Citizens Exhibits 56

RAS 14373

U.S. NUCLEAR REGULATORY COMMISSION
In the Matter of: AmerGen Energy Co. LLC
Docket No. 50-0219-LR Official Exhibit No. Citizens Ex. 56
OFFERED by: Applicant
IDENTIFIED on 9/20/07
Action Taken: ADMITTED REJECTED WITHDRAWN

April 24, 1992

Docket No. 50-219

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October 1, 2007 (10:45am)

OFFICE OF SECRETARY
RULEMAKINGS AND
ADJUDICATIONS STAFF

Mr. John J. Barton
Vice President and Director
GPU Nuclear Corporation
Oyster Creek Nuclear Generating Station
Post Office Box 388
Forked River, New Jersey 08731

Dear Mr. Barton:

SUBJECT: EVALUATION REPORT ON STRUCTURAL INTEGRITY OF THE OYSTER CREEK DRYWELL (TAC NO. M79166)

The staff has completed the review and evaluation of the stress analyses and stability analyses reports of the corroded drywell with and without the sand bed. Our evaluation report is contained in the enclosure. GPUN used the analyses to justify the removal of the sand from the sand bed region. Even though the staff, with the assistance of consultants from Brookhaven National Laboratory (BNL), concurred with GPUN's conclusion that the drywell meets the ASME Section III Subsection NE requirements, it is essential that GPUN continue UT thickness measurements at refueling outages and at outages of opportunity for the life of the plant. The measurements should cover not only areas previously inspected but also accessible areas which have never been inspected so as to confirm that the thickness of the corroded areas are as projected and the corroded areas are localized.

We request that you respond within 30 days of receipt of this letter indicating your intent to comply with the above requirements as discussed in the Safety Evaluation.

The requirements of this letter affect fewer than 10 respondents, and therefore, are not subject to Office of Management and Budget review under P.L. 96-511.

Sincerely,

/s/

Alexander W. Dromerick, Sr. Project Manager
Project Directorate I-4
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

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Enclosure:
As stated

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See next page

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

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

DRYWELL STRUCTURAL INTEGRITY

OYSTER CREEK NUCLEAR GENERATING STATION

GPU NUCLEAR CORPORATION

DOCKET NO. 50-219

## I. INTRODUCTION

In 1986 the steel drywell at Oyster Creek Nuclear Generating Station (OCNGS) was found to be extensively corroded in the area of the shell which is in contact with the sand cushion around the bottom of the drywell. Since then GPU Nuclear Corporation, (GPUN, the licensee of OCNGS), has instituted a program of periodic inspection of the drywell shell sand cushion area through ultrasonic testing (UT) thickness measurements. The inspection has been extended to other areas of the drywell and some areas above the sand cushion have been found to be corroded also. From the UT thickness measurements, one can conclude that corrosion of the drywell shell in the sand cushion area is continuing. In an attempt to eliminate corrosion or reduce the corrosion rate, the licensee tried cathodic protection and found it to be of no avail. An examination of the results of consecutive UT measurements, confirmed that the corrosion is continuing. There is concern that the structural integrity of the drywell cannot be assured. Since the root cause of the corrosion in the sand cushion area is the presence of water in the sand, the licensee has considered sand removal to be an important element in its program to eliminate the corrosion threat to the drywell integrity.

In the program, the licensee first established the analysis criteria and then performed the analyses of the drywell for its structural adequacy with and without the presence of the sand. The licensee performed stress analyses and stability analyses for both with and without the sand cases and concluded the drywell with or without the sand to be in compliance with the criteria established for the reevaluation. It is to be noted that the original purpose of the sand cushion is to provide a smooth transition of stresses from the fixed portion to the free-standing portion of the steel drywell.

## II. EVALUATION

The staff with the assistance of consultants from Brookhaven National Laboratory (BNL) has reviewed and evaluated the information (Refs. 1,2,3,4,5) provided by the licensee.

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1. Re-Analysis Criteria

The drywell was originally designed and constructed to the requirements of ASME Section VIII code and applicable code cases, with a contract date of July 1, 1964. The Section VIII Code requirements for nuclear containment vessels at that time were less detailed than at any subsequent date. The evolution of the ASME Section III Code for metal containments and its relation with ASME Section VIII Code were reviewed and evaluated by Teledyne Engineering Services (TES). The evaluation criteria used are based on ASME Section III Subsection NE Code through the 1977 summer addenda. The reason for the use of the Code of this vintage is that it was used in the Mark I containment program to evaluate the steel torus for hydrodynamic loads and that the current ASME Section III Subsection NE Code is closely related to that version. The following are TES's findings relevant to Oyster Creek application:

a) The steel material for the drywell is A-212, grade B, Firebox Quality (Section VIII), but it is redesignated as SA-516 grade in Section III.

b) The relation between the allowable stress (S) in Section VIII and the stress intensity (Smc) in Section III for metal containment is 1.1S = Smc.

c) Categorization of stresses into general primary membrane, general bending and local primary membrane stresses and membrane plus bending stresses is adopted as in Subsection NF.

d) The effect of a locally stressed region on the containment shell is considered in accordance with NE-3213.10.

In addition to ASME Section III Subsection NE Code, the licensee has also invoked ASME Section XI IWE Code to demonstrate the adequacy of the Oyster Creek drywell. IWE-3519.3 and IWE-3122.4 state that it is acceptable if either the thickness of the base metal is reduced by no more than 10% of the normal plate thickness or the reduced thickness can be shown by analysis to satisfy the requirements of the design specification.

The staff has reviewed the licensee's adoption of ASME Section III Subsection NE and Section XI Subsection IWE in its evaluation of the structural adequacy of the corroded Oyster Creek drywell, and has found it to be generally reasonable and acceptable.

By adopting the Subsection NE criteria, the licensee has treated the corroded areas as discontinuities per NE-3213.10, which was originally meant for change in thicknesses, supports, and penetrations. These discontinuities are highly localized and should be designed so that their presence will have no effect on the overall behavior of the containment shell. NE-3213.10 defines clearly the

level of stress intensity and the extent of the discontinuity to be considered localized. A stress intensity limit of 1.1 Smc is specified at the boundary of the region within which the membrane stress can be higher than 1.1 Smc. The region where the stress intensity varies from 1.1 Smc to 1.0 Smc is not defined in the Code because of the fact that it varies with the loading. In view of this, the licensee rationalized that the 1.1 Smc can be applied beyond the region defined by NE-3213.10 for localized discontinuity without any restriction throughout the drywell. The staff disagreed with the licensee's interpretation of the Code. The staff pointed out that for Oyster Creek drywell, stresses due to internal pressure should be used as the criterion to establish such a region. The interpretation of Section XI Subsections IWE-3519.3 and IWE-3122.4 can be made only in the same context. It is staff's position that the primary membrane stress limit of 1.1 Smc not be used indiscriminately throughout the drywell.

In order to use NE-3213.10 to consider the corroded area as a localized discontinuity, the extent of the reduction in thickness due to corrosion should be reasonably known. UT thickness measurements are highly localized; however, from the numerous measurements so far made on the Oyster Creek drywell, one can have a general idea of the overall corroded condition of the drywell shell and it is possible to judiciously apply the established re-analysis criteria.

2. Re-analyses

The re-analyses were made by General Electric Company for the licensee, one reanalysis considered the sand present and the other considered the drywell without the sand. Each re-analysis comprises a stress analysis and stability analysis. Two finite element models, one axisymmetric and another a 36° pie slice model were used for the stress analysis. The ANSYS computer program was used to perform the analyses. The axisymmetric model was used to determine the stresses for the seismic and the thermal gradient loads. The pie slice model was used for dead weight and pressure loads. The pie slice model includes the vent pipe and the reinforcing ring, and was also used for buckling analysis. The same models were used for the cases with and without sand, except that in the former, the stiffness of sand in contact with the steel shell was considered. The shell thickness in the sand region was assumed to be 0.700" for the with-sand case and to be 0.736" for the without-sand case. The 0.70" was, as claimed by the licensee, used for conservatism and the 0.736" is the projected thickness at the start of fuel cycle 14R. The same thicknesses of the shell above the sand region were used for both cases. For the with-sand case, an analysis of the drywell with the original nominal wall thicknesses was made to check the shell stresses with the allowable values established for the re-analyses.

The licensee used the same load combinations as specified in Oyster Creek's final design safety analysis report (FDSAR) for the re-analyses. The licensee made a comparison of the load combinations and corresponding allowable stress

limits using the Standard Review Plan (SRP) section 3.8.2 and concluded they are comparable.

The results of the re-analyses indicated that the governing thicknesses are in the upper sphere and the cylinder where the calculated primary membrane stresses are respectively 20,360 psi and 19,850 psi vs. the allowable stress value of 19,300 psi. There is basically no difference, in the calculated stresses at these levels, between the with and without sand cases. This should be expected, because in a steel shell structure the local effect or the edge effect is damped in a very short distance. The stresses calculated exceed the allowable by 3% to 6%, and such exceedance is actually limited to the corroded area as obtained from UT measurements. However, in order to perform the axisymmetric analysis and analysis of the pie slice model, uniform thicknesses were assumed for each section of the drywell. Therefore, the calculated over-stresses may represent only stresses at the corroded areas and the stresses for areas beyond the corroded areas are less and would most likely be within the allowable as indicated in results of the analyses for nominal thicknesses. The diagram in Ref. 6 indicated such a condition. It is to be noted that the stresses for the corroded areas were obtained by multiplying the stresses for nominal thicknesses by the ratios between the corroded and nominal thicknesses.

The buckling analyses of the drywell were performed in accordance with ASME Code Case N-284. The analyses were done on the 36° pie slice model for both with-sand and without-sand cases. Except in the sand cushion area where a shell thickness of 0.7" for the with-sand case and a shell thickness of 0.736" for the without-sand case were used, nominal shell thicknesses were considered for other sections. The load combinations which are critical to buckling were identified as those involving refueling and post accident conditions. By applying a factor of safety of 2 and 1.67 for the load combinations involving refueling and the post-accident conditions respectively, the licensee established for both cases the allowable buckling stresses which are obtained after being modified by capacity and plasticity reduction factors. It is found that the without-sand, case for the post-accident condition is most limiting in terms of buckling with a margin of 14%. The staff and its Brookhaven National Laboratory (BNL) consultants concur with the licensee's conclusion that the Oyster Creek drywell has adequate margin against buckling with no sand support for an assumed sandbed region shell thickness of 0.736 inch.

A copy of BNL's technical evaluation report is attached to this safety evaluation.

## III. CONCLUSION

With the assistance of consultants from BNL, the staff has reviewed and evaluated the responses to the staff's concerns and the detailed re-analyses of the drywell for the with-sand and without-sand cases. The reanalyses by the licensee indicated that the corroded drywell meets the requirements for

containment vessels as contained in ASME Section III Subsection NE through summer 1977 addenda. This Code was adopted in the Mark I containment program. The staff agrees with the licensee's justification of using the above mentioned Code requirements with one exception, the use of 1.1 Smc throughout the drywell shell in the criteria for stress analyses. It is the staff's position that the primary membrane stress limit of 1.1 Smc not be used indiscriminately throughout the drywell. The staff accepted the licensee's reanalyses on the assumption that the corroded areas are highly localized as indicated by the licensee's UT measurements. The stresses obtained for the case of reduced thickness can only be interpreted to represent those in the corroded areas and their adjacent regions of the drywell shell. In view of these observations, it is essential that the licensee perform UT thickness measurements at refueling outages and at outages of opportunity for the life of the plant. The measurements should cover not only areas previously inspected but also accessible areas which have never been inspected so as to confirm that the thicknesses of the corroded areas are as projected and the corroded areas are localized. Both of these assumptions are the bases of the reanalyses and the staff acceptance of the reanalysis results.

References:

1. "An ASME Section VIII Evaluation of the Oyster Creek Drywell Part I, Stress Analysis" GE Report No. 9-1 DRF #00664 November 1990, prepared for GPUN (with sand).

2. "Justification for use of Section III, Subsection NE, Guidance in Evaluating the Oyster Creek Drywell" TR-7377-1, Teledyne Engineering Services, November 1990 (Appendix A to Reference 1).

3. "An ASME Section VIII evaluation of the Oyster Creek Drywell, Part 2, Stability Analysis" GE Report No. 9-2 DRF #00664, Rev. 0, & Rev. 1. November 1990, prepared for GPUN (with sand).

4. "An ASME Section VIII Evaluation of Oyster Creek Drywell for <u>without sand case</u>, Part I, stress analysis" GE Report No. 9-3 DRF #00664, Rev. 0, February 1991. Prepared for GPUN.

5. "An ASME Section VIII Evaluation of Oyster Creek Drywell, for <u>without sand case</u>, Part 2 Stability Analysis" GE Report No. 9-4, DRF #00664 Rev. 0, Rev. 1 November 1990, prepared for GPUN.

6. Diagram attached to a letter from J. C. Devine Jr. of GPUN to NRC dated January 17, 1992 (C321-92-2020, 5000-92-2094).

Principal Contributor: C.P. Tan

Date: April 24, 1992

Attachment:
BNL Technical Evaluation Report