RAS 14199

APPLICANT'S EXHIBIT C.1

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:
E. Roy Hawkens, Chair
Dr. Paul B. Abramson
Dr. Anthony J. Baratta

In the Matter of:	)	September 14, 2007
AmerGen Energy Company, LLC	)	Docket No. 50-219
(License Renewal for Oyster Creek Nuclear Generating Station)	)	

AMERGEN'S PRE-FILED SURREBUTTAL TESTIMONY PART 1 INTRODUCTION, DRYWELL PHYSICAL STRUCTURE, HISTORY, AND COMMITMENTS

I. WITNESS BACKGROUND

Q. 1: Please state your names and current titles. The Board knows that a description of your current responsibilities, background and professional experience was provided in Part 1 of AmerGen's Pre-Filed Direct Testimony on July 20, 2007, so there is no need for you to repeat that information here.

A. 1: (JFO) My name is John F. O'Rourke. I am a Senior Project Manager, License Renewal, for Exelon, AmerGen Energy Company, LLC's ("AmerGen") parent company.

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SECY-02

(FWP) My name is Frederick W. Polaski. I am the Manager of License Renewal for Exelon.

(MPG) My name is Michael P. Gallagher, and I am the Vice President for License Renewal for Exelon.

Q. 2: Would you please summarize the purpose of this SurRebuttal Testimony?

A. 2: (All) The purpose of this SurRebuttal Testimony is to respond to the information provided in Citizens' Rebuttal Statement Regarding Relicensing of Oyster Creek Nuclear Generating Station ("Citizens' Rebuttal Statement") and in the Pre-Filed Rebuttal Testimony of Dr. Rudolf H. Hausler, regarding the drywell physical structure and AmerGen's regulatory commitments.

II. DRYWELL PHYSICAL STRUCTURE

Q. 3: Dr. Hausler alleges that "the exterior of the sandbed region . . . has very limited air exchange." (Citizens' Rebuttal Testimony, A.22). Citizens use this allegation to question Ed Hosterman's evaporation calculation in AmerGen's Direct Testimony, Part 6, A.19. Is Dr. Hausler correct?

A. 3: (All) No. Applicant's Exhibits 4 and 7 show that the drywell vents penetrate the concrete at the top of the sand bed region. The clearance between the concrete and the vents is greater than 3". There are 10 vents. Since the vent lines are approximately 4 feet in diameter, the gap between the vent and the concrete provides approximately 5.3 square feet for air flow in each bay. Additionally, many piping penetrations from the drywell have similar openings. Thus, there is substantial area for air flow through the sand bed region. In Part 6, Ed Hosterman will explain why air flow is expected through the sand bed region.

III. REGULATORY COMMITMENTS

Q. 4: Citizens allege that "[t]he plant could be forced into an outage that requires the fuel cavity to be flooded before there is any chance to apply measures to mitigate leaks in the cavity liner" (Citizens' Rebuttal Statement, page 19; Hausler Rebuttal Testimony, A.23). How do you respond?

A. 4: (All) To clarify Part 1 of AmerGen's Direct Testimony, we did not state, nor did we imply, that strippable coating and metal tape would not be applied during a forced outage in which the reactor cavity is filled with water. We merely stated that, "[t]he reactor cavity may be required to be filled with water during a forced outage when the reactor vessel must be opened. Such outages are rare." AmerGen Dir. Part 1 A.17.

(MPG) My testimony summarized AmerGen's commitments to perform future actions related to drywell shell sand bed region corrosion control, including the commitment that "[a] strippable coating will be applied to the reactor cavity liner to prevent water intrusion between the drywell shield wall and the drywell shell *during periods when the reactor cavity is flooded.*" (emphasis added.) Citizens then appear to have assumed that this commitment did not apply to forced outages, but Citizens are wrong. The commitment *does* extend to any non-refueling outage that would require the reactor cavity to be filled with water. The reason that the implementation schedule refers only to "refueling outages" is that we do not anticipate such an outage in the future.

Q.5: Does this conclude your testimony?

A. 5: (All) Yes.

In accordance with 28 U.S.C. § 1746, I state under penalty of perjury that the foregoing is true and correct:

John F. O'Rourke — Date: 9-12-07

Frederick W. Polaski — Date: 9/12/07

Michael P. Gallagher — Date: 9-12-07

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AMERGEN'S PRE-FILED SURREBUTTAL TESTIMONY
PART 2
ACCEPTANCE CRITERIA

I. WITNESS BACKGROUND

Q. 1: Please state your names and current titles. The Board knows that a description of your current responsibilities, background and professional experience was provided in Parts 1 and 2 of AmerGen's Pre-Filed Direct Testimony on July 20, 2007, and in Part 2 of AmerGen's Pre-Filed Rebuttal Testimony on August 17, 2007, so there is no need for you to repeat that information here.

A. 1: (MPG) My name is Michael P. Gallagher, and I am Vice President of License Renewal for Exelon.

(PT) My name is Peter Tamburro, and I am a Senior Mechanical Engineer in the Engineering Department at the Oyster Creek Nuclear Generating Station ("OCNGS").

(AO) My name is Ahmed Ouaou, and I am a registered Professional Engineer specializing in civil structural design. I am an independent contractor.

Q. 2: Would you please summarize the purpose of your testimony?

A. 2: (All) The purpose of our testimony is to address the Atomic Safety and Licensing Board's ("Board") questions asked during the September 5, 2007 pre-hearing conference call regarding the established drywell shell thickness acceptance criteria for the sand bed region.

II. RESPONSE TO BOARD QUESTIONS

Q. 3: Where can the Board find documentation that the three acceptance criteria—general and local buckling criteria, and the pressure criteria—are part of the CLB?

A. 3: (All). In general, the CLB as defined in 10 C.F.R. § 54.3 includes NRC approvals as well as design basis information contained in a plant's Updated Final Safety Analysis Report ("UFSAR"). The general buckling criterion (uniform thickness of 0.736") is part of the CLB as documented in the NRC's approval of this criterion in the April 1992 NRC Safety Evaluation attached as Applicant's Exhibit 37.

The local buckling criterion (0.536" in the tray configuration described in Part 2 of AmerGen's Direct Testimony and as shown in Applicant's Exhibit 11) and the pressure criterion (0.490" over circular areas of diameters up to 2.5") are part of the CLB as documented in the design basis information contained in the

OCNGS UFSAR. Relevant pages of the UFSAR are attached as Applicant's Exhibit 38. The Table of Contents to the UFSAR shows that Section 3.8 addresses the "DESIGN OF CATEGORY I STRUCTURES." Section 3.8.2.1 discusses the drywell shell as part of the containment, which is a Category I structure. Section 3.8.2.4.1, discusses the "Drywell." Section 3.8.2.5, entitled "Structural Acceptance Criteria" states, with italics added for emphasis:

> The Structural Acceptance Criteria relating the design and analysis results for the loads and load combinations given in Subsection 3.8.2.3 to the allowables, is presented in Subsection 3.8.2.4 and other referenced documents. The Basic Design phase of the Containment System is given in Subsection 3.8.2.4 *and the references listed in Subsection 3.8.6. These reference documents must be addressed to obtain complete information.*

It is clear, therefore, that the references in Section 3.8.6 provide the detailed information about the CLB acceptance criteria. Section 3.8.2.8, entitled "Drywell Corrosion" states:

> During 14R, UT measurements were taken from the outside of the drywell vessel in the sand bed region. Measurements were taken in each of the ten sand bed bays. The results of the inspection and the structural evaluation of the "as found" condition of the vessel is contained in Reference 44 [TDR-1108]. As documented in the TDR, the vessel was evaluated to conform to ASME code requirements given the deteriorated thickness condition."

Reference 44 is listed in Section 3.8.6 as the "GPUN Technical Data Report TDR-1108, 'Summary Report of Corrective Action Taken from Operating Cycle 12 through 14R', April 28, 1993", which is Applicant's Exhibit 27 ("TDR-1108"). Page 17 of TDR-1108 states:

Acceptance Criteria – Local Wall:

> If the thickness for the evaluation is less than 0.736 inches, then the use of specific GE studies is employed (Ref. 2.21). These studies contain analyses of the drywell using the pie slice finite element model, reducing the thickness by 0.200 inches in an area 12 x 12 inches in the sand bed region, tapering to original thickness over an additional 12 inches, located to result in the largest reduction possible. This location is selected at the point of maximum deflection of the eigen-vector shape associated with the lowest buckling load. The theoretical buckling load was reduced by 9.5 % from 6.41 to 5.56. Also, the surrounding areas of thickness greater than 0.736 inches is [*sic*] used to adjust the actual buckling values appropriately. Details are provided in the body of the calculation.

Note that the TDR's discussion of the local "wall" criterion includes only GE's modeling of 0.536" in the tray configuration as shown in Applicant's Exhibit 11. It does not include any other thickness or configuration.

As the quote above shows, the TDR identifies "(Ref. 2.21)" as the basis of its local buckling criterion. Reference 2.21, listed on page 5 of the TDR, is the "GE Letter Report, "Sandbed Local Thinning and Raising the Fixity Height Analyses (line Items 1 and 2 in Contract # PC-0391407)", dated December 11, 1992." This Letter Report contains GE's analysis of 0.536" in the tray configuration. It is attached as Applicant's Exhibit 39.

Page 18 of TDR-1108 discusses the pressure criterion, establishing the "required minimum thickness" for "Very Local Wall (2½ Inch Diameter)" to be 0.490".

In A.16 of AmerGen's Direct Testimony, we provided references for the Board to find how the CLB is carried through for License Renewal.

Q. 4: Is there another document that explains the technical basis for the established acceptance criteria and describes the modeling of the drywell used in the GE analyses upon which the acceptance criteria were established in the 1990s?

A. 4: (All) Yes. The presentations AmerGen provided to the Advisory Committee on Reactor Safeguards ("ACRS") License Renewal Subcommittee on January 18, 2007, and the full ACRS on February 1, 2007 are attached as Applicant's Exhibits 40 and 41. Slides 15 through 35 from the January 18 meeting describe the modeling of the drywell and buckling analysis in GE's December 11, 1992 Letter Report (Applicant's Exhibit 39). Slides 36 through 45 of Applicant's Exhibit 40 summarize General Electric's ASME Section VIII Stress Analysis. Similar information is also summarized in Applicant's Exhibit 3, beginning on page 6-7.

Applicant's Exhibits 40 and 41 [ACRS Presentations] also contain information regarding the drywell physical structure, the causes of historical corrosion in the sand bed region, the actions taken to arrest corrosion, and the actions taken to verify that corrosion has been arrested.

Q. 5: Do you have anything else to add?

A. 5: (MPG, PT) Yes. In our Direct Testimony, A.8, we stated that, with respect to the design and function of the drywell, "AmerGen complies with the [General Design Criteria] by meeting the applicable ASME Boiler and Pressure Vessel Code, standards, and specifications." The relevant portion of ASME Code Section III is attached as Applicant's Exhibit 42.

Q. 6: Does this conclude your testimony?

A. 6: (All) Yes.

In accordance with 28 U.S.C. § 1746, I state under penalty of perjury that the foregoing is true and correct:

Michael P. Gallagher — 9-12-07
Date

Peter Tamburro — Date

Ahmed Ouaou — 9/12/07
Date

In accordance with 28 U.S.C. § 1746, I state under penalty of perjury that the foregoing is true and correct:

Michael P. Gallagher	Date
Peter Tamburro	9/13/07 Date
Ahmed Ouaou	Date

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:
E. Roy Hawkens, Chair
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AMERGEN'S PRE-FILED SURREBUTTAL TESTIMONY
PART 3
AVAILABLE MARGIN

I. WITNESS BACKGROUND

Q. 1: Please provide the Licensing Board with your names and current titles. The Board knows that a description of your current responsibilities, background and professional experience was provided in Parts 1, 2 and 3 of AmerGen's Pre-Filed Direct Testimony on July 20, 2007, so there is no need for you to repeat that information here.

A. 1: (FWP) My name is Frederick W. Polaski. I am the Manager of License Renewal for Exelon.

(DGH) My name is Dr. David Gary Harlow. I am a Professor in the Mechanical Engineering and Mechanics Department at Lehigh University located in Bethlehem, Pennsylvania.

(JA) My name is Julien Abramovici. I am a consultant with Enercon Services, Inc. located in Mt. Arlington, New Jersey, but formerly worked for the Oyster Creek Nuclear Generating Station ("OCNGS").

(PT) My name is Peter Tamburro. I am a Senior Mechanical Engineer in the OCNGS Engineering Department.

Q. 2: Please summarize the purpose of your testimony and overall conclusions.

A. 2: (All) The purpose of this SurRebuttal Testimony is to respond to the information provided in Citizens' Rebuttal Statement Regarding Relicensing of Oyster Creek Nuclear Generating Station ("Citizens' Rebuttal Statement") and in the Pre-Filed Rebuttal Testimony of Dr. Rudolf H. Hausler, regarding the topic of available margin. Our overall conclusions, as explained below, are that Dr. Hausler and Citizens have presented no new information that would call into question our previous testimony on available margin.

Q. 3: In their Rebuttal Statement, on page 3, Citizens appear to argue that "reasonable assurance" requires 95% confidence. What is your response to this argument?

A. 3: (All) Citizens have never clearly explained what they mean by the term "95% confidence." In a statistical analysis of UT thickness data, this term could describe one of two distinct concepts. It is possible to calculate a lower and upper 95% confidence limit about the *mean*, *i.e.*, sample average, or a lower and upper 95% confidence limit for the *data*. The significant difference between these two

confidence limits is shown in Applicant's Exhibit 43, which displays the Bay 19 internal UT grid measurements from 1992.

In that Exhibit, the short dashed (blue) vertical lines indicate the $\pm 3\sigma$, $\pm 2\sigma$, and $\pm 1\sigma$ values for measurements which have an average of 0.800" and a standard deviation of about 0.059". The long dashed (red) lines are the 95% confidence limits computed for the mean (μ) using the student t distribution with 44 degrees of freedom. The difference between the actual measurements and the confidence limits for the mean (μ) are striking. This is because the distribution for the measurements (*i.e.*, the 49 points) and the distribution for the mean (μ) are actually different. The distribution for the measurements is "normal" whereas the distribution for the mean (μ) is the student t distribution. Consequently, describing the measurements and the confidence interval for the mean (μ) must be done precisely and carefully.

Q. 4: How do Citizens use the term "95% confidence"?

A. 4: (All) Citizens' Statement and Dr. Hausler's testimony suggests that Citizens are interested in the 95% confidence limit *for the data*. Examples of this argument include:

- Citizens' Exh. 39, page 6 ("the 95% confidence limits embrace 95% of all data . . . defined as the mean of the data +/- approximately two (2) standard deviations");
- Citizens' Rebuttal Statement, page 11 ("AmerGen bears the burden of evaluating the current margins using the estimated *lower* 95% confidence limits for the various required parameters...");

- Citizens' Rebuttal Statement, page 14 ("the external data do not comply with the acceptance criteria at the 95% confidence level if the *thinnest* measurements obtained are used.");

- Citizens' Rebuttal Statement, page 16 ("if the *lower* 95% confidence limit was compared to the acceptance criterion");

- Citizens' Rebuttal Statement, page 18 ("the lower 95% confidence limit for the thickness of certain parts of the drywell shell is below [the pressure] criterion" of 0.490"");

- Citizens' Exh. 38, page 6 ("structures do not fail by averages....[they] fail where the deepest pit is located").

Q. 5: Is it appropriate to analyze UT measurement data in terms of a 95% confidence level for the data?

A. 5: (All) No. Citizens' argument that the *internal* UT data should be analyzed using a 95% confidence limit for the data is particularly absurd. This would result in an analysis that focuses on the thinnest UT data points from among the 49 internal UT measurements in each grid, effectively ignoring 48 other known data points from the same 6" x 6" grid. This approach has no scientific basis. As Dr. Harlow stated in his Rebuttal testimony (Part 3, A.22):

> AmerGen is primarily interested in the data within a grid which are between ± two sigma about the sample average because this region accounts for 95% of normally distributed data. If there is relatively little scatter in these data, which has been demonstrated elsewhere, so that they are also reasonably close to the sample average, then the sample *average* is the quantity that should be used in comparison to the general buckling criterion. The 5% of the data outside ± two sigma about the sample average pose no threat to buckling; however, these data are considered relative to the pressure criterion.

Q. 6: But AmerGen uses only the average of the 49 points from an internal grid. Why doesn't AmerGen evaluate the internal UT grid data using a 95% confidence interval about the mean?

A. 6: (PT, JA, DGH) AmerGen *does evaluate* the 95% confidence interval of the sample average for each internal grid after each inspection to understand the variability of each calculated average. (Applicant's Exh. 20 (41 Calc)). The variability of the sample average demonstrates, however, that the calculated averages over time are well behaved and repeatable. There is an equal probability that the true mean is either greater or less than the calculated sample average within the 95% confidence interval because the internal grid data are normally distributed. Based on this calculation, and based on the Grand Standard Error calculation discussed in AmerGen's Rebuttal Testimony, A.17, it is concluded, therefore, that the average is the best representation of the thickness over the inspected area. Therefore, AmerGen uses the sample average to identify the available margin, without adjustment to include the lower 95% confidence limit.

Q. 7: Citizens allege that AmerGen is being inconsistent in that it evaluated future corrosion rates using a 95% confidence lower limit about the mean, but does not do that to evaluate the mean to identify the available margin. What is your response?

A. 7: (PT, JA, FWP) As described above in A.6, there is no discrepancy because this is a conservative approach.

Q. 8: Citizens argue that AmerGen has "erroneously claimed it has actually calculated the minimum margins based on the lower 95% confidence limit." (Citizens'

Rebuttal Statement, page 4 (citing Applicant's Exh. 3 at 6-15 to 6-16; Applicant's Exh. 12 at 13-14.)). What is your response?

A. 8: (PT, FWP) Citizens have identified an error in AmerGen's documents. The cited margins are not calculated with 95% confidence. Citizens' first citation is to Applicant's Exhibit 3, pages 6-15 and 6-16, which are two tables from a submittal to the Advisory Committee on Reactor Safeguards ("ACRS"), with titles that use the term "95% Confidence Level Average Thickness." These titles are based on the second document which Citizens cite (Applicant's Exhibit 12 (pages 13-14)), the LRA Supplement submitted to the NRC on December 3, 2006, which states, for example, that "Analysis of the 2006 UT data, at the 19 grid locations, indicates that the minimum 95% confidence level mean thickness in any bay is 0.807" (Bay #19). This is compared to the 95% confidence level minimum measured mean thickness in bay #19 of 0.806 and 0.800" measured in 1994 and 1992, respectively."

The statement is not correct as written. The values in the tables in Applicant's Exhibit 3, pages 6-15 and 6-16 are simply the calculated averages for each grid. This table does not report the upper or lower 95% confidence limits or the 95% confidence interval. The statement is correct if "95% confidence level" is deleted in both locations. As discussed in A.6, above, the 95% confidence lower limit was evaluated for the sample averages, so this only a cosmetic error.

Q. 9: Citizens state that "AmerGen argues that the external measurements are not accurate enough to allow margins to be determined, but AmerGen has also maintained that it can use those same measurements to determine whether the

shell complies with the acceptance criteria. This position is unsustainable." (Citizens' Rebuttal Statement, page 10). Do you agree?

A. 9: (PT, FWP, JA) No. First, AmerGen does *not* claim that the "external measurements are not accurate enough." The measurements are accurate over the very small area covered by the UT probe (less than 3/8" in diameter). Buckling, however, is a phenomenon that is implicated here when metal is lost over a significant area. The volumetric nature of the local buckling criterion is based on this principle: "[t]he entire [124.8 cubic inch] tray, on average, needs to corrode away for that loss of metal to be significant from a buckling perspective and to exceed the local buckling criterion." (AmerGen Dir. Part 3, A.15). Thus any calculation of margin to the local buckling criterion must be expressed in cubic inches, not in inches, and there simply are not sufficient external UT data points to calculate such a volumetric margin.

As we explained in our Direct Testimony, A.29 and A.30, in the "24 Calc." external single point UT data are averaged as a conservative method of "demonstrating compliance with the general buckling acceptance criterion." It is simply not realistic to average these data for the purpose of quantifying the actual estimated available margin.

As explained in our direct testimony, in the 24 Calc. AmerGen uses conservative assumptions to demonstrate compliance with the ASME Code. These assumptions would not be appropriate for quantifying the actual available margin. "In other words, [the 24 Calc.] confirms that you meet the applicable ASME Code, but not by how much." (AmerGen Dir. Part 3, A.29).

Q. 10: Please respond to Dr. Hausler's statement that, "[a] number of AmerGen evaluations of 'representative thickness' admit plainly that the internal grid data in certain Bays is not representative of the true mean thickness of the Bay because of the pattern of corrosion." (Citizens' Rebuttal Statement, page 12, citing Citizens' Exh. 45 at 3 (discussing this issue in Bay 1); Exh. 46 at OCLR29744-5 (discussing Bays 1, 3, 7, and 15).

A. 10: (PT, FWP) Dr. Hausler is taking these documents out of context. Citizens' Exhibit 45 and 46 are documents AmerGen used to develop inputs to a future containment analysis. This analysis is a commitment AmerGen made as documented in Exhibit 10, page 11 of 13 (Commitment #18). The inputs for thickness were selected to establish a thickness profile for the sand bed that was representative but appropriately conservative in representing the current thickness conditions. In general, internal grid thickness measurements were used. When appropriate, more conservative thicknesses were used such as adjacent bay thickness or UT data from the trenches. In no cases were external UT measurements used since they are not representative of the average thickness in the bays since they were biased as the thinnest points in the bay.

Q. 11: Citizens allege that Applicant's Exh. 16, pages 34 and 92-93 "shows a 3 foot by 3 foot area that is less than 0.736 inches in average thickness." (Citizens' Rebuttal Statement, page 16). Is this correct?

A. 11: (PT, JA, FWP) No. Dr. Hausler's statement is incorrect and misleading. Revision 2 of the 24 Calc. (Applicant's Exh. 16 at 92-93) concludes that there is a 3' by 3' area in Bay 19 that is "*at least* 0.720" thick." This is conservatively

based on only *two of the lowest* external points in this 3' by 3' area. The calculation does *not* conclude that this area is on average 0.720" thick. First, the external point measurements are taken at locations that "are biased thin compared to their surroundings," as stated in AmerGen Dir. Part 3, A.42. So even without more information, we know that the area in question is much thicker. Second, there is a third external point within the 3' by 3' area, between the two thinner points, that measured 0.736". Third, internal grids 19B and 19C coincide with the same 3' by 3' area and they have average thicknesses of 0.848" and 0.824", respectively. These data conclusively demonstrate that the area in question is thicker.

Finally, contrary to Citizens' implication, the 3' by 3' area is compared to the local buckling criterion, not the 0.736" general buckling criterion, so even if the area was, on average, 0.720" thick, it would not be significant from a buckling perspective.

Q. 12: In the previous Answer, you stated that the internal grids 19B and 19C coincide with specific external areas. How do you know that?

A. 12: (PT, FWP) We first relied upon Applicant's Exhibit 28, which generally shows the overlap of the internal grids and trench UT locations with the external data points. That Exhibit, however, is not to scale and shows all ten bays on a single sheet of paper. We then prepared similar maps for the bays identified as a concern by Citizens (Bays 1, 13, 17, and 19). Those maps, which are an excellent representation of the location of the UT measurement locations and are essentially to scale, are provided as Applicant's Exhibit 44.

Q. 13: In Dr. Hausler's Rebuttal Testimony, A.8 (referencing Citizens' Exh. 38), he states that he "refined [his] calculation of the sample standard deviation." How has Dr. Hausler "refined his calculations?

A. 13: (DGH) It is unclear exactly how Dr. Hausler has "refined" his calculation. In footnote 4 of Exhibit 38, he appears to provide more detail: "[t]he standard deviations derived from repeat measurements shown in Table 1 differ slightly from those previously presented, because I have used a more rigorous calculation method than previously. [sic]" This statement makes very little sense, unless Dr. Hausler is correcting mathematical errors. The standard deviation for a set of measurements is defined as follows:

$$s = \sqrt{\sum_{k=1}^{n} (x_k - \bar{x})^2 / (n-1)}.$$

All standard software and all calculators use this as the definition for standard deviation. Spreadsheets have its computation built into the computation library so that its computation is simple. I cannot imagine what Dr. Hausler means by "a more rigorous calculation method than previously" used.

Q. 14: In Dr. Hausler's Rebuttal Testimony, A.11, he states: "the 2006 measurements showed that the shell is now approximately 2 to 3% thinner overall than measured in 1992." What is the basis for this statement?

A. 14: (PT, JA, FWP) We could not identify any basis for Dr. Hausler's statement other than the statement "[m]y analysis of the data."

Q. 15: Do you agree with Dr. Hausler's statement?

A. 15: (PT, JA, FWP) No. Visual observations and the results of the UT grid readings over time demonstrate that corrosion has been arrested.

Q. 16: In Dr. Hausler's Rebuttal Testimony, A.14, Citizens quote an OCNGS document from 1993, attached as Citizens' Exhibit 44 (on page 2) as follows: "I could not determine visually which of the thin spots are the thinnest." Does this quote accurately reflect this document?

A. 16: (PT, FWP) No, the quote is egregiously taken out of context. The full quotation, with italics for emphasis, is:

> In addition to the dimples, there are spots that appear to be thinner than the general area. The dimples in the surface occur in these thin spots to the same degree as in the rest of the corroded portion of the shell. The "thin" spots are typically a foot to 18" in diameter and probably comprise about 20% of the corroded area. In general, except in Bay 13, the thin spots are not readily apparent. Therefore, a more detailed characterization is difficult for the other bays .... I could not determine visually which of the thin spots are the thinnest. However, due to the small differences between the "thick" areas and the "thin" areas, and the amount of metal removed in preparation for the UT measurements, *it is highly likely that the thickness readings reported in the UT measurements encompass the thinnest spots in the shell.*

Thus, Citizens' Exhibit does not support their conclusion. Instead, it supports the opposite conclusion, that the external points are biased thin.

Q. 17: In Citizens' Rebuttal, A.16, Dr. Hausler discusses the alleged "overgrinding" of metal at the external UT locations. In this discussion, he acknowledges that the curvature of the prepared area created an air gap on the exterior shell that may have created a bias in the 1992 UT data. He then argues that, "If this bias indeed

exists, the only explanation offered assumes that the measured points were not overground." What is your response to this argument?

A. 17: (PT) We have previously testified that "additional good metal" may have been removed at some of the external data points, leading to some additional conservatism in AmerGen's calculations. (AmerGen Dir. at A.42). Dr. Hausler's statement assumes that the metal removal process would have eliminated any curvature in the prepared surface, thus eliminating the bias. This is wrong. Ultimately, the question of whether these areas were "overground" or not is significantly less important than the fact that they are biased thin when compared to the rest of the shell. So we believe that Dr. Hausler's argument is a red herring.

Q. 18: In Dr. Hausler's Rebuttal Testimony, A.19, he claims that it was "unlikely" that the corrosion occurred between 1986 and 1992 "because Bays 5 & 17 are the least corroded Bays and the estimated corrosion rate in Bay 17 was not significant or was very small (no corrosion rate was even estimated for Bay 5)." He does this in an effort to show that significant corrosion is occurring or can occur on the interior embedded surface of the drywell shell in the sand bed region. Do you agree?

A. 18: (PT, FWP) No. First, with respect to Bay 17, this trench was selected because it was representative of significant external corrosion, so Dr. Hausler is simply wrong. Data from bay 17 show significant external metal loss between 1986 and 1992. For example, as shown in Applicant's Exhibit 3, page 6-15, the average measurement in grid #17D was 0.922" in February 1987 and 0.817" during the

1992 refueling outage; the average thickness in grid #17A bottom was 0.999" in December 1986 and 0.941" during the 1992 refueling outage.

Second, with respect to Bay 5, Dr. Hausler's speculation of significant interior corrosion is also contradicted by all of the available evidence. We know from Barry Gordon's Rebuttal Testimony that any corrosion from the interior would be expected to be "vanishingly small and of no engineering concern." (AmerGen Reb. Part 6, A.10). We also know from visual inspections of Bay 5 following sand removal that some exterior corrosion was experienced prior to the 1992 refueling outage. This is documented in Applicant's Exhibit 27, page 27 (the physical condition of bay 5 "was very similar to [the corrosion in] bay 3"). We know that the interior of the trench was observed visually during the 2006 refueling outage, and the surface was smooth with only minor surface corrosion. And we know from AmerGen's Direct and Rebuttal Testimony, Part 5, that the epoxy coating is intact with no signs of deterioration, so we know that corrosion from the exterior has been arrested since 1992.

Q. 19: In Citizens' Exhibit 38, page 3, Dr. Hausler states that "[d]uplicate & triplicate measurements were made externally in some bays" in 2006. Is this correct?

A. 19: (All) No. In some cases two and three UT thickness values were recorded at some external locations. However, the multiple measurements were *not* taken at the same exact points. They were taken about ¼-inch around the measurement points, but within the prepared area. This is documented, for example, in the 24 Calc., Applicant's Exhibit 16, on pages 171 and 176, which are the data sheets for

bays 5 and 15. In all cases the 24 Calc. used the thinnest value recorded for each location.

But Dr. Hausler then uses these "duplicate and triplicate" measurements to generate an uncertainty value for the external data: "It was then possible to estimate the measuring error form [sic] these repeated measurements." Dr. Hausler's assumption that the differences in these values can be attributed to the "error in measurement only" is wrong because these data are not from the exact same points. So Dr. Hausler's calculations are statistically improper.

Q. 20: Do you have anything else to add?

A. 20: (PT, JA) Yes. In our Rebuttal Testimony, A.54, we referenced ASME Code Case N513, NRC Bulletin 87-01, "Thinning of Pipe Wall in Nuclear Power Plants," NRC Generic Letter 89-08, "Erosion/Corrosion-Induced Pipe Wall Thinning" ASME Code Section XI, and API 653 in our answer to the Board's question on the statistical analysis of UT thickness measurements. Relevant portions of these documents are attached as Applicant's Exhibits 45 through 49.

Q. 21: Does this conclude your testimony?

A. 21: (All) Yes.

In accordance with 28 U.S.C. § 1746, I state under penalty of perjury that the foregoing is true and correct:

Frederick W. Polaski	Date
Dr. David Gary Harlow	Date
Julien Abramovici	Date
Peter Tamburro	Date

In accordance with 28 U.S.C. § 1746, I state under penalty of perjury that the foregoing is true and correct:

Frederick W. Polaski	Date
David Gary Harlow Dr. David Gary Harlow	9/13/07 Date
Julien Abramovici	Date
Peter Tamburro	Date

In accordance with 28 U.S.C. § 1746, I state under penalty of perjury that the foregoing is true and correct:

Frederick W. Polaski	Date
Dr. David Gary Harlow	Date
Julien Abramovici	9-15-07 Date
Peter Tamburro	Date

In accordance with 28 U.S.C. § 1746, I state under penalty of perjury that the foregoing is true and correct:

Frederick W. Polaski	Date
Dr. David Gary Harlow	Date
Julien Abramovici	Date
Peter Tamburro	9/13/07 Date

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:
E. Roy Hawkens, Chair
Dr. Paul B. Abramson
Dr. Anthony J. Baratta

In the Matter of:	)	September 14, 2007
AmerGen Energy Company, LLC	)	Docket No. 50-219
(License Renewal for Oyster Creek Nuclear Generating Station)	)	

AMERGEN'S PRE-FILED SURREBUTTAL TESTIMONY
PART 4
SOURCES OF WATER

I. WITNESS BACKGROUND

Q. 1: Please state your names and current titles. The Board knows that a description of your current responsibilities, background and professional experience was provided in Parts 1 and 4 of AmerGen's Pre-Filed Direct Testimony on July 20, 2007, so there is no need for you to repeat that information here.

A. 1: (JFO) My name is John F. O'Rourke. I am a Senior Project Manager, License Renewal, for Exelon, AmerGen Energy Company, LLC's ("AmerGen") parent company.

(AO) My name is Ahmed Ouaou. I am a registered Professional Engineer specializing in civil/structural design and an independent contractor.

(FHR) My name is Francis H. Ray. I am the Engineering Programs Manager at the Oyster Creek Nuclear Generating Station ("OCNGS").

II. KNOWN SOURCES OF WATER IN THE SAND BED REGION

Q. 2: Please summarize the purpose of this SurRebuttal Testimony and your conclusions.

A. 2: (All) The purpose of this SurRebuttal Testimony is to respond to the information provided in Citizens' Rebuttal Statement Regarding Relicensing of Oyster Creek Nuclear Generating Station ("Citizens' Rebuttal Statement") and in the Pre-Filed Rebuttal Testimony of Dr. Rudolf H. Hausler, regarding the sources of water in the sand bed region. Our overall conclusions, as explained below, are that Dr. Hausler and Citizens have presented no new information that would call into question our previous testimony on the sources of water in the sand bed region.

Q. 3: Citizens have alleged that the reactor cavity concrete "trough is still subject to high temperatures that could cause the concrete to deteriorate and the condition of the trough was seen to be far from ideal in the most recent outage." (Citizens' Rebuttal Statement, page 20 (citing Citizens' Exhs. 48 & 49)). How do you respond to this allegation?

A. 3: (All) Citizens' Exhibits provide no support for their conclusion that the condition of the trough was seen to be far from ideal in the "most recent" outage. The exhibits are from 1986 and 1996, not 2006. And there was no evidence of any defects in the trough drain during the 2006 refueling outage. The trough

functioned as designed by conveying any water to the trough drain and, thereby, preventing water from entering the external sand bed region.

Q. 4: Citizens allege that "[t]he plant could be forced into an outage that requires the fuel cavity to be flooded before there is any chance to apply measures to mitigate leaks in the cavity liner." (Citizens' Rebuttal Statement, page 19; Rebuttal Testimony, A.23, citing AmerGen Dir. Part 1, A.17). How do you respond to this allegation?

A. 4: (AO, JFO, FHR) As stated in Part 1 of this SurRebuttal Testimony, A.4, AmerGen has committed to apply a strippable coating "to the reactor cavity liner to prevent water intrusion between the drywell shield wall and the drywell shell *during periods when the reactor cavity is flooded.*" This includes forced outages. Further, as stated in AmerGen's Direct Testimony, Part 4, A.6, "forced outages when the reactor cavity had to be filled with water are rare, and OCNGS has not experienced such an outage since at least 1990."

Q. 5: Citizens allege that AmerGen has failed to account "for other forced outages that could lead to condensation on the exterior of the drywell surface." (Citizens' Rebuttal Statement, page 23; Rebuttal Testimony, A.23). How do you respond?

A. 5: (All) Citizens are wrong. Mr. Gordon's analysis assumed that the exterior surface of an uncoated drywell shell is exposed to water for 30 days every two years. The average duration of OCNGS's past four refueling outages, since AmerGen took over management, however, has been 26 days. Thus, Mr. Gordon's analysis contains margin to account for potential drywell entry time during forced outages during which condensation is assumed to be present.

Nevertheless, such condensation remains highly speculative. Citizens fail to recognize that, as described in AmerGen's Direct Testimony, Part 4, A.16, there was no evidence of condensation on the exterior of the drywell shell in the sand bed region at any time during the 2006 outage, even while the drywell chillers were in operation. Thus, even if there is a theoretical potential for condensation, there is no evidence that it has actually taken place. Citizens present no evidence that it has, or even that it is likely. As a result, "the potential for condensation is entirely speculative." (AmerGen Dir. Part 4, A.17).

Q. 6: Do you have anything else to add?

A. 6: (All) Yes. In our Direct Testimony, A.9, we discussed the results of the reactor cavity liner leakage inspections during the 2006 refueling outage, and in our Direct Testimony, A.10, and Rebuttal Testimony, A.6, we discussed the results of the daily and quarterly poly bottle inspections from the Torus Room since March 2006. Relevant portions of the completion documentation for these inspections are attached as Applicant's Exhibits 50 through 56.

Q. 7: Does this conclude your testimony?

A. 7: (All) Yes.

In accordance with 28 U.S.C. § 1746, I state under penalty of perjury that the foregoing is true and correct:

John F. O'Rourke — Date: 9-12-2007

Ahmed Ouaou — Date: 9/12/2007

Francis H. Ray — Date:

In accordance with 28 U.S.C. § 1746, I state under penalty of perjury that the foregoing is true and correct:

John F. O'Rourke	Date
Ahmed Ouaou	Date
Francis H. Ray	Date 9/12/2007

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:
E. Roy Hawkens, Chair
Dr. Paul B. Abramson
Dr. Anthony J. Baratta

In the Matter of:	September 14, 2007
AmerGen Energy Company, LLC	Docket No. 50-219
(License Renewal for Oyster Creek Nuclear Generating Station)	

AMERGEN'S PRE-FILED SURREBUTTAL TESTIMONY
PART 5
THE EPOXY COATING

I. WITNESS BACKGROUND

Q. 1: Please state your name and current title. The Board knows that a description of your current responsibilities, background and professional experience was provided in Part 5 of AmerGen's pre-filed Direct Testimony on July 20, 2007, so there is no need for you to repeat that information here.

A. 1: (JRC) My name is Jon R. Cavallo. I am Vice President of Corrosion Control Consultants and Labs, Inc., and Vice-Chairman of Sponge-Jet, Inc.

Q. 2: Please summarize the purpose of this SurRebuttal Testimony and your overall conclusions.

A. 2: (JRC) The purpose of this SurRebuttal Testimony is to respond to the information provided in Citizens' Rebuttal Statement Regarding Relicensing of Oyster Creek Nuclear Generating Station ("Citizens' Rebuttal Statement") and in the Pre-Filed Rebuttal Testimony of Dr. Rudolf H. Hausler, regarding the epoxy coating system installed on the exterior of the OCNGS drywell shell in the sand bed region. My overall conclusions are that Citizens have presented no new information that would call into question my previous conclusion that the epoxy coating system should preclude further corrosion of the exterior drywell shell in the sand bed region, and that Dr. Hausler's expertise appears to be fundamentally inapplicable to that epoxy coating system.

II. RESPONSE TO CITIZENS' REBUTTAL

Q. 3: Do you agree with Dr. Hausler's statement that "tests with the wet sponge technique . . . as standardized by NACE are quite simple to carry out and it is unclear why these tests were not done."? (Citizens' Exh. 39, page 17).

A. 3: (JRC) No, I do not. Discontinuity (holiday) testing using the wet sponge technique is not required for a coating system in atmospheric service when benign exposure conditions exist, such as in the sand bed region of OCNGS. The NACE standard that Dr. Hausler refers to is SP0188-2006, "Standard Practice / Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates." In the Forward to the NACE standard, the following statement appears, with italics added for emphasis:

> This standard was originally prepared in 1988 by Task Group T-6A-37, a component of Unit Committee T-6A on *Coating and Lining Materials for Immersion Service*. It

was reaffirmed in 1990, revised in 1999, and reaffirmed in 2006 by Specific Technology Group (STG) 03. This standard is issued by NACE International under the auspices of STG 03 on *Protective Coatings and Linings: Immersion and Buried.*

It is evident from this Forward that discontinuity (holiday) testing using the wet sponge technique is intended for use in aggressive corrosion environments, such as encountered in buried or underwater service, and not for benign atmospheric conditions such as those found in the OCNGS sand bed region.

Q. 4: Dr. Hausler has stated that "Residual stresses . . . can lead to spontaneous cracking, particularly under conditions of constant vibration and fatigue and elevated temperature." (Citizens' Exh. 39, page 17). What is your response to this statement?

A. 4: (JRC) Dr. Hausler's statement demonstrates a lack of understanding of the exposure conditions of the three-coat epoxy coating system applied to the drywell exterior in the OCNGS sand bed region. The exterior surface of the OCNGS drywell in the sand bed region is not subject to vibration or flexure (fatigue) during normal plant operations, and as stated in AmerGen's Direct Testimony, Part 6, A.19, the reasonable operating internal temperature in the sand bed region of 130°F is far below the maximum allowable continuous temperature limit of the three-coat epoxy coating system (250°F). Applicant's Exhibit 35 (Devran 184 data sheet).

Q. 5: Dr. Hausler also warns that "epoxy coatings are subject to spontaneous delamination as a consequence of abrupt pressure drops." (Citizens' Exh. 39 at 17). Does this warning apply to the coating on the exterior sand bed region?

A. 5: (JRC) No, it does not. The only pressure changes that will be encountered in the OCNGS exterior sand bed region will be as a result of changes in environmental conditions within the reactor building that would result in slow increases and decreases of pressure. Small, slow fluctuations in atmospheric pressure will not cause the "spontaneous delamination" phenomenon proposed by Dr. Hausler.

Q. 6: Please respond to Dr. Hausler's allegation in A.18 that "areas of the shell in the sandbed region were not coated with epoxy because they are inaccessible."

A. 6: (JRC) Citizens' A.18 makes clear that Dr. Hausler bases his allegation on two documents: Citizens' Exhibits 40 and 41. As discussed below, neither of these documents supports Dr. Hausler's allegation.

Exhibit 40 is a November 2006 AmerGen e-mail discussing the *possibility* that parts of the exterior drywell shell in the sand bed region are not coated with epoxy. It states that "[a]ssuming there are areas that could not be accessed and/or protective coating applied. . ." And its discussion is based entirely on a historical document that pre-dated the cleaning and coating of the exterior shell. Therefore, this historical source cannot possibly provide reliable evidence of whether areas of the shell were not coated because it was written before the coating was applied.

Exhibit 41 also does not support Dr. Hausler's allegation, for the same reasons as Exhibit 40. Exhibit 41 is a two-page excerpt from a GPUN evaluation written in December 1992. The evaluation similarly talks about the coating of the exterior of the drywell shell in the future tense, for example: "some patches of the drywell exterior may be left uncleaned and/or uncoated."

The workers who inspected the external coating in all ten bays during the 2006 refueling outage confirmed that all of the areas were coated. These actual visual observations clearly trump Dr. Hausler's speculation, which is based on documents that pre-date application of the epoxy coating.

II. DR. HAUSLER'S EXPERTISE

Q. 7: Are you aware of any new information about Dr. Hausler's expertise with regard to the OCNGS epoxy coating system?

A. 7: (JRC) Yes. Citizens submitted additional information about Dr. Hausler's qualifications and the papers he has authored in their response to AmerGen's Motion in Limine of July 27. Dr. Hausler identified some articles that are attached as Applicant's Exhibit 57 (R. H. Hausler, et al., "Corrosion Management in the Arun Oil Field," 1996), Applicant's Exhibit 58 (R.H. Hausler, et al., "Development of a Corrosion Inhibition Model I: Laboratory Studies," 1999), and Applicant's Exhibit 59 (R.H. Hausler, et al., "Development of a Corrosion Inhibition Model II: Verification of Model by Continuous Corrosion Rate Measurements Under Flowing Conditions with a Novel Downhole Tool," 1999). I was not able to retrieve these documents in time to incorporate any comments on them into AmerGen's Rebuttal Testimony. I have now reviewed these papers and the topics discussed in them confirm that Dr. Hausler's expertise is primarily in oil field applications that have very little in common with OCNGS epoxy coating system and the benign sand bed region environment that the epoxy coating system is exposed to.

In closing, my review has identified no evidence that Dr. Hausler serves on any NACE or EPRI or other technical committees, or has any experience related to coatings in atmospheric service.

Q. 8: Does this conclude your testimony?

A. 8: (JRC) Yes.

In accordance with 28 U.S.C. § 1746, I state under penalty of perjury that the foregoing is true and correct:

Jon R. Cavallo

13 September 2007
Date

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:
E. Roy Hawkens, Chair
Dr. Paul B. Abramson
Dr. Anthony J. Baratta

In the Matter of:	)	September 14, 2007
AmerGen Energy Company, LLC	)	Docket No. 50-219
(License Renewal for Oyster Creek Nuclear Generating Station)	)	

AMERGEN'S PRE-FILED SURREBUTTAL TESTIMONY
PART 6
FUTURE CORROSION

I. WITNESS BACKGROUND

Q. 1: Please state your names and current titles. The Board knows that a description of your current responsibilities, background and professional experience was provided in Parts 1, 2 and 6 of AmerGen's Pre-Filed Direct Testimony on July 20, 2007, so there is no need for you to repeat that information here.

A. 1: (BG) My name is Barry Gordon. I am an Associate with Structural Integrity Associates, Inc. ("SIA"), located in San José, California.

(EWH) My name is Edwin Hosterman, and I am a Senior Staff Engineer in the Corporate Engineering Programs Group in Exelon's Headquarters in Kennett Square, Pennsylvania.

Q. 2: Please summarize the purpose of this SurRebuttal Testimony and your overall conclusions.

A. 2: (All) The purpose of this SurRebuttal Testimony is to respond to the information provided in Citizens' Rebuttal Statement Regarding Relicensing of Oyster Creek Nuclear Generating Station ("Citizens' Rebuttal Statement") and in the Pre-Filed Rebuttal Testimony of Dr. Rudolf H. Hausler, regarding the potential for future corrosion of the exterior drywell shell in the sand bed region. Our overall conclusions are that Dr. Hausler's Testimony, once again, is based on inapplicable analyses and mistaken assumptions, and that Dr. Hausler's expertise appears to be fundamentally inapplicable to the actual conditions of the drywell shell in the sand bed region.

II. POTENTIAL CORROSION RATE

Q. 3: Dr. Hausler has opined that sand bed region "corrosion could be as rapid as it was in the presence of the sand." (Citizens' Exh. 39, page 17). Do you agree with this statement?

A. 3: (BMG) No. There are three main reasons why this would not be the case. First, the drywell corrosion mitigation steps as described throughout AmerGen's testimony, such as applying a strippable coating to the reactor cavity liner, removing the sand, clearing the drains, and installing a three-layer epoxy coating system on the exterior drywell shell surface, will prevent this high rate of corrosion.

Second, as described in my Rebuttal Testimony, A.14, due to the above mitigation steps, the expected time of wetness, T_w, on the drywell shell has been dramatically

reduced to the point where the coated drywell exterior could be dry all of the time. If there is no moisture, there is no corrosion.

Third, as described in my Rebuttal Testimony, A.7, the rate of general corrosion decreases with time due to the formation of corrosion products/films on the metal surface. Therefore, any subsequent corrosion on a freshly-wetted, previously corroded surface would not corrode at the same rate as measured previously. General corrosion rates typically decrease with the square root of time.

Q. 4: With respect to potential corrosion from the interior, Dr. Hausler has testified that "[c]onsiderably higher short term [interior] corrosion rates have probably occurred. In the absence of any good information on this issue. I believe it would be prudent to allow for an interior corrosion rate that is a multiple of 0.002 inches per year, if new water is introduced into the interior floor by repairs to control rod drives, use of the containment spray, or other sources." (Rebuttal Testimony, A.19). Is this realistic?

A. 4: (BMG) No, for the reasons provided in Part 6 of AmerGen's Rebuttal Testimony, A.9 and A.10. "Any corrosion [in the interior embedded drywell surface] would be vanishingly small and of no engineering concern." This is due to the high pH of any water in contact with the interior surface of the embedded drywell shell, the lack of measurable corrosion on the newly-exposed shell surface during the 2006 refueling outage, and the inerted air environment inside the drywell during operations.

Any new water introduced on to the concrete floor by "repairs to control rod drives, the use of containment spray, or other sources" will have its pH subsequently increased due to the high solubility of calcium hydroxide, $Ca(OH)_2$, *i.e.*, the most soluble cement paste compound, from the concrete. This phenomenon is document in L.

Bertolini, et al., *Corrosion of Steel in Concrete – Prevention, Diagnosis, Repair*, Wiley-VCH, Weinheim, Germany, 2004, page 57. Relevant excerpts are attached as Applicant's Exhibit 60.

Q. 5: Apparently based on the interior corrosion rate of 0.002" per year postulated in Dr. Hausler's Testimony, A.19, Citizens' argue that, "[i]n the absence of any good information on this issue, it is prudent to allow for a corrosion rate of up to 10 mils per year after new water is introduced onto the interior floor by repairs to control rod drives, the use of containment spray, or other sources." (Citizens' Rebuttal Statement, page 23) Do you agree with this statement?

A. 5: (BMG) There is absolutely no justification for multiplying this assumed general corrosion rate of 0.002" per year by a factor of five to derive an even a more dubious general corrosion rate of 0.010" per year. It is important to note that normal corrosion engineering practice is to conservatively double the general corrosion rate to provide extra margin, not to multiply the general corrosion rate by a factor of five.

The general corrosion rate of carbon steel embedded in clean concrete, *i.e.*, no chlorides or carbon dioxide, is negligible (<0. 000008" per year). This value is based on L. Bertolini, *et al.*, *Corrosion of Steel in Concrete – Prevention, Diagnosis, Repair*, Wiley-VCH, Weinheim, Germany, 2004, page 74. (Applicant's Exh. 60). Even in the presence of aggressive substances such as chlorides or carbon dioxide, which degrade the passive film formed on the carbon steel surface, at a high relative humidity (RH) of 80% and 90%, respectively, the general corrosion rate of steel is approximately only 0.0006" per year, as described in Applicant's Exhibit 60, page 74.

Thus, Citizens' postulated internal surface proposed corrosion rate is unreasonable and the added margin multiplier factor lacks any engineering basis.

Q. 6: Citizens state that the total (annual) corrosion rate could be 0.050" per year (Citizens' Rebuttal Statement, page 11). This is based on their estimate that "[f]uture corrosion rates after refueling outages are up to 0.01 inches per year from the interior and 0.39 inches per year from the exterior. The total corrosion rate could therefore be approximately 0.05 inches per year." Is this a reasonable estimate of the potential corrosion rate?

A. 6: (BMG) No. The highest historical general corrosion rate ever measured in the OCNGS sand bed region of 0.039" per year took place in a corrosion system consisting of water-saturated sand in direct contact with an uncoated carbon steel drywell. That corrosion system no longer exists, so the corrosion rate value is no longer valid. The corrosion system has changed as follows:

- The water-retaining and ion-containing sand has been removed
- The ingress of additional water has been mitigated
- The carbon steel drywell has been coated

Nevertheless, as I described in my Rebuttal testimony, A.15, even "if I assumed that the highest levels of corrosion ever experienced in the sand bed region could recur, the total potential corrosion rate," when accounting for the time of wetness ("T_w"), is only 0.007" over two years.

Citizens' estimate of the interior corrosion rate of 0.010" per year is unjustified, for the reasons described in A.5, above. Citizens also add 0.001" per year, for no apparent reason. Thus, there is no basis for a total corrosion rate of 0.50" per year.

Q. 7: Dr. Hausler cites the "Handbook of Chemistry and Physics" to counter AmerGen's position that "corrosion product occupies from 7 to 10 times the volume of the iron from which it originates." (Citizens' Exh. 39, page 18). Please respond to Dr. Hausler's statement.

A. 7: (BMG) In the information cited by Dr. Hausler from the "Handbook of Chemistry and Physics," the relative densities of iron and its common corrosion products are based on theoretical values of pure oxides. In reality, oxides are not pure and usually occupy much larger volumes due to defects in the oxide/hydrate structure such as vacancies and voids.

III. AIR FLOW IN THE SAND BED REGION

Q. 8: Is Dr. Hausler correct when he says that "the exterior of the sandbed region . . . has very limited air exchange"? (Citizens' Rebuttal Testimony, A22).

A. 8: (EWH) No. While the exterior of the sand bed region is not served by forced ventilation, air exchange will occur in the sand bed region in response to temperature changes in the drywell shell and the surrounding air. As explained in AmerGen's SurRebuttal Testimony, Part 1, A.3, Applicant's Exhibits 4 and 7 show that the drywell vents penetrate the concrete at the top of the sand bed region. The gaps between the vent headers and the concrete provide substantial area for air flow, as do many piping penetrations from the drywell. All of these openings combined with the air gap between the drywell liner and the concrete shield walls create a "chimney" which will tend to promote airflow in this area. In particular, as the drywell liner heats up following an outage, the resulting temperature differential between the drywell shell and the surrounding air will induce natural circulation air flow in the sand bed region.

Q. 9: Citizens have alleged that AmerGen's testimony uses the incorrect equation to determine the evaporation rate of water from the drywell shell surface following an outage.

Specifically, Dr. Hausler states that because the air in the sand bed region is "totally stagnant," the equation used "describes a steady state, while the rate of evaporation in the confined space of the sand bed area would have to be described by a transient equation." (Citizens' Exh. 39, page 19). Is Dr. Hausler correct?

A. 9: (EWH) No. As I stated in my response above (A.8), the air in the sand bed region is not stagnant. Since air can, and does, flow through this area, the evaporation in this region would not have to be described by a transient equation.

Q. 10: In your direct testimony (A.19), how did you account for the potential low velocity of air across the shell surface?

A. 10: (EWH) I conservatively accounted for the low velocity of air across the shell by setting the wind velocity equal to zero. At this point, the evaporation is strictly governed by differences in saturation pressure between the water film assumed on the drywell exterior, and the air in the sand bed region.

Q. 11: Please explain why it is acceptable to use a velocity of zero in this equation, rather than using a different equation altogether.

A. 11: (EWH) Because air is free to be exchanged in the sand bed region, but the velocity is not known, setting the value equal to zero conservatively limits evaporation to differences in saturation pressure, which are temperature-driven. Because air is free to flow through the area, the air will not saturate and steady state equations will adequately describe evaporation in this area.

Q. 12: Do you agree with Dr. Hausler that, "[i]t is therefore likely that in the event of water leakage into the region, the air in the sandbed region would become fully saturated during the outage (transient phenomenon). It would then have very limited capacity to absorb

moisture as the temperature increased with plant start up."? (Citizens' Rebuttal Testimony, A22).

A. 12: (EWH) No. Once again, because air is free to circulate through this region, the air in the sandbed region will not become fully saturated, so Dr. Hausler is wrong.

Q. 13: Do you agree with Dr. Hausler that "[t]he ability of new air to reach the sand pocket has been reduced by the placement of tubes leading to polystyrene bottles in the sand bed drains. Thus, it is likely that any moisture on the exterior of the shell would evaporate slowly."? (Citizens' Rebuttal Testimony, A22).

A. 13: (EWH) No. As I stated in A.8, above, significant air flow area exists in the sand bed region, even with the drainage tubes installed in the sand bed drains.

IV. DR. HAUSLER'S EXPERTISE

Q. 14: Mr. Gordon, are you aware of any new information about Dr. Hausler's expertise with regard to the potential corrosion rate in the OCNGS sand bed region?

A. 14: (BMG) Yes. Citizens submitted additional information about Dr. Hausler's qualifications and the papers he has authored in their response to Amergen's Motion in Limine of July 27. Dr. Hausler identified some articles that are attached as Applicant's Exhibits 57, 58, and 59. I was not able to retrieve these documents in time to incorporate any comments on them into AmerGen's Rebuttal Testimony. I have now reviewed these papers and the topics discussed in them confirm that Dr. Hausler's expertise is primarily in oil field applications that have very little in common with the OCNGS sand bed region.

Q. 15: Do you have anything else to add?

A. 15: (BMG) Yes. In my Rebuttal Testimony, A.10, I compared the chemistry sample results of water from the drywell shell interior to the guidelines in NRC Generic Aging Lessons

Learned (GALL) Report (Vol. 2, Rev. 1, at II A.1 through 5). Relevant portions of the GALL Report are attached as Applicant's Exhibit 61.

Q. 16: Does this conclude your testimony?

A. 16: (All) Yes.

In accordance with 28 U.S.C. § 1746, I state under penalty of perjury that the foregoing is true and correct:

Barry Gordon	9/12/07 Date
Edwin Hosterman	Date

In accordance with 28 U.S.C. § 1746, I state under penalty of perjury that the foregoing is true and correct:

Barry Gordon	Date
Edwin Hosterman	9-12-07 Date