRs included evaluation of the risk from the storage and distribution of hydrogen for the main generators, and other small sources of hydrogen (e.g., off-gas system, battery rooms). However, the scope of this evaluation did not include the risk from hydrogen storage facilities for a Hydrogen Water Chemistry System (HWCS) at BWRs. HWCS was addressed by the NRC through the approval of the EPRI Guidelines.

The NRC SER dated April 3, 1989 which approved LCR 88-05 to allow operation of the HWCS for Hope Creek recommended that PSE&G consider including the main generator hydrogen supply with the

permanent hydrogen storage facility for the HWCS. This would ensure that all hydrogen systems meet the EPRI Guidelines.

At the present time, PSE&G will keep the HC Turbine Generator Hydrogen System (TGHS) and the HWCS storage facility separate. Evaluation of the HC TGHS was completed and concluded that a postulated release of hydrogen in the HC Turbine Building would not adversely impact safety related equipment should an explosion occur. This evaluation was completed in response to the General Electric 10CFR21 notification that was included in GL 93-06. Although no specific actions or response is required to Generic Letter 93-06, PSE&G will evaluate the main generator hydrogen supply system for Salem and other small sources of hydrogen for Salem and Hope Creek based upon the analysis results contained in Generic Letter 93-06. The evaluation will determine if additional actions are warranted to reduce the risk of a fire or explosion from these systems that may impact safety related equipment.