DESH 801
BNE

State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION

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April 26, 2007

Dr. Pao-Tsin Kuo
Director Division of License Renewal
U. S. Nuclear Regulatory Commission
One White Flint North
Mail Stop O-11 F1
11555 Rockville Pike
Rockville, MD 20852

Subject: Oyster Creek Drywell Corrosion - Expert Review Findings

Dear Dr. Kuo:

As you are aware, by letter dated January 17, 2007, I informed you of the State of New Jersey Bureau of Nuclear Engineering 's (BNE) intention to hire an independent expert in the field of corrosion mechanisms to review and comment on the Oyster Creek Engineering Evaluation performed for AmerGen, by Structural Integrity Associates, on the potential corrosion consequences of the water unexpectedly discovered inside the drywell during the 2006 refueling outage. Oyster Creek's Engineering Evaluation supported AmerGen's conclusion that Oyster Creek could restart from the last refueling outage and continue to operate for an extended license renewal period.

Additionally, as part of this independent review, BNE requested comments on three memorandums, previously submitted to the NRC as part of the currently open license renewal citizen's coalition contention relating to the serviceability of the Oyster Creek drywell, prepared by Rutgers Environmental Law Clinic's corrosion expert, Mr. Rudolph Hausler.

Enclosed with this letter is a copy of the BNE sponsored independent review, dated March 26, 2007, conducted by Dr. Ronald M. Latanision, Principal and Director, Mechanics and Materials Practice, Exponent, Inc. Dr. Latanision is a recognized expert in corrosion mechanisms with an extensive and noteworthy resume of accomplishments in this field.

In general, Dr. Latanision's findings where in agreement with the Stuctural Integrity Associates report. He did provide precautionary comments in four areas.

First, if voids in the concrete exist in which water could accumulate at the concrete/steel interface, this could compromise the conditions which are necessary to support the premise that the embedded steel is in a passive condition. He notes that no such voided condition at the concrete/steel interface has been identified at Oyster Creek but offers that corrosion of embedded steel could be probed using reference electrodes.

Second, any subsequent water ingress should remain low in impurities such as chlorides, sulfates and other aggressive anions.

Third, nitrogen inerting during plant operation would not mitigate corrosion inside the drywell if water exposed to the atmosphere is being continuously transported into the concrete thereby allowing the pore water to remain saturated with oxygen.

Fourth, the position that negligible corrosion occurs when the inside of the drywell is not nitrogen inerted since the oxygen in the water is consumed by corrosion of the steel can be questioned if the water inside the drywell is being refreshed by atmospheric exposure.

Dr. Latanision further suggests that drywell thickness be monitored in real time using corrosion monitoring devices at locations known to be troublesome since the thickness margins that exist in some places of the drywell are small and given that unexpected changes to the corrosion "system", such as the introduction of aggressive impurities to the pore water chemistry, could result in accelerated corrosion.

Finally, Dr. Latanision's review of the Hausler memos indicates that the epoxy coating in the sandbed region could be assessed in ways other than visual but the coating does seem to be working, Hausler's water chemistry concerns seem speculative and inconsistent, and a chloride environment would not subject carbon steel to stress corrosion cracking.

Should you have any questions or need additional information, please contact me directly at (609) 633-7964 or Mr. Kent Tosch, Manager of the Bureau of Nuclear Engineering, at (609) 984-7700.

Sincerely yours,

Jill Lipoti

Jill Lipoti, Ph.D.
Director

Enclosure

Timothy Rausch, Oyster Creek Site Vice President
Graham B. Wallis, Chairman, ACRS
R. DeGregorio, Exelon
Samuel Collins, Regional Administrator, NRC Region I
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March 26, 2007

Mr. Ron Zak
NJDEP-Bureau of Nuclear Engineering
33 Arctic Parkway
PO Box 415
Trenton, New Jersey 08625

Subject: Oyster Creek Review
Exponent Project No. BN64124

Dear Mr. Zak,

This report is in response to my review of Attachment 7.5 of the Oyster Creek Engineering Evaluation, which is the Structural Integrity Associates report concerning a corrosion evaluation of the Oyster Creek drywell steel shell. In particular, I have focused on the question of whether the water discovered during the 2006 refueling outage in two trenches that had been excavated earlier in order to permit inspection of the inside of the shell would lead to future corrosion problems. This question is central to the Structural Integrity report.

I am, in general, in agreement with the findings of the Structural Integrity report, but I would add the following commentary. Structural Integrity concludes that no significant corrosion of the inside surface of the drywell steel shell will occur as long as the current environmental conditions inside the drywell are maintained for the following reasons:

(1) The concrete floor pore water inside the drywell is such that embedded steel is in a passive condition and thereby protected from corrosion. I would add that passive does not mean that oxidation (corrosion) is entirely inhibited, but, rather, that the rate of oxidation is sufficiently slow that corrosion is not significant. The low impurity content of the pore water limits the otherwise potential breakdown of the passive film, which could under different circumstances give rise to corrosion at significant rates. The above applies to the case of steel that is well embedded in concrete. If voids are present at the concrete/steel interface and the steel is thereby poorly embedded, water may accumulate. In such instances oxygen and carbon dioxide may be transported through the porous concrete, dissolve in the accumulated water and increase the corrosion rate of the steel. Corrosion of embedded steel which has the above origin may be probed remotely using reference electrodes, a common practice in the case of concrete deck slabs, for example. It is important to note that there is no indication in the documents that I have seen that the latter is of concern at Oyster Creek.

(2) Any subsequent water ingress will take on the chemistry of concrete pore water. I would agree provided that the source of the water remains low in impurities such as chlorides, sulfates and otherwise aggressive anions.

(3) Corrosion of the steel shell that is not wetted by the concrete pore water will be mitigated by the inerting of the inside of the drywell with nitrogen during plant operation. I agree that the use of nitrogen for this purpose is helpful in that this will minimize the presence of oxygen, but it will not eliminate it. This is a positive step. However, one must consider the source of the water that is of potential concern. If that water is exposed to the atmosphere and is continuously transported into the concrete, then the pore water is likely to remain saturated with oxygen.

(4) Negligible corrosion would occur during outages when the nitrogen inerting is not present. I agree that this calculation shows that if all of the dissolved oxygen initially present in the water were consumed by corrosion of the steel, the steel lost as a consequence would be insignificant. However, this calculation refers to a non-refreshed system and, as pointed out in (3) above, if the source of the transported water is such that the oxygen is refreshed by atmospheric exposure, then the metal loss may be somewhat larger.

It was of value in the context of the above review to examine the presentation material from the January 18, 2007 *Oyster Creek License Renewal Presentation to the ACRS Subcommittee*. In the AmerGen presentation, it was noted that following the October 2006 outage the drywell shell current condition in the sand bed region is such that a 64 mil available thickness margin is present (i.e., the minimum measured wall thickness exceeded the code required average thickness by 64 mils). The thinned areas are typically near and below vent headers. While it appears that corrosion is under control, given the UT wall thickness data that were collected during the 2006 inspection and that no degradation was noted in the visual inspection of the external shell coating, I fully support the apparent plan to repeat UT measurements in both trenches during the 2008 outage. The corrosion rate appears to be low at the moment, but any upset to the system that might, for example, introduce aggressive anionic impurities into the concrete pore water could change that markedly. On this point, the drywell steel shell thickness could in principle be monitored with corrosion monitoring devices in real time and at locations that are known to be troublesome. These areas could be identified by mapping wall thinning data on a drywell steel shell model. Such monitors are used for continuous monitoring of uniform corrosion in various industrial circumstances. I am not aware of commercial experience with comparable equipment for the present purpose, but this seems tractable to me.

I have additionally reviewed documents which you had provided to me from the Rutgers Environmental Law Clinic. My review of those documents is appended to this letter.

Please do call me if you would like to discuss any of the above.

Sincerely,

R.M. Latanision
Principal and Director
Mechanics and Materials Practice

Appendix: Review of Documents from the Rutgers Environmental Law Clinic

I have reviewed the following documents:

(1) January 16, 2007 letter to ACNS from Richard Webster which includes a Memorandum from Rudolph Hausler to Mr. Webster
(2) July 26, 2006 Memorandum from Rudolph Hausler to Paul Gunter
(3) December 19, 2006 Memorandum from Rudolph Hausler to Richard Webster.

These documents are directed toward a number of issues related to the serviceability of the Oyster Creek drywell. Mr. Webster represents a citizen's coalition that has expressed concern regarding drywell corrosion. Mr. Hausler consults with Mr. Webster. These documents are in general critical of AmerGen. As an objective observer, I find some points associated with technical questions with which I agree, some which I do not share, and others that I believe to be incorrect. The language is clearly adversarial as might be expected. The following is an example of each of the above.

(a) On the subject of the inspection of the epoxy coating that has been applied in the former sandbed area, I do agree that there are techniques other than visual that could be used to assess the condition of the coating. I note in this regard that the reported absence of coating degradation during the 2006 inspection was the result of a visual inspection. On the other hand, the fact that UT data indicated that corrosion had been arrested provides a confirmation, when coupled with the visual observation of the coating condition, that is indicative of a protective coating and is in that context reassuring.

(b) On the subject of the chemistry of the water draining from the sandbed, Mr. Hausler speculates that the water should contain chlorides in the ppm range if not in the hundreds of ppm (page 5 of the December 19 letter), despite evidence to the contrary. I would agree that a repeat of the water analysis would have been useful. However, the facts are that in the reported analysis the chloride content was relatively low and, thus, not of concern from the point of view of the passivity of the embedded steel. I do not share this willingness to speculate on such matters.

(c) Mr. Hausler speculates further as to the conductivity of the water on page 6 of the December 19 letter and on page 11 of the July 26 letter, in both cases in the context of the operation of differential aeration cells. In short, my understanding is that he argues that the low conductivity of the water that is present would confine the differential aeration cell to the top of the sandbed in order to account for the observations related to the "bathtub ring" corrosion. The low conductivity of the water seems contrary to the speculation in (b), above, that the chloride content was much higher than the reported values. There is a seeming disconnect in these two arguments since the presence of a large chloride concentration would surely increase the water conductivity.

(d) Reference is made in the January 16 letter by Mr. Webster to chloride stress corrosion cracking of carbon steels (page 4). Mr. Hausler, in the Memorandum attached to Mr. Webster's letter, appears on page 2 to come to the same conclusion: although he does not explicitly argue that chlorides induce stress corrosion cracking of carbon steels, he observes that chlorides have been identified in the corrosion products and in the water present in the sandbed and concludes that in principle all the conditions for stress corrosion cracking are present. Carbon steels are subject to stress corrosion cracking in certain environments, as is true of virtually all engineering alloys, but chlorides are not among those environments.