UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

PERMANENT HYDROGEN AND OXYGEN STORAGE FACILITIES

HOPE CREEK GENERATING STATION

DOCKET NO. 50-354

1.0 INTRODUCTION

On September 28, 1988, Public Service Electric & Gas Company (PSE&G), the licensee for the Hope Creek Generating Station (HCGS), submitted a request for an amendment to Facility Operating License No. NPF-57 for the HCGS to permit the use of a BWR Hydrogen Water Chemistry System (HWCS). This system was approved by the NRC staff on April 3, 1989, for operation on an interim basis until the licensee could complete an economic study. The hydrogen to be used in the HWCS is contained in tubes stored at the plant site on two United States Department of Transportation (DOT) approved transportable trailers.

PSE&G has completed the economic study and decided to continue to use both the hydrogen tube trailers and the existing oxygen storage tank as permanent storage facilities. These facilities were assessed by the licensee using the criteria contained in the EPRI Special Report entitled "Guidelines for Permanent BWR Hydrogen Water Chemistry Installations-1987 Revision" (Reference 1). This report was approved by NRC for use by the licensees of BWR plants in a safety evaluation dated July 13, 1987 (Reference 2) transmitted in a July 13, 1987 letter from J. Richardson, NRC, to G. Neils, BWR Owners Group. The licensee performed an assessment of the hydrogen and oxygen storage facilities and provided the results by letter dated April 7, 1994 (Reference 3). On the basis of its evaluation, PSE&G concluded that the HWCS as currently installed at Hope Creek is in conformance with the criteria of Reference 1 and therefore is acceptable.

The staff reviewed and evaluated the licensee's assessment of the use of the existing hydrogen and oxygen storage facilities on a permanent basis in accordance with the criteria of Reference 1.

2.0 EVALUATION

Section 2.1 of Reference 1 states, "The HWCS is not safety-related. Equipment and components need not be redundant (except where required to meet good engineering practice), Seismic Category I, Electric Class IE, or environmentally qualified. Nevertheless, proximity to safety-related equipment or plant systems requires special consideration in the design, fabrication, installation, operation and maintenance of hydrogen addition system components." Reference 1 gives very detailed guidelines for the design, fabrication, installation, operation and maintenance of the HWCS so that any credible failure of the system would be highly unlikely. This is very desirable from the point of view of not only the safe operation of the plant but also the capital investment involved. However, in the unlikely

event of an explosion, (the most serious accident associated with combustible gas) the structures, components and systems in the immediate vicinity most likely will be destroyed or incapacitated. Therefore, as a mitigating factor, the HWCS should be located so that Seismic Category I structures, components and systems will not be affected by such an event.

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 use of the DOT approved transportable trailers is acknowledged in the NRC July 13, 1987 Safety Evaluation with respect to the EPRI Guidelines. The EPRI Guidelines give general criteria for all aspects of the HWCS as indicated in the preceding paragraph. All the potential causes of vessel failure to be considered in the design as specified in the guidelines have been assessed by the licensee (Reference 3). The locations of the storage vessels in relation to nearby Seismic Category I structures, components and systems are examined to determine that they are situated beyond the required separation distance, which is defined as the distance beyond the reach of the effects of a postulated explosion originating from the storage vessels. For Hope Creek, the required separation distance, as determined by the licensee from Reference 1, for the 12,000 scf (standard cubic feet) tube used at Hope Creek is 82 feet (less than the distance of 275 feet between the tube trailers and the nearest Seismic Category I structure). Therefore, we conclude that the location of the tube trailers meets the separation distance requirement of Reference 1.

In order to assure that the required separation distance will still be maintained even if the hydrogen tube trailers are blown off from their sites by tornado winds and transported a distance, the licensee made calculations for each of the following three cases:

1. The trailer with all the tubes attached,
2. The tubes separate from the trailer -(a) the trailer and (b) each tube alone travels a distance, and
3. Trailer with one tube attached and airborne.

The distances traveled for the three cases that the licensee calculated are:

Case 1: 28 feet,
Case 2a: 28+97.5 = 125.5 feet,
Case 2b: 28+37.0 = 65.0 feet, and
Case 3: assumed same as Case 2a, 125.5 feet.

Thus, the maximum distance traveled is 125.5 feet; thus, the separation distance is reduced to approximately 149 feet. Instead of one tube being attached to the trailer, two tubes on the trailer were assumed to be struck by a tornado missile after being transported 125.5 feet, causing the simultaneous explosion of both tubes and the required separation distance for such a case is found to be 123 feet (which is less than 149 feet provided).

As a further assurance that the resultant hydrogen release due to a tornado missile striking a tube will be below the lower flammability limit of 4% before reaching air pathways into safety-related structures as specified in Section 4.1.3 of the EPRI guidelines, the licensee performed a hydrogen concentration analysis based on the tube trailer with two tubes being struck simultaneously by a tornado missile as mentioned above. The result of the analysis indicates that the minimum safe separation distance is maintained thus ensuring that the hydrogen concentration will be below the 4% flammability limit before reaching safety related air intakes in the event of a hydrogen release.

For the liquid oxygen (LOX) facility the licensee performed similar analyses, assuming that the anchors of the LOX tank would fail under the tornado winds and concluded that it meets the separation distances requirement of the EPRI guidelines.

On the basis of the results of its analysis, the licensee concluded that the HWCS as currently installed at Hope Creek can be considered adequate for permanent use.

The staff has reviewed and evaluated the information submitted by the licensee as summarized above. Even though the licensee has shown through analysis that the hydrogen tube trailers meet the requirements of EPRI guidelines by satisfying the required separation distances, the staff has some reservation about such a conclusion by the licensee for the cases involving the tube trailers which are not permanently anchored and can be transported by a tornado. This is due to the fact that Reference 4, which is a comprehensive EPRI treatise on tornado missiles, indicates missile transport determination is a complex subject and there are many uncertainties. This issue is fully discussed in References 4 and 5, both EPRI Reports. It appears that the licensee is cognizant of this fact. In the licensee's consideration of the transport of the tubes as tornado missiles, no credit was taken for the restraining effect of the metal straps and bulkheads. In view of this fact, in spite of the uncertainties in the analysis, there is some inherent conservatism in the results of the analysis for the tubes (see Section 4 d, Chapter IV, Reference 5). This also can be said for the LOX tank, because in its analysis no credit for the restraint was taken. However, this cannot be said with confidence for the cases involving the trailer since no effective restraint of the trailer is provided. The uncertainties in predicting the transport distances and the adoption of the probabilistic transport methodology are discussed in detail in References 4 and 5.

The licensee has shown a very low probability of the tube trailer being hit by a postulated tornado missile. However, because of the uncertainties involved and the importance of the Seismic Category I structures, components and systems, the staff has reservations about the licensee's conclusion that the use of DOT approved tube trailers as currently installed at Hope Creek on a permanent basis is supported by its analysis.

3.0 CONCLUSION

On the basis of the review and evaluation of the information provided by the licensee (References 3 and 6) and supplemented by References 1, 4, and 5, the analyses performed by the licensee appears to be acceptable; however, the staff has reservations on the distances calculated in considering the tube trailers transported as a result of the tornado because of the uncertainties involved in such calculations. In view of this fact, it is the NRC staff's position that some form of detachable permanent anchorage for the tube trailers should be provided. This is to ensure that they will have a low likelihood of being transported by a tornado. The added benefit of such anchorage will justify the minimal cost involved.

The effects of earthquake ground motion on the storage facilities have been assessed by the licensee. The effects of earthquake ground motion are mitigated through the fixed separation distances. For floods, the effects on the storage tube trailers and on the oxygen tank will be mitigated through administrative controls as indicated by the licensee. For the tube trailers, administrative controls would involve their removal off-site. This may not be necessary if the trailers are provided with detachable permanent anchors.

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4.0 REFERENCES

1. EPRI Special Report No. NP-5283-SR, "Guidelines for Permanent BWR Hydrogen Water Chemistry Installations-1987 Revision, September 1987

2. Letter and Safety Evaluation, "Acceptance for Referencing of Topical Report Titled, "Guidelines for Permanent BWR Hydrogen Water Chemistry Installations, 1987 Revision," From J. E. Richardson, NRC to GL Neils, BWR Owners Group, dated July 13, 1987

3. Letter (NLR-N93182) from Steven E. Miltenberger, PSE&G, to U.S NRC, April 7, 1994

4. EPRI Report No. NP-2005, "Tornado Missile Simulation and Design Methodolog. Volume 2: Model Verification and Data Base Update," August, 1981

5. EPRI Report No. NP-2005, "Tornado Missile Simulation and Design Methodology, Volume 1: Simulation Methodology, Design Application, and TORMIS Computer Code," August 1981

6. Letter (NLR-N94185) from Stanley LaBruna, PSE&G, to U.S. NRC, Response to Request for Additional Information, dated October 24, 1994