RAS 14217

APPLICANT'S EXH. 13

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U.S. NUCLEAR REGULATORY COMMISSION
In the Matter of AMERGEN ENERGY CO., LLC
Docket No. 50-0219-LR Official Exhibit No. 13
OFFERED by: Applicant/Licensee Intervenor ______
NRC Staff Other ______
IDENTIFIED on 9/27/07 Witness/Panel N/A
Action Taken: ADMITTED REJECTED WITHDRAWN
Reporter/Clerk ______

2130-06-20290
April 7, 2006

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

Oyster Creek Generating Station
Facility Operating License No. DPR-16
NRC Docket No. 50-219

Subject: Response to NRC Request for Additional Information, dated March 10, 2006, Related to Oyster Creek Generating Station License Renewal Application (TAC No. MC7624)

Reference: "Request for Additional Information for the Review of the Oyster Creek Nuclear Generating Station, License Renewal Application (TAC No. MC7624)," dated March 10, 2006

In the referenced letter, the NRC requested additional information related to Sections B.1.12, B.2.3, 2.3, and 3.3 of the Oyster Creek Generating Station License Renewal Application (LRA). Enclosed are the responses to this request for additional information.

If you have any questions, please contact Fred Polaski, Manager License Renewal, at 610-765-5935.

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

Respectfully,

Executed on 04-07-06

Michael P. Gallagher
Vice President, License Renewal
AmerGen Energy Company, LLC

Enclosure: Response to 03/10/06 Request for Additional Information

cc: Regional Administrator, USNRC Region I, w/o Enclosure
USNRC Project Manager, NRR - License Renewal, Safety, w/Enclosure
USNRC Project Manager, NRR - License Renewal, Environmental, w/o Enclosure
USNRC Project Manager, NRR - OCGS, w/o Enclosure
USNRC Senior Resident Inspector, OCGS, w/o Enclosure
Bureau of Nuclear Engineering, NJDEP, w/Enclosure
File No. 05040

A114

Template=SECY-028

SECY-02

Enclosure

Response to 3/10/06 Request for Additional Information
Oyster Creek Generating Station
License Renewal Application (TAC No. MC7624)

RAI B.1.12-1
RAI B.2.3-1
RAI 2.3.1.6-1
RAI 2.3.1.7-1
RAI 3.3.2.1.16-1
RAI 2.3.3.36-1

Corrosion in the sand bed region

The high rate of corrosion in the sand bed region was attributed to galvanic corrosion of the drywell shell caused by water retained in the sand because of lack of proper drainage. To reduce the corrosion rate, Oyster Creek initiated several corrective actions as described in item (c) below. Evaluation of these corrective actions concluded that the most effective action to reduce corrosion rate is to remove the sand from sand bed region and protect the drywell shell from additional corrosion by applying a protective coating.

Location of the UT measurements was not based on a sampling process. Instead the locations were based on UT measurements taken at all accessible locations that correspond to the sand bed region from inside the drywell to establish the thinnest area. After sand was removed in 1992, and prior to coating the shell, thickness measurements were taken in each of the 10 bays, from outside the drywell, to establish the minimum general and local thickness of the thinned shell. The measurements from inside the drywell showed that the minimum general thickness of the sand bed region is 0.800 inches, and the minimum local thickness is 0.618 inches. The measurements from outside the drywell in the sand bed region showed that the minimum general thickness is generally greater than 0.800 inches. There were local areas where the thickness is less than 0.800 inches. However the minimum average thickness in these areas is greater than 0.736 inches, which is required for satisfying ASME Code requirements. The minimum local thickness measured from outside the sand bed region is 0.603 inches. Considering measurement and instrument accuracies, it is concluded that locations examined from inside the drywell represent the condition of the sand bed region.

The results of these measurements and subsequent analysis, which considered all design basis loads and load combinations, confirmed that the "as found" condition of the drywell shell thickness satisfies ASME Section III minimum thickness requirements. Additional thickness measurements taken at all accessible locations (total of 19) from inside the drywell in 1992, 1994, and 1996 show no corrosion, or no significant corrosion (see Table –2). In addition, inspection of the protective coating on exterior surfaces of the drywell shell in the sand bed region, every other refueling outage, shows no degradation of the coating or the underlying shell.

Corrosion of the upper region, above the sand bed region

Based on the results of approximately 1000 UT measurements, Oyster Creek continued to monitor elevations 50'-2", and 87'-5" in the regions above the sand bed region. A third elevation, 51'-10", was added to the scope of inspection after it was determined that the supplied plate thickness is slightly less than the adjacent 50'-2". For each elevation, UT measurements spaced approximately 1" within a 6"x6" array were taken from inside the drywell around the entire perimeter of each elevation. Engineering evaluation of the UT results concluded that monitoring of 12 locations would represent the drywell shell condition and provide reasonable assurance that significant corrosion would be detected prior to a loss of an intended function. This is because the 12 locations were selected considering the degree of drywell shell thinning and the minimum required thickness to satisfy ASME stress requirements. The locations are, 7 locations 50'-2", 3 locations at elevation 87'-5", and 2 locations at elevation 51'-10". These locations are inspected from the inside of the drywell shell on a frequency of every other refueling outage.

In response to NRC Staff concern regarding whether the inspected locations represent the condition of the entire drywell, in 1990 GPU prepared a new random UT inspection plan (also known as augmented inspection) designed to address the concern. The plan was based on a non-parametric statistical approach using attribute sampling that assumes no prior knowledge of the distribution of corrosion above the sand bed region. It consisted of random UT testing of 57 plates using the 6"x6" grid. Acceptance criteria are that the mean and local thickness of the shell equals or exceeds the required minimum thickness plus a corrosion allowance necessary in order to reach the next inspection.

Inspection results using the new random inspection plan confirmed that previously monitored locations bound the condition of the drywell above the sand bed region; except one location at elevation 60'-10". This elevation was added to elevations 50'-2", 51'-10", and 87'-5" and monitored on the frequency of every other refueling outage since identified in 1992.

The augmented inspection plan, the original inspection plan, and justification for sampling techniques and statistical methodology were submitted to the NRC on November 26, 1990. In its Safety Evaluation dated November 1, 1995, the Staff noted that the licensee provided a table of UT measurement results from the 15th refueling outage inspection. This table shows the locations of the measurements, the nominal as-constructed thickness, the minimum as-measured thickness, the ASME Code required thickness and the corrosion margin available at the time. The Staff found the current program, based on the submitted information acceptable. The Staff also noted in the Safety Evaluation that since water leaking from the pools above the reactor cavity has been the cause of corrosion, the licensee should make a commitment to the effect that an additional inspection of the drywell will be performed about 3 months after discovery of significant water leakage onto the outside of the drywell shell. Oyster Creek is committed to inspect the drains for leakage during refueling outages and during plant operation. The source of water leakage will be investigated and appropriate corrective actions taken, including an evaluation of the drywell shell to ensure drywell integrity. A review of plant documentation did not provide objective evidence that the commitment has been implemented since 1998. Issue Report #348545 was issued in accordance with Oyster Creek corrective action process to document the lapse in implementing the commitment and to reinforce strict compliance with commitment implementation in the future.

During a recent walkdown of the torus by the system engineer, water was found in three 5-gallon containers that are installed to collect water leakage from the sand bed drains. Two of the 3 containers were found nearly full. The third container was approximately half full. Inspection of the drain lines shows that the lines are currently dry and that water in the containers is not due to a current water leakage.

The containers are closed such that their overflow is unlikely as confirmed by no water ponding on the floor. Thus it is concluded with reasonable assurance that the volume of water is limited to what is contained in the containers. This small amount of water is not expected to have significant impact on the drywell shell and on the coating of the shell since the coating is designed for submerged environment. Furthermore, inspection of sand bed region coating conducted in 2004 did not indicate coating degradation or indications of drywell shell corrosion. Similarly, UT examinations on the upper region of the drywell showed a decrease in the corrosion rate since the previous inspection in 2000. Thus, the small volume of water found in the bottles should not have created an environment that would result in significant corrosion to the drywell shell. Issue Report #00470325 was issued, in accordance with Oyster Creek corrective action process, to investigate the source of water and evaluate its impact on the drywell shell.

Based on the discussion above and as indicated in the tables supplied in response to item d) below, Oyster Creek concluded that drywell corrosion is effectively managed both during the current and proposed renewed terms of plant operation. The monitored locations under the current term were subject to extensive UT measurements conducted over several years. NRC Staff found the sampling methodology to identify these locations, and the results of inspections, acceptable for the current term. The same locations will be inspected during the extended period of operation.

In summary Oyster Creek has conducted extensive examinations to identify the cause of drywell corrosion, employed a robust sampling process, quantified with reasonable assurance the extent of drywell shell thinning due to corrosion, and assessed its impact on the drywell structural integrity.

Water intrusion into the gap between the drywell shell and the drywell shield wall was identified as the cause for corrosion. Corrective actions have been taken to mitigate corrosion in the sand bed region and in the upper region of the drywell. Corrosion of the drywell shell in the sand bed region has been arrested. These actions also have effectively reduced the rate of corrosion to a negligible amount in the upper region as demonstrated by UT thickness measurements (see Table-1, and Table-2). Oyster Creek and its consultants performed stress and buckling analyses considering all design basis loads and load combinations. The results of these analyses indicate that buckling controls the minimum drywell shell thicknesses in the sand bed region while areas above the sand bed region are controlled by accident pressure membrane stresses. In both cases, the minimum measured drywell shell thickness satisfies ASME Section III requirements.

(b) The factors considered in establishing the minimum required drywell thickness at various elevations of the drywell are described in detail in engineering analyses documented in two GE Reports, Index No. 9-1, 9-2, and 9-3, 9-4. Report Index No. 9-1, 9-2 was generated for the drywell condition with sand in the sand bed region and Report Index No. 9-3, 9-4 is for the drywell condition without sand in the sand bed region (see Attachment 2 &3) The two reports were transmitted to the NRC Staff in December 1990 and in 1991 respectively. Report Index No. 9-3, 9-4 was revised later to correct errors identified during an internal audit and was resubmitted to the Staff in January 1992. Analysis described in Report Index No. 9-3, 9-4 (i.e., without sand) is the current applicable analysis to the drywell.

The analysis is based on the original Code of record, ASME Code, Section VIII, and Code Cases 1270N-5, 1271, and 1272N-5. The Code and the Code Cases do not provide specific guidance in two areas. The first relates to the size of a region of increased membrane stress due to thickness reductions from local or general corrosion effects, and the second pertains to the allowable stresses for Service Level C or post-accident conditions. In the first case, guidance was sought from ASME Section III, NE-3213.10. For Service Level C or post-accident conditions, the Standard Review Plan was used as guidance to develop the allowable stresses.

The analysis is based on a 36-degrees section model that takes advantage of symmetry of the drywell with 10 vents. The model includes the drywell shell from the base of the sand bed region to the top of elliptical head and the vent and vent header. The torus is not included in this model because the vent bellows provide a very flexible connection, which does not allow significant structural interaction between the drywell and the torus. The analysis considered drywell geometry and materials, thickness reduction from corrosion, test loads, normal operating loads, design basis accident loads, seismic loads, refueling loads, and design basis load combinations. Pressure and temperature were in accordance with approved Technical Specification Amendment No. 165, which established a revised design bases accident pressure of 44 psig and accident temperature of 292°F. The results of the analysis show that the minimum required ASME Code thickness of the drywell shell above the sand bed region is controlled by membrane stresses and the minimum drywell shell thickness in the sand bed region is controlled by buckling. The minimum required ASME Code thicknesses above the sand bed region are shown in Table-1.

For the sand bed region, the analysis conservatively assumed that the shell thickness in the entire sand bed region has been reduced uniformly to a thickness of 0.736 inches. This thickness satisfies ASME Code requirements and considered the minimum required thickness.

As described above, the buckling analysis was performed assuming a uniform general thickness of the sand bed region of 0.736 inches. However the UT measurements identified isolated, localized areas where the drywell shell thickness is less than 0.736 inches. Acceptance for these areas was based on engineering calculation C-1302-187-5320-024.

The calculation uses a Local Wall Acceptance Criteria". This criterion can be applied to small areas (less than 12" by 12"), which are less than 0.736" thick so long as the small 12" by 12" area is at least 0.536" thick. However the calculation does not provide additional criteria as to the acceptable distance between multiple small areas. For example, the minimum required linear distances between a 12" by 12" area thinner than 0.736" but thicker than 0.536" and another 12" by 12" area thinner than 0.736" but thicker than 0.536" were not provided.

The actual data for two bays (13 and 1) shows that there are more than one 12" by 12" areas thinner than 0.736" but thicker than 0.536". Also the actual data for two bays shows that there are more than one 2 ½'" diameter areas thinner than 0.736" but thicker than 0.490". Acceptance is based on the following evaluation.

The effect of these very local wall thickness areas on the buckling of the shell requires some discussion of the buckling mechanism in a shell of revolution under an applied axial and lateral pressure load.

To begin the discussion we will describe the buckling of a simply supported cylindrical shell under the influence of lateral pressure and axial load. As described in chapter 11 of the Theory of Elastic Stability, Second Edition, by Timoshenko and Gere, thin cylindrical shells buckle in lobes in both the axial and circumferential directions. These lobes are defined as half wave lengths of sinusoidal functions. The functions are governed by the radius, thickness and length of the cylinder. If we look at a specific thin walled cylindrical shell both the length and radius would be essentially constants and if the thickness was changed locally the change would have to be significant and continuous over a majority of the lobe so that the compressive stress in the lobe would exceed the critical buckling stress under the applied loads, thereby causing the shell to buckle locally. This approach can be easily extrapolated to any shell of revolution that would experience both an axial load and lateral pressure as in the case of the drywell. This local lobe buckling is demonstrated in The GE Letter Report "Sandbed Local Thinning and Raising the Fixity Height Analysis" where a 12 x 12 square inch section of the drywell sand bed region is reduced by 200 mils and a local buckle occurred in the finite element eigenvalue extraction analysis of the drywell. Therefore, to influence the buckling of a shell the very local areas of reduced thickness would have to be contiguous and of the same thickness. This is also consistent with Code Case 284 in Section –1700 which indicates that the average stress values in the shell should be used for calculating the buckling stress. Therefore, an acceptable distance between areas of reduced thickness is not required for an acceptable buckling analysis except that the area of reduced thickness is small enough not to influence a buckling lobe of the shell. The very local areas of thickness are dispersed over a wide area with varying thickness and as such will have a negligible effect on the buckling response of the drywell. In addition, these very local wall areas are centered about the vents, which significantly stiffen the shell. This stiffening effect limits the shell buckling to a point in the shell sand bed region which is located at the midpoint between two vents.

The acceptance criteria for the thickness of 0.49 inches confined to an area less than 2½ inches in diameter experiencing primary membrane + bending stresses is based on ASME B&PV Code, Section III, Subsection NE, Class MC Components, Paragraphs NE-3213.2 Gross Structural Discontinuity, NE-3213.10 Local Primary Membrane Stress, NE-3332.1 Openings not Requiring Reinforcement, NE-3332.2 Required Area of Reinforcement and NE-3335.1 Reinforcement of Multiple Openings. The use of Paragraph NE-3332.1 is limited by the requirements of Paragraphs NE-3213.2 and NE-3213.10. In particular NE-3213.10 limits the meridional distance between openings without reinforcement to 2.5 x (square root of Rt). Also Paragraph NE-3335.1 only applies to openings in shells that are closer than two times their average diameter.

The implications of these paragraphs are that shell failures at these locations from primary stresses produced by pressure cannot occur provided openings in shells have sufficient reinforcement. The current design pressure of 44 psig for drywell requires a