

RUTGERS ENVIRONMENTAL LAW CLINIC

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January 16, 2007

VIA E-MAIL AND US MAIL

The Advisory Committee on Reactor Safeguards
Plant License Renewal Subcommittee
United States Nuclear Regulatory Commission
Washington, DC 20555-0001

Dear Committee Members:

I am writing on behalf of STROC, the citizen's coalition comprising Nuclear Information and Resource Service, Jersey Shore Nuclear Watch, Inc., Grandmothers, Mothers and More for Energy Safety, New Jersey Sierra Club, New Jersey Environmental Federation and New Jersey Public Interest Research Group. Thank you once again for the opportunity I had to present at the last meeting of the Advisory Committee on Reactor Safeguards Plant License Renewal Subcommittee ("ACRS") on October 3, 2006 and for the time you are affording to listen to our concerns at the next meeting on January 18, 2007. To avoid an overly detailed presentation at that meeting, this letter provides a brief preview of the main thrust of the material to be presented, raises significant new issues regarding aging management of the corroding torus region of the containment, which is related to the drywell corrosion issues already raised, and answers some questions that were raised by Committee members at the meeting on October 3, 2006.

Key Issues Regarding Drywell Corrosion

In my presentation on Thursday I will deal primarily with the corrosion of the drywell in the sandbed region and will show that AmerGen has failed to establish any margin above code requirements. This failure stems from reliance on overly optimistic modeling, failure to adequately measure the extent of the areas that have suffered from serious corrosion, and failure to take account of the latest results from the October 2006 outage, which indicate that corrosion in the sandbed region may be ongoing. Most glaringly, AmerGen stated in an e-mail to NRC Staff dated April 5, 2006 at 10 (ML060960563) that areas corroded to less than 0.736 inches in thickness "could be contiguous, *provided their total area did not exceed one square foot*" and their average thickness was greater than 0.536 inches. This statement was based on modeling conducted by General Electric ("GE") which showed that a shell with a general uniform thickness of 0.736 inches in the sandbed region, but with a one square foot area that was 0.536 inches thick in each bay, would fail code requirements by around 10%. Even if this predicted

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degree of code failure were acceptable, which we believe it is not, such contiguous areas measuring more than one square foot probably already existed in 1992 and have probably expanded since then. In addition, the most recent study by Sandia Laboratories (ML070120395, "Sandia Drywell Study") shows that the modeling by GE included an erroneous capacity reduction factor leading to underestimation of the necessary thickness in the sandbed region. Sandia Drywell Study at 67, 77. In fact, the uniform thickness required in the sandbed region to meet the code requirements is 0.844 inches, not 0.736 inches. *Id.* at 79-80. External measurements show that Bays 1, 9, 11 and 13 have large areas of average thickness less than 0.844 inches. *Id.* at 91-100. In addition, grids of points measured from the interior in Bays 11, 17, and 19 have an average thickness of less than 0.844 inches. Thus, if the applicant's acceptance criteria were adjusted to reflect the mistake in the GE analysis, the shell would not meet the corrected criteria. Its serviceability is therefore in doubt.

The safety of the drywell is brought into further question by two other results from the Sandia Drywell Study that are indirectly related to the sandbed corrosion issue. First, the predicted stresses at the bottom of the sandbed under accident conditions are "extremely large exceeding the assumed allowable even for the case with no degradation." *Id.* at 59. With degradation, the degree of exceedance increases. *Id.* Thus, the Study shows that the containment could fail under accident conditions, precisely the situation when it is most needed. Second, the Study shows that the drywell fails to meet the requirement for a safety factor of 2 because buckling could occur in the upper region of the drywell at stresses corresponding to a safety factor of 1.95. *Id.* at 70-71. While Sandia cautioned against using its model as an absolute prediction, this result shows that AmerGen has failed to establish that the drywell will meet safety requirements throughout any extended licensing period.

Torus Corrosion

The torus corrosion issue largely parallels the drywell corrosion issue. Once more, AmerGen is attempting to age manage a corroding safety-critical component through a combination of visual inspections of a protective coating and occasional UT measurements of identified degraded areas. The narrowness of the margins derived from measurements gives rise to doubts about whether the margin has been established given the uncertainty of the measurements. In addition, even though the claimed margins in this area are even narrower than the sandbed region, the proposed inspection regime appears less rigorous. Furthermore, based on the information available to us, we believe that AmerGen may have already failed to carry out a committed action regarding revising the torus corrosion acceptance criteria.

Taking the potential missed commitment first, on May 1, 2006, AmerGen committed to providing "refined acceptance criteria and thresholds for entering torus corrosion coating defects in the corrective action program for further evaluation . . . prior to the next torus coating inspection, which is also prior to the extended period of operation." Letter from Gallagher to NRC, dated May 1, 2006. NRC staff have confirmed that a torus inspection occurred during the October 2006 outage. Thus, we believe that to meet this commitment AmerGen should have provided the refined criteria prior to the last outage. However, the updated SER, issued in December, failed to contain the refined criteria. Instead, it continued to state that AmerGen would provide the criteria "prior to the next [torus coating] inspection and prior to the period of

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extended operation.” SER at 3-136. In addition, searches of ADAMS have not yielded the criteria. When we asked NRC staff for the refined criteria, they indicated that they did not believe the May 1, 2006 commitment required AmerGen to develop refined criteria for the torus inspection in October 2006. Because we believe the plain meaning of the commitment is that refined criteria had to be developed before October 2006 and, despite diligent efforts, we have been unable to find any refined criteria, we believe AmerGen may have failed to carry out a committed action. We also question how NRC staff can make a final evaluation of the aging management program for the torus when the acceptance criteria, which are a critical part of that program, have not yet been submitted by the applicant.

Moving on to the substance of the torus corrosion issue, the information available indicates that the margins for general corrosion are 0.004 inches to 0.008 inches, depending on the exact location. Letter from Gallagher to NRC dated April 7, 2006 at 29. In addition, individual pits must be less than 0.141 inches or 0.261 inches, depending on the diameter of the pit and spacing between pits. *Id.* at 30. At the outset, we question whether the accuracy of UT measurements is sufficient to be certain any margin exists and note that no estimate of uncertainty was included in the reporting of the measured thickness of the torus. *Id.* at 29. In the sandbed region, AmerGen recently found that a single measurement was incorrect by over 0.4 inches, SER at 3-126, and a whole set of results taken in 1996 were recently found to contain systematic error of around 0.02 inches. At this time, AmerGen claims that instrument error for UT measurements in the sandbed is around 0.01 inches. SER at 3-127. Thicknesses in the torus are around half the thickness of the sandbed, but even if the instrument error were 0.005 inches and there were also no danger of systematic error, that would lead to doubt about the existence of the claimed margins in the torus, which in some areas are the same or less than the instrument error.

Turning to the individual results, the deepest pit measured was 0.069 inches in 1992. Letter from Gallagher to NRC dated April 7, 2006 at 31. However, it appears that the local acceptance criteria are based on the nominal thickness of 0.385 inches rather than the measured thickness of 0.343 to 0.345 inches. *Id.* at 30-31. If this is the case, it is hardly surprising that the local acceptance criteria need to be “refined.” It also remains unexplained how around 0.04 inches of general corrosion has already occurred. A consultant employed by AmerGen has estimated that corrosion of exposed steel could occur at up to 0.005 inches per year. *Id.* at 28-29. Furthermore, the last visual inspection results available to us from 2002 show that “blister count indicated a general increase in the formation of new blisters [in the protective coating] and the occurrence of fractured blisters.” *Id.* at 28. AmerGen's summary fails to indicate how its coatings consultant concluded from these results that no inspection was warranted in 2004. *Id.* at 29. On the contrary, it appears that even more frequent inspections should have been required. As Dr. Hausler pointed out in his letter raising torus corrosion issues with the staff, blistering of the coating is caused by corrosion occurring below the coating. Letter from Hausler to Paul Gunter, dated July 26, 2006. Therefore, because blistering is becoming more extensive as the coating ages, there is a danger of generalized corrosion at a rate of up to 0.005 inches per year. This means that the claimed margin could be consumed in less than a year. To manage this issue, AmerGen has proposed visual inspection of the torus coating every other refueling outage. *E.g.* Letter from Gallagher to NRC, dated October 20, 2006. Even if the claimed margins are actually present, which we question, this appears insufficient for two reasons. First, as Dr.

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Hausler has pointed out repeatedly corrosion can occur under a coating without being visible and, unlike in the sandbed region, we have found no commitment to take quantitative measurements as a backstop to the visual inspection. Second, the narrow margin and potential corrosion rate seem to indicate that inspection frequency must be increased to less than one year.

Answers to Questions

Finally, at the last meeting I promised to provide you with answers to a few questions. Most simply, the coating testing standards to which Dr. Hausler refers are as follows:

1. National Association of Corrosion Engineers, International, Standard Test Method **TM-00384**: *"Holiday Detection of Internal Tubular Coatings of 250 μm (10 mils) dry Film Thickness"*
2. National Association of Corrosion Engineers, International, Standard Recommended Practice, **RP-0188-90**, *"Discontinuity Testing of Protective Coatings"*
3. National Association of Corrosion Engineers, International, Standard Test Method **TM-0186-94**: *Holiday Detection of Internal Tubular Coatings of 250 to 760 μm (10 to 30 mils) Dry Film Thickness*
4. National Association of Corrosion Engineers, International, Test Method **TM-0183**, *"Evaluation of Internal Plastic Coating for Corrosion Control of Tubular Goods in Aqueous Flowing Environment"*

With regard to Stress Corrosion Cracking, you asked for a citation regarding chloride stress corrosion cracking in carbon steels. The attached memo from Dr. Hausler discusses this issue. Overall, Dr. Hausler believes that this failure mechanism must be considered much more carefully before it can be eliminated as a possibility.

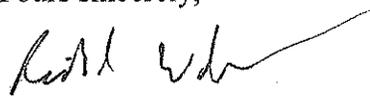
Finally, you asked about the source of the chlorides. Unfortunately, once again this not certain. However, empirical evidence shows that in the worst areas over 0.5 inches of steel has corroded from the drywell in the sandbed region and chlorides were observed in the corrosion products. Because the source of the water has not been totally eliminated, it is prudent to work on the basis that chlorides could be present, unless they are shown to be absent.

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Conclusion

We trust you will understand that these matters are of the utmost importance for those who live close to the plant and in the region. Most of the issues raised here concern both current safety and relicensing. They must therefore be addressed urgently. At present, we are puzzled how the NRC staff could conclude that the Oyster Creek Nuclear Power Plant currently meets safety requirements, let alone how the staff could decide that it would continue to meet safety requirements for twenty years beyond its current license. We therefore respectfully request the ACRS not to recommend issuance of the SER until the issues raised orally and in this letter are fully resolved.

Yours sincerely,

A handwritten signature in black ink, appearing to read "Richard Webster", with a long horizontal stroke extending to the right.

Richard Webster

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Memorandum

To: Richard Webster, Esq.
Rutgers University

January 16, 2007

From: Rudolf H. Hausler

**Subject: Oyster Creek Drywell Liner
The Possibility of Stress Corrosion Cracking**

Richard,

The ACRS at its last meeting relative to the safety of the Oyster Creek Dry Well Liner inquired with regards to the possibility of *stress corrosion cracking* in carbon steels. A reference relating in a general way to the subject of stress corrosion cracking can be found in the ASM Metals Handbook, Desk Edition, 1985, Chapter 32, pgs 24 – 26. Special reference is made to low alloy and high strength carbon steels, cross-referenced to temperature and aggressive ions. Carbon steels are only listed in the general overview table of this chapter in connection with caustic and carbonate cracking.

The particular steel of the drywell liner is said to be ASTM A 285 (no grade specified) with up to 0.28% carbon and up to 0.9% Mn. As such A-285 is not classified as a low-alloy carbon steel, even though the Mn content is already fairly high, but is considered to be a quenched and tempered carbon steel.

For stress corrosion to occur there are three simultaneous conditions, which need to be fulfilled: The material has to be susceptible, there has to be stress (at a certain level), and the environment has to contain species, which can induce SCC. This basic three-parameter space is further complicated by the many metallurgical and environmental variables. Hence, such a complex situation makes prediction impossible beyond certain general guidelines which have been established over the years and which are summarized in the referenced paper.

With respect to the specific material of the drywell liner, A-285 is a quenched and tempered steel with hardness levels generally well below where a steel is known to become susceptible to SCC. However, there are no specific requirements for this steel with regards to purity, either chemical or due to inclusions. It is well known that inclusions, such as carbides and/or oxides may constitute stress risers, and if they occur at, or near, the surface, are locations for SCC initiation. Furthermore, uneven temper may also induce local stresses, which can be cause for SCC origination.

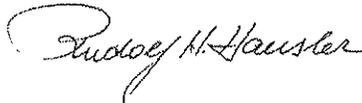
Perhaps the locations most susceptible to SCC are the welds, of which there are many and some are certainly located in the areas under consideration with regards to general corrosion attack. Welds constitute complex metallurgical entities and if not properly heat-treated present many internal stresses high enough for the metal to become susceptible to SCC.

It might be argued that stress corrosion cracking of the drywell liner is unlikely because the liner is under compressive load rather than tensile stress. However, it cannot be assumed that the structure is completely symmetrical. Asymmetries, such as have been proposed by Stress Engineering can certainly cause linear stresses. Furthermore, there may be internal stresses due to heat treatment, welding, etc, etc. Corrosion pits have been identified as locations where SCC can start. Additionally we should not forget that the entire structure is subject to vibrations. Hence SCC may be aggravated by fatigue.

While at the concrete/metal boundaries the conditions for carbonate induced SCC are certainly present we also know that chlorides have at various times been identified both in the corrosion products as well as in the water present in the sand bed or the former sandbed area.

Therefore a case can be made that in principle all the conditions for SCC are present, or potentially present. It would therefore be unwise to totally rule out such possibilities based on general arguments. We think that detailed studies and measurements should be made in the most susceptible areas, such as the former sand bed and the areas close to the embedded shell wall.

Dr. Rudolf H. Hausler

A handwritten signature in cursive script, reading "Rudolf H. Hausler". The signature is written in dark ink and is positioned below the typed name.