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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges
E. Roy Hawkens
Dr. Paul B. Abramson
Dr. Anthony Baratta

In the Matter of AMERGEN ENERGY COMPANY, LLC (License Renewal for the Oyster Creek Nuclear Generating Station)	Docket No. 50-0219-LR ASLB No. 06-844-01-LR

CITIZENS' POST-HEARING PROPOSED FINDINGS OF FACT AND CONCLUSIONS OF LAW

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TABLE OF CONTENTS

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PRELIMINARY STATEMENT

The contention in this proceeding is that the frequency of monitoring proposed by AmerGen Energy Company LLC ("AmerGen") is insufficient to ensure that the required safety margins would be maintained throughout any extended period of operation. The Board appropriately required the parties to address the contention in three stages: margin, future corrosion rate, and then monitoring frequency. In this proceeding AmerGen bears the burden of showing by a clear preponderance of the evidence that the contention is incorrect. Nuclear Information and Resource Service, Jersey Shore Nuclear Watch, Inc., Grandmothers, Mothers and More for Energy Safety, New Jersey Public Interest Research Group, New Jersey Sierra Club, and New Jersey Environmental Federation (collectively "Citizens" or "Petitioners") have shown that AmerGen has failed to meet its burden because it failed to evaluate a mid-range estimate of the most limiting margin, and it failed to systematically evaluate and take account of the uncertainty associated with the estimates for the margins it had calculated and the potential future corrosion rate. Depite warnings from the Board, AmerGen has failed to correct these critical deficiencies in its case and therefore by default the contention is correct.

Citizens have also shown that the drywell probably fails the ASME code requirement for a factor of safety of 2.0 during refueling, that it also has local areas of severe corrosion that do not meet the established requirements for such areas, and that the thinnest point on the drywell is probably thinner than permitted. In addition, the lower 95% confidence limit of the estimate of the mean thickness derived from the external ultrasonic ("UT") measurements is within 0.01 inches of the required thickness in four of ten Bays and is actually below the permitted thickness in Bay 13.

These facts mean that there is no reasonable assurance that the plant currently meets the current licensing basis ("CLB"). Indeed, there is also no reasonable assurance that public safety is being protected, as required by the Atomic Energy Act. Because there is no reasonable assurance that the plant meets the CLB now and AmerGen has no plans for repairs to the drywell shell prior to end of the currently licensed operating period, there is no reasonable assurance that the plant will meet the CLB at the start of any extended period of operation. Therefore, on the record before this Board, AmerGen's application for renewal of the operating license for the Oyster Creek Nuclear Generating Station ("Oyster Creek") should be denied.

PROPOSED FINDINGS OF FACTS

I. Background

The drywell shell is a vital part of the safety equipment at Oyster Creek. The shell provides containment in the event of an accident and structural support to many pipes that penetrate the shell. The lower portion of the shell is spherical with an inside diameter of 70 feet.

Citizens' Ex. 1 at 47.[1] It is free standing from an elevation of 8 feet 11.75 inches from the bottom. *Id.* at 40. An interior floor is at elevation 10 feet 3 inches, *id.* at 47, and concrete curbs around the edge of the floor go up to the 11 foot elevation below the downcomers and to 12 feet 3 inches elevation elsewhere. *See* Citizens' Ex. 2. In the sand bed region, the thickness of the shell wall was 1.154 inches in its uncorroded state. Citizens' Ex. 1 at 40.

II. Definition of The Sandbed Region

By definition, the Sandbed region is that portion of the drywell that formerly had sand on the outside of it. Nominally, this is from elevation 8'11" at the bottom to 12'3" at the top.[2] However, AmerGen has produced no records that document where the sand was found within the nominal region and the corrosion pattern on the exterior of the drywell within the nominal region suggests that that sand did not fill the entire nominal sandbed.[3] In fact AmerGen's own evaluations suggest that there is a transition line at approximately 11' above which the thickness of the vessel is close to the nominal wall thickness.[4]

III. Visual Observations of Corrosion In The Sandbed Region

Visual observations suggest that the transition line between the corroded sandbed and the uncorroded area above the sandbed is not horizontal, but instead varies in height around the circumference of the vessel.[5] Inspectors characterized the outside surface of the sandbed region as "rough" and full of dimples "like a golf ball." *E.g.* AmerGen Ex. 17 at 7. Bay 1 was assessed as "uniform in thickness," except for a visible thinner "bathtub ring" at the top of the sandbed region. *Id.* at 7, 12. Other Bays except Bay 13 were similar, except that some did not contain

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1 Citizens' exhibits are referred to throughout as "Citizens' Ex. __," where the blank is the exhibit number. AmerGen's and NRC Staff's exhibits are referred to as "AmerGen Ex. __" and "NRC Staff Ex. __."

2 AmerGen Ex. 40 at 10

3 Hearing Tr. 48:1-49:17

4 Citizens' Ex. 45 at 2.

5 *E.g.* AmerGen Ex. 40 at 91; Citizens' Ex. 45 at 3.

the visible bathtub ring. *E.g., id.* at 21. Photographs of the exterior of the Bay 1 in 2006 confirm that generalized corrosion has occurred and that the surface also has local undulations. AmerGen Ex. 24 at OCLR27362-64.

A memorandum dated January 28, 1993 provides a detailed visual inspection of the shell when only Bays 17 and 19 had been fully coated. Citizens' Ex. 44. The memorandum describes the surface as relatively uniform with small dimples most of which are approximately 0.5 inches in diameter. *Id.* at 1. In addition to the dimples, the inspection noted an area that is relatively uncorroded, below which were "two strips around the vessel" which were "slightly thinner than the general area." *Id.* In addition, the inspection noted less localized thin spots that were approximately a foot to 18 inches in diameter and covered around 20% of the corroded area. *Id.* at 2. Except for Bay 13, these thin spots were hard to detect because the variation in thickness is small. *Id.* In Bay 13, the thickness variations were more pronounced and the thin spots were at least one foot apart edge to edge near the downcomers and further apart toward the edges of the Bay. *Id.* The inspector noted that for Bays other than Bay 13 "due to the small differences between the 'thick' areas and the 'thin' areas . . . I could not determine visually which of the thin spots are the thinnest." *Id.*

IV. Measurements of Corrosion In The Sandbed Region

A. Methods Employed For Measuring Drywell Thickness

The available UT data fall into three categories, grids of data taken at center line 11'3" above the interior concrete floor of the drywell,[6] additional grids of data taken in two trenches that were created on the inside of the drywell in 1982 before the sand in the sandbed region was removed,[7] and data taken from the exterior of the sandbed region at various points, some of

6 E.g. AmerGen Ex. 40 at 72
7 E.g. AmerGen Ex. 40 at 122

which were visually selected to be a locally thin area.[8] However, some of the external measurements were taken in the uncorroded region above level 11'3".[9]

The grid and trench data consists mainly of 49 points taken at one inch spacing over various 6 inch by 6 inch areas. In each trench six such areas were measured. The drywell shell in the sandbed region is divided into ten odd numbered Bays numbered from 1 to 19.[10] The locations of the grids taken above the interior concrete floor were selected by a horizontal scan in accessible areas below the downcomers at elevation 11'3." NRC Staff Ex. 1 at 3-137. Grids were taken at the worst 12 of these locations in Bays 9, 11 (two areas), 13 (two areas), 15, 17 (two areas), 19 (three areas), and the frame between bays 17 and 19. Citizens' Ex. 7 at 16. At seven other locations a single horizontal line of 7 points was taken in Bays 1, 3, 5, 7, 9, 13, and 15. *Id.* Measurements were taken at the 12 grids at various times between 1986 and 1992, and then in 1992, 1994, 1996, and 2006. *Id.* at 18; AmerGen Ex. 20 at 6. Location control on the interior grids was achieved using a metal template and so should be very good. AmerGen Ex. 40 at 75.

AmerGen only measured the thicknesses in two trenches below the drywell interior floor twice, in 1986 and in 2006. AmerGen Ex. 40 at 123. The reactor operator created the two trenches in Bay 5 and 17 to a depth about equal to the sandbed floor on the outside. *Id.* at 1. These trenches enabled the operator to perform UT measurements below the interior concrete floor prior to removal of the sand from the outside. The measurements in each trench consisted of 6 49 point grids placed on top of each other. Citizens' Ex. 12 at 3.

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8 E.g. AmerGen Ex. 27 at 16

9 Hearing Tr. 196:20-194:4

10 AmerGen Ex. 40 at 109

Finally, measurements have been taken from the exterior in 1992 and 2006 at various locations. AmerGen Ex. 20 at 48. These measurements were taken as spot readings within a ground area, but location control was poor in 1992, so that some of the locations examined in 1992 could not be found in 2006. Hearing Tr. 284:6-285:2. Thus, the 1992 external data is not directly comparable with the 2006 data on a point to point basis.

B. Results From The Internal Grid Data At Elevation 11'3"

The latest grid data show that the mean thickness of the normally distributed data taken in the grids at 11'3" varied from 0.807 inches at grid 19A to 1.122 inches at grid 17A (top). AmerGen Ex. 20 at 6. The thinnest average internal grid average measured was 0.800 inches in 1992 at grid 19A. *Id.* The thinnest single point measured was 0.646 inches in grid 17D location 13 in 1994. *Id.* at 7. Furthermore, the results show that grids 11C, 13D, 17A and 17/19 straddle the vertical transition between the corroded area and the uncorroded area. Because the results from these grids did not meet the test to check that they were normally distributed at some point, they were split horizontally into different regions. *E.g., id.* at 30-31. Finally, the locations where only 7 horizontal readings were taken instead of a grid showed little corrosion. *Id.* at 8.

C. Results From The Trench Data In Bays 5 and 17

The results from the trench in Bay 5 show that the area below 11'3" was slightly more corroded than the 7 point "grid" taken in Bay 5, but that overall corrosion was minimal. AmerGen Ex. 40 at 54. In Bay 17, the average of all the trench data is generally slightly higher than the average thickness of the grid data taken in Bay 17. *Id.*

In order to examine the spatial variation of the observed corrosion in more detail, Dr. Hausler provided a detailed analysis of the Bay 17 trench data. Figure 2, attached to Citizens' Ex. 12, plots all individual 2006 measurements from the trench in Bay 17. The 6 traces represent the variation of the wall thickness in the horizontal direction while the traces themselves extend from the bottom of the trench (left hand side) to the top of the trench (right hand side). The undulations of the 6 traces, which are at times (at the same elevation) in synch and at other times out of phase, further illustrate the nature of the "golf ball type" surface described in AmerGen's documents. Where the undulations are in synch, the pit at that location extends over an area larger than just one inch in diameter. The average amplitude of the undulations in Figure 2 are of the order of 0.1 inch. Citizens' Ex. 12 at Figure 2.

Figure 2 further shows that the corrosion is most severe at the top, almost uniform in severity over most of the depth of the sandbed and again somewhat more severe at the very bottom. *Id.* The data are consistent with the visual observation that the thinnest areas are generally found towards the top of the sandbed.

D. Results From The External Data

Turning to the measurements taken from the exterior, the average of the results taken in each Bay ranged from 0.783 inches to 0.995 inches. AmerGen Ex. 16 at 5. In order of mean thickness, lowest first, Bays 11, 13, 15, 19, and 1 are the worst Bays with average thicknesses ranging from 0.783 inches to 0.802 inches. *Id.*

In terms of individual points, the lowest single measured reading in 2006 was 0.602 inches at location 7 in Bay 13. AmerGen Ex. 19 Attachment 4 at 14. However, a considerable number of points that would have been expected to be of the same magnitude or less were not measured in 2006 due to problems finding them. *E.g.,* Citizens' Ex. 61 at 13. Statistical plots of the external data for Bays 1, 13, 15 and 19 are given in Citizens' Ex. 12 at 16-17.

To facilitate better analysis of the external data Dr. Hausler produced contour plots of the data in some of the external data in some of the more corroded Bays. Citizens' Ex. 13 at 17-23 (Bays 19, 1, 13, 15, 11); Citizens Ex. 61 at 14-17 (various plots for Bays 1 and 13).

E. Evaluation of Uncertainty

In addition to deriving mid-range estimates of parameters of interest from the UT data, it is also important to consider the uncertainties. This is particularly critical where data is scarce and the issue at hand is whether a nuclear power plant meets its safety requirements. It is also important to consider two different kinds of error, systematic error, which cannot be reduced by combining data points, and random error, which reduces as the number of measurements increases.

1. Systematic Error

AmerGen has previously estimated that the uncertainty in the mean of the 49 measurements in a grid is around 0.021 inches, consisting of the standard deviation of the mean, 0.011 inches, plus 0.01 inches allowance for "instrument accuracy." Citizens'Ex. 10 at 2; NRC Staff Ex. 1 at 3-121. It appears that the latter term was actually meant to indicate that an allowance should be made for systematic error.

Confirming the importance of considering both random and systematic errors, Citizens highlighted systematic errors in the 1996 UT data. After Citizens pointed out that the 1996 means were consistently higher than the 1992 means, NRC Staff also "pointed out a definite bias in the 1996 readings because the average thicknesses . . . increased at almost all locations." SER at 3-127. The Staff also noted that "UT measurements taken from inside the drywell after 1992 show a general increase in metal thickness." NRC Staff Ex. 1 at 4-53. The Staff further expressed doubt about the validity of the 1994 and 1996 results stating "it appears that the UT measurements taken after 1992 require proper calibration." *Id.* After discussing a response by AmerGen, the NRC Staff concluded that the 1994 and 1996 readings were "anomalous." *Id.* at 4-55. Providing the magnitude of the systematic error, AmerGen calculated that the 1996 values were on average 0.015 inches thicker than those taken in 1992. Citizens' Ex. 11 at 1. Thus, an allowance of at least 0.01 inches to control for systematic error is justified.

For the external data, AmerGen has claimed that the 1992 measurements were biased high by 12 to 20 mils. Citizens' Ex. 9 at 5-2. Dr. Hausler has confirmed that the 2006 external results were around 18 mils thinner than the 1992 results, Citizens' Ex. 12 at 15, even though some of the most severely corroded areas were not remeasured in 2006. Citizens' Ex. 61 at 13. Although AmerGen has reasonably claimed that the 2006 technique was an improvement over the previous method, Citizens' Ex. 9 at 5-2, given the history it is prudent to allow for the possibility of systematic bias. The best approach to this problem is to regard the external readings as representative, even though they might actually be very slightly biased to the thin side by their method of selection.[11] This approach ensures that the required degree of conservatism is maintained.

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11 Even if all the points were selected to include the most corroded areas, which they were not, the surface roughness of the shell is at most 0.1 inches. Thus, the external points must have less than 0.05 inches of bias in comparison to the mean thickness. Although AmerGen has sought to suggest that some metal was removed through excessive grinding of some of the points, it conceded on sur-rebuttal that the grinding issue was "significantly less important" than the bias introduced by location selection. AmerGen Ex. C1 Part 3 at A17. As shown in Section IX of the Conclusions of Law, AmerGen testimony at the hearing about overgrinding was incorrect, because it was based on an erroneous interpretation of some micrometer data taken in Bay 13. Finally, and most importantly, Table 1 below shows that for Bays 17 and 19 there is good agreement between the internal grid data and the external data, showing that there is little to no inherent bias in the external measurements.

2. Random Errors

In the past, the reactor operator took account of random error by determining the lower 95% confidence limit of the parameters of interest. For example, when rapid corrosion was ongoing, AmerGen compared the current and projected lower 95% confidence limit of the means to the acceptance criteria for the uniform thickness. NRC Staff Ex. 1 at 4-60. Furthermore, AmerGen has admitted that it must determine the variance of the means of these data and compare the "mean and the variance" to the acceptance criterion. NRC Staff Ex. 1 at 4-55. Indeed, in 2006, AmerGen mistakenly stated that it had used the 95 percentile of the measured means to calculate the margin. Citizens' Ex. 35 at 13; AmerGen Ex. C1 at A8. In fact, to date AmerGen has largely failed to take account of the variance of the means when comparing them to the acceptance criteria, except prior to 1992, when corrosion was clearly ongoing. *Id.*

AmerGen has previously estimated that the uncertainty in the mean of the 49 measurements in a grid is around 0.021 inches, consisting of the standard deviation of the mean, 0.011 inches, plus 0.01 inches allowance for "instrument accuracy." Citizens' Ex. 10 at 2; NRC Staff Ex. 1 at 3-121. Confirming that AmerGen really was referring to the standard deviation in that communication, the standard deviation of the data set from the interior grid at location 19A is around 0.06 inches, AmerGen Ex. 20 at 28, 50, giving rise to a standard deviation in the mean of around 0.01 inches, because 49 points were used to calculate the mean. However, AmerGen only applied one standard deviation to derive the uncertainty. As AmerGen has admitted, the random uncertainty in the means of each of the interior grids at 95% confidence is approximately 0.02-0.03 inches. AmerGen Ex. 25. For instance, the mean of grid 19A is estimated as 0.807 at the mid-range with a lower 95% confidence interval of 0.788 inches. *Id.* Even if AmerGen were able to lump the 4 sets of data from 1992 to 2006 together, which it cannot because the 1996 results were systematically biased upwards, the 95% confidence interval is approximately plus or minus 0.005 inches to 0.01 inches. *See Id.* (taking two times the grand standard error). Finally, confirming that the uncertainty in the trench data is similar to the interior grids, and that the random variability of the mean of the measured data in the trenches should be taken into account, AmerGen subtracted 0.02 inches before it compared the mean to the appropriate acceptance criterion. *See, e.g.* AmerGen Ex. 19 at 8. In short, in the absence of correct detailed calculations of the lower 95% confidence intervals of the interior grids, one should allow for approximately plus or minus 0.03 inches of random error if the data cannot be lumped together over time and approximately plus or minus 0.01 inches of random error if the statistical tests allow multiple years of data to be combined.

For the 2006 external results, in Bay 11, the standard deviation of the data set is 0.048 inches (this includes the random error of the instrument and the variability of the surface itself). Because eight points were measured, the standard deviation of the mean is 0.017 inches.[12] This leads to a 95% confidence interval of plus or minus 0.046 inches (taking a multiple of 2.365 for seven degrees of freedom from the Student's t distribution).[13] The mean thickness is 0.793 inches. AmerGen Ex. 16 at 5. Therefore, the lower 95% confidence limit for the mean thickness is therefore 0.742 inches. Similarly, in Bay 13, the lower 95th percentile of the mean of the 2006 external data is 0.723 inches, and in Bay 1, it is 0.745 inches.

Dr. Hausler has also used repeat external measurements that were taken very close to a few a single points to derive an estimate of the uncertainty of the measurement technique separately from the variation in the thickness of the surface. Citizens' Ex. 38 at 3. He showed that the estimated uncertainty increased as the wall thickness got smaller. *Id.* at Table 1. The standard deviation of the measurements ranged from 0.017 inches to 0.029 inches. *Id.* Dr.

12 *See* Citizens' Ex. 38 at 6.

13 *See* AmerGen Ex. C Part 3 at A14.

Hausler roughly estimated the 95% confidence limits as approximately 0.06 inches. *Id.* at 6. However, because this standard deviation is only estimated from 3 readings, the Student's t distribution suggests that the 95% confidence limits are given by around 4 times the standard deviation. Thus, the 95% confidence interval for the single point external measurements is actually approximately plus or minus 0.1 inches.

V. Established Acceptance Criteria

AmerGen has established that, on average, each Bay must be thicker than 0.736 inches and that no area should be thinner than 0.49 inches. In addition, AmerGen has recognized the need for a local acceptance criterion to control the extent of contiguous areas that are less than 0.736 inches. However, AmerGen's practice regarding this criterion has been inconsistent and it is unclear whether the local area acceptance criterion was incorporated into the CLB. Therefore, the Board must determine which of the local area criteria used is the most appropriate.

A. The Local Area Acceptance Criterion

Until recently, the reactor operator consistently used the local area acceptance criterion to accept areas that were thinner than 0.736 inches, larger than 2 inches in diameter, but less than one square foot in extent. For example, in March of 2006, Mr. Tamburro, AmerGen's employee who has authored many of the reports accepting the measurements, wrote that calculation C-1302-187-5320-024 "uses a Local Wall Acceptance Criteria . . . [which] can be applied to a small area (less than *12 by 12*), which are less than 0.736 inches thick so long as the small area is at least 0.536 inches thick." Citizens' Ex. 3 at 2 (emphasis added).

Ultimately, the NRC Staff also adopted this approach in the SER by quoting AmerGen's Request for Additional Information ("RAI") response of April 7, 2006 stating that:

> UT measurements identified isolated, localized areas where the drywell shell thickness is less than 0.736 inches. Acceptance for these areas was based on engineering calculation C-1302-187-

> 5320-024. The calculation uses a "Local Wall Acceptance Criteria." This criterion can be applied to small areas (less than *12" by 12"*) which are less than 0.736" thick so long as the small *12" by 12"* area is at least 0.536 inches thick.

NRC Staff Ex. 1 at 4-56 (emphasis added). After a discussion of buckling issues, the quoted document applied that criterion, stating that the total area thinner than 0.736 inches was 0.68 sq. ft, and thus less than one square foot. *Id.* at 4-58. AmerGen continued "these local areas [that are less than 0.736 inches] could be continuous, provided their total area did not exceed one square foot *and* their average thickness was greater than . . . [0.536 inches or 0.636 inches]." *Id.* (emphasis added). Thus, prior to April 2006 AmerGen documents state that the local acceptance criterion can only be applied to small areas that are less than one square foot in area and NRC Staff adopted this approach in the SER.

Mr. Tamburro's memorandum of March 2006, expressed concerns that calculation C-1302-187-5320-024 was deficient, even though it was the only safety related calculation demonstrating that the drywell shell in the sandbed region met safety requirements. Citizens' Ex. 3 at 1. Mr. Tamburro himself noted that when a nine square foot area thinner than 0.736 inches was modeled by General Electric, the buckling capacity of the shell decreased by 9.5%. *Id.* at 2. Thus, Mr. Tamburro recommended that calculation C-1302-187-5320-024 be revised to ensure that "a 9.5% reduction in buckling load still meets code allowables." *Id.* at 4. He also noted numerous other deficiencies, the most glaring of which was that four engineers with at least 15 years experience had reviewed the calculation and none could understand how the calculation method and acceptance criteria demonstrated the conclusions of the calculations. *Id.* at 1.

Revision 1 of calculation C-1302-187-5320-024, dated September 21, 2006, did not take the path recommended by Mr. Tamburro. Instead, the authors adopted a more stringent local area acceptance criterion. In a summary table on page 2, the revised calculation applied a local thickness criterion of 0.636 inches to areas that are less than 12 inches square. AmerGen Ex. 17 at 5. The calculation also applies this criterion in the text. *E.g., id.* at 17, 36. However, while it never clearly states the origin of the criterion employed, it does state that modeling done by General Electric ("GE") used tapered shapes with minimum thickness 0.536 inches and 0.636 inches. *Id.* at 10-11. Thus, although the document authors were aware of the approach previously taken, which was to compare the measurements over a 12 by 12 inch area to 0.536 inches, they took a more conservative approach by using 0.636 inches as the allowable thickness over a one square foot area.

In December 2006, AmerGen applied the following local area acceptance criterion: "if an area is thinner than 0.736" thick, then that area shall be greater than 0.693 inches thick and shall be no larger than 6" by 6" wide." Calculation C-1302-187-E310-041, AmerGen Ex. 20 at 11. This is yet more stringent than the criterion previously put forward by AmerGen. More recently, for the purpose of summary disposition, AmerGen alleged that the "local area average thickness" criterion is 0.536 inches for a 1 square foot area, but the total area that can be thinner than 0.736 inches is *nine square feet*. Affidavit of Peter Tamburro, dated March 26, 2007, Citizens' Ex. 6 at ¶¶ 20-23 (emphasis added). This 2007 criterion is considerably less stringent than that used in December 2006. Furthermore, Mr. Tamburro failed to provide justification of why a 9.5% reduction in buckling capacity would be acceptable, contrary to his March 2006 recommendations.

Most recently, Revision 2 of calculation C-1302-187-5320-024, dated May 18, 2007, authored by Mr. Tamburro, discusses yet another less stringent criterion. Amergen Ex. 16 at 10-11. The report requires the UT results to either meet the requirements for general wall thickness given in Section 6.1, or the requirements for local areas that are less than 36 inches by 36 inches in extent given in Section 6.2. *Id.* at 10. The acceptance criterion for general wall thickness requires the average thickness of a 36 inch by 36 inch area to be greater than 0.736 inches. *Id.* If an area fails Section 6.1, it must meet Section 6.2 regarding local wall thickness. In turn, the local wall thickness criterion requires areas that "an evaluated area for local buckling shall not be larger than 36" by 36" wide." *Id.* at 10, Figure 6.2-1. In addition, the 12 inch by 12 inch center of the evaluated area must be thicker than 0.636 inches on average, and the one foot long transition area surrounding the thinnest central area must be "on average thicker than the transition from 0.636 inches to 0.736 inches." *Id.*

In summary, the SER and AmerGen documents show that AmerGen first established an acceptance criterion that required contiguous areas thinner than 0.736 inches to be smaller than one square foot in extent and thicker than 0.536 inches on average. This was accepted by NRC Staff in the SER. Thereafter, in response to internal concerns, AmerGen made the criterion more stringent requiring areas thinner than 0.736 inches to be smaller than one square foot and thicker than 0.636 inches. In December 2006, AmerGen then used a still more stringent criterion: "if an area is thinner than 0.736" thick, then that area shall be greater than 0.693 inches thick and shall be no larger than 6" by 6" wide." Calculation C-1302-187-E310-041, AmerGen Ex. 20 at 11. In 2007, AmerGen then deviated from past practice by allowing contiguous areas of up to nine square feet in extent to be thinner than 0.736 inches on average.

Another major issue with the local area acceptance criterion is that it assumes that the corroded areas are trays with idealized geometries, which is obviously unrealistic. The idea behind the trays was that if all the corrosion present could be encompassed within a tray, then the reduction in the factor of safety would be less than predicted by the GE sensitivity analysis. *See*

AmerGen Ex. 39. This study modeled the effect of a 3 foot by 3 foot cut out area straddling two Bays that was present in alternate Bays. *Id.* at Fig. 1a; NRC Staff Ex. C1 at A.48. The model assumed that the tray had a flat center area that was one square foot in extent and a one foot long transition zone outside of the center one square foot. *Id.* When the center of the tray was 0.636 inches, the factor of safety reduced by 3.5% and when the center of the tray was 0.536 inches, the factor of safety reduced by 9.5%. *Id.*

AmerGen has alleged that this model was incorporated into the CLB. Citizens dispute this and believe that the CLB actually requires local areas thinner than 0.736 inches to be "highly localized." This issue is discussed in the legal argument below at Section V of the Conclusions of Law. However, for the purposes of the factual discussion, Citizens assume *arguendo* two alternative local area acceptance criteria. The first, termed LAC1, requires contiguous areas thinner than 0.736 inches in each Bay to be fully within the full dimensions of tray shape modeled by GE (i.e. a 3 feet by 3 feet tray). The second, termed LAC2, requires contiguous areas thinner than 0.736 inches in each Bay to be fully within half the dimensions of tray shape modeled by GE (i.e. a 3 feet by 1.5 feet tray).

VI. Current Margins Above Acceptance Criteria

A. Comparison Of Estimates Of Mean Thickness

If the purpose of the measured data is to characterize the current state of the drywell, each of the three available data sets has different advantages and disadvantages. The interior grid data at elevation 11'3" allows a reasonably precise estimate of the average thickness of the measured areas to be estimated because 49 measurements normally go into the estimate of that mean. However, this data set has the major disadvantage that it covers a very limited spatial area. In particular, it does not cover the area lower than 11', which in many Bays is the line at which the corrosion starts. Obviously, if the measurement is not in the corroded area, it cannot serve as a useful estimate of the extent of corrosion. As a corollary, where a Bay is corroded between 11' and 11'6", the interior grid may give a reasonable estimate of the expected mean thickness of a Bay if the area within that Bay at that elevation is corroded to a similar extent as the rest of the Bay. Finally, the trench data provide much improved vertical spatial coverage compared to the grid data at 11'3" and a more precise estimate of the mean thickness. However, because the trench data only measures a 6 inch wide slide of a 160 inch wide Bay, there is a danger of missing local areas of severe corrosion.

The limitations of the internal grid data are best illustrated by considering the results for Bay 1, where the the 7 point sweep at 11'3" gave a mean thickness of 1.122 inches. AmerGen Ex. 20 at 8. In contrast, the mean of the external measurements is 0.802 inches, even including two points (14 and 15) that were deliberately biased high because they were taken in the uncorroded region. AmerGen Ex. 16 at 5, 20. Eliminating those points would lower the mean thickness estimate in the corroded area to 0.767 inches. *See* AmerGen Ex. 19 Attachment 4 at 2.

AmerGen has recognized this problem, but has tried to evade its consequence. For example, AmerGen has suggested that the best mean thickness estimate for Bay 1 should be derived from a grid taken in Bay 19 because the Bay 19 internal grid better represents Bay 1 than the Bay 1 internal sweep. Citizens' Ex. 45 at 3. This logic exhibits almost willful blindness. Bay 19 exhibits a different corrosion pattern to Bay 1 and in any event considerable Bay to Bay variation has been observed. Furthermore, 23 external measurements were taken in Bay 1, more than in any other Bay. AmerGen Ex. 19 Attachment 4 at 2. Thus, it makes far more sense to estimate the thickness of the corroded area of Bay 1 using the external measurements taken in Bay 1, rather than grid results taken at a higher elevation in Bay 19. Partially confirming this view, in early February 2007, AmerGen decided to base its thickness estimates on the external measurements. Citizens Ex. 65. Inexplicably, in late February AmerGen changed its mind and decided not to use the external measurements to characterize the mean thickness of the sandbed region. Citizens Ex. 46. This was a decision that cannot have been driven by considerations of scientific rigor. Basic principles indicate that in a data sparse situation, one must utilize as much of the data as possible, not ignore a whole data set. Citizens' Ex. 61 at 3.

AmerGen has stated "Where the internal grid measurements were clearly not representative of the corrosion of the shell in that bay, representative measurements from adjacent Bays were utilized to provide a representative general thickness." Citizens' Ex. 45 at 3. AmerGen's evaluation of representative average thickness shows that it believes that the internal grids in Bays 1, 3, 7, and 15 do not properly represent the average thickness in those Bays. Citizens' Ex. 45 at 5. Thus, for these Bays at least, the average thickness of the external measurement in each Bay is more representative than the grid measurements from adjacent Bays.

At the hearing AmerGen's statistical expert, Dr. Harlow suggested that a good method of assessing the accuracy of the external data would be to compare it with the internal data. Hearing Tr. 366:11-18. To provide such a comparison, Table 1 summarizes the estimates for the mean thickness of each Bay from each data set, including the uncertainty attached to each estimate. It shows that in Bays 5 and 17, there are three data sets available to estimate the mean thickness of the Bay. In contrast in Bays 1, 3, 7, and 15, only the external data set is available to estimate the mean thickness.

Table 1 shows that the discrepancies between these data sets have been much exaggerated. For example in Bay 19, there is agreement between the internal grid data and the external measurements within the estimated margins of error. Similar agreement is observed in Bay 17, although the trench results come in significantly higher than the internal girds, but only slightly higher than the external data. In Bay 5, the external data agrees with the trench data within the 95% confidence interval, but the grid data come in slightly higher than either the trench data or the external data. Comparison of the data sets for Bays 5, 17 and 19 show that the external data does not have any significant systematic bias and, although the data are less precise, they have a wider spatial coverage. Thus, the external data provide at least as good an estimate of the mean thickness of each Bay as the other data sets. It is important to note that there is no evidence of significant bias in the external measurements, illustrating that all the sound and fury about bias in one direction or another ends up signifying nothing because any deliberate bias induced in the external data by sample selection and any overgrinding of a few points was small and was offset by the selection of some points at which little corrosion had occurred.[14]

For Bays 9, 11, and 13, it appears that there are valid internal measurements, but there is some disagreement between the estimates of the average thickness derived from each data set, with the external data providing a significantly lower estimate than the grid data. For Bay 13 this is not surprising because the pattern of corrosion is not the same as was observed in most of the other bays and was very variable. In particular, the most corroded area appears to slope up to the left of the Bay and the plots produced by Dr. Hausler illustrate that the worst corrosion in 2006 was observed towards the left center region of the sandbed. Citizens' Ex. 61 at 17. It is therefore not surprising that the average of interior grids does not agree with the average of the external measurements.

[14] Footnote 11, *supra*, summarizes why the arguments about grinding and selection bias put forward by AmerGen are overblown.

Table 1 Comparison of Available Estimates Of Mean Thickness (in Mils)

	External Results			Internal Results				Trench Results	
Bay	2006 Average	95% confidence interval	Lower 95%	2006 Average	95% confidence interval	Lower 95%	Allow for 0.01 systematic error	2006 Ave	95% conf interval
1	802	58	743	*					
3	865	71	794	*					
5	960	32	928	1185	5	1180	1170	1074	5
7	995	43	951	*					
9	905	62	845	1074	28	1046	1034		
11	783	40	743	860	18	842	832		
13	786	60	726	907	18	889	879		
15	788	43	744	*					
17	892	64	826	863	14	849	839	963	10
19	801	58	743	826	12	814	804		

Notes Regarding Table 1

* AmerGen's assessment (Citizens Ex. 45) states internal grids are not representative for these Bays.
2006 external data average taken from AmerGen Ex. 16 at 5.
95% confidence intervals for external data calculated using methods described in AmerGen Exhibit C Part 3 and standard tables of the Student's t distribution.
Internal grid averages taken from Citizens' Ex. 45 at 5, above 11'0" column.
95% confidence intervals for internal grids at 11' estimated from AmerGen Ex. 25. *E.g.* Where two 49 point grids are averaged the interval was approximated by dividing the largest interval stated by the square root of 2.
Trench data and uncertainty taken from AmerGen Ex. 40 at 123, except that the mean for Bay 17 is taken from AmerGen Ex. 19 at 6.

For Bay 9, the disagreement is difficult to resolve, but this is not critical because this Bay does not contain the limiting margin. Finally, for Bay 11, the mean thickness estimate derived from internal data should be 0.825 inches from grid 11A because grid 11C exhibited some stratification. AmerGen Ex. 20 at 6. The mean thickness estimate derived from the external measurements is 0.783 inches. AmerGen Ex. 16 at 5. As Table 1 shows, this difference is within the margin of error.

To further compare these results, Figure 5, also attached to Citizens' Ex. 61, compares the average remaining wall thickness from trench measurements in Bay 17 (averaged over the horizontal direction) with the average of the 6 by 6 grid measurement from the inside. Also graphed in this figure are the averages of the external measurements for the three zones for which data are reported.[15] At the hearing there was some discussion of the vertical accuracy of this plot, but the correction suggested (moving the origin of the figure up by 20 inches, Hearing Tr. 82:3-11) is incorrect. The trench data show that the corrosion in this Bay is at its worse around 3 feet above the base of the trench. Citizens' Ex. 61 at Figure 5. Because the bottom of the trench was at elevation 9'3," AmerGen Ex. 19 at 1, that means the corrosion extends to elevation 12'3" and is actually worse between 11' and 12'3". Thus, the grid results are shown correctly starting at elevation 11', 21 inches above the bottom of the trench. This figure illustrates that it is not possible to over generalize the corrosion in the sandbed region. While corrosion above 11' is generally smaller, that is obviously not always the case. Furthermore, in this Bay corrosion is worse at both the extreme top and the extreme bottom of the sandbed.

Finally, for grids 9, 11, and 13, it probably would have been ideal to produce weighted averages of all the data. This could be accomplished by doing contour plots of all the data and then averaging the areas produced by the contours. Unfortunately, Dr. Hausler was unable to do this because he did not have the internal and external data points in a comparable coordinate system. Citzens' Ex. 61 at A8. For Bay 13, the external grids appear to confirm that the line of corrosion is sloped upwards from left to right. AmerGen Ex. 44 Bay 13 Plot. Furthermore, the measurements from grid 13A (0.846 inches) agrees reasonably well with the exterior measurement at 13A (0.814 inches), Citizen's Ex. 61 at 17, meaning that the addition of the those points would make little difference to Dr. Hausler's extrapolated plot for Bay 13. Citizen's Ex. 61 at 17. The same plot shows a very thin area at 0, -30, where there is no grid

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[15] The zones are: Zone 1 < 9'4" wetted surface; Zone 2 9'4" to 10'3" floor; Zone 3 10'3" to 12'3" curb; Zone 4 >12'4" above curb. Citizens' Ex. 9 at Figure 4-6

measurement. Grid 13D is in the area projected to be thicker. *Id.* Finally, grid 13C might have the effect of extending the tongue of thicker material that comes in from the right and reducing the area below 0.736 inches to a small extent. However, even adding in these grids would not change the essence of the prediction, although they would push up the estimate of mean thickness to an unknown extent.

B. Mid Range Estimates of Margins Above The Mean Thickness Acceptance Criterion

The acceptance criterion for the mean values is 0.736 inches. According to AmerGen the most limiting margin above this criterion was 0.064 inches. *E.g.* AmerGen Ex. 40 at 94-95. However, using the external measurements, the mid-range estimate of the margin above this criterion in each Bay ranges from 0.047 inches in Bay 11 to 0.259 inches in Bay 7. *See, e.g.* Table 1, *supra*. Apart from Bay 11, other Bays with mid-range estimates of margins that are less than 0.1 inches are Bay 1, 0.065 inches, Bay 13, 0.05 inches, Bay 15, 0.052 inches, and Bay 19, 0.065 inches. *Id.*

C. Lower 95% Confidence Interval Estimates of Margins Above The Mean Thickness Acceptance Criterion

The lowest estimated mean from the 2006 interior grids is 0.807 at grid 19A. AmerGen Ex. 25. According to AmerGen the lower 95% confidence limit is 0.788 inches. *Id.* In addition, Citizens have shown above that an allowance of 0.01 for possible systematic error is justified. Thus, taking account of uncertainty, the estimated limiting margin at the 95% confidence level from the 2006 results is 0.778 inches minus 0.736 inches, which equals 0.042 inches.

If all four averages from the same grid could be combined, the uncertainty would be reduced to approximately plus or minus 0.01 inches of random error at the lower 95% confidence limit plus an allowance of 0.01 for systematic error. This approach would yield an established limiting margin of around 0.052 inches. However, the 1994 and 1996 results are known to have suffered from poor calibration and the 1996 results contain a systematic bias. Thus, it would not be good practice to utilize these results. If the 1992 and 2006 results for grid 19A were combined, the average would be 0.804 inches and the error would reduce from approximately 0.02 to approximately 0.014 (0.02 times the square root of 49 divided by the square root of 100). The established margin at the 95% confidence level would then be (0.804 minus 0.014 (allowance for random error) minus 0.01 inches (allowance for systematic error)) minus 0.736, which equals 0.780 minus 0.736, which equals 0.044 inches.

Turning to the exterior measurements, the lowest lower 95% confidence limit of the means derived from the external data is 0.726 inches in Bay 13. Table 1, *supra.* The mean thickness of Bays 1, 11, and 19 is estimated at 0.743 inches at the lower 95% confidence limit. *Id.* Thus, AmerGen has not established that it meets the mean thickness acceptance criterion in Bay 13 within the 95% confidence limits of the estimated mean thickness. For three other Bays the established margin at the lower 95% confidence limit is 0.007 inches.

D. Margins For Very Local Areas Less Than Two Inches In Diameter

AmerGen's testimony merely states that the thinnest local measurement is 0.602 inches and uses this to compare with the acceptance criterion of 0.49 inches implying margin estimate of 0.13 inches. AmerGen Initial Testimony Part 3 at A.5, A.32. However, at the hearing AmerGen admitted that this was not an adequate approach when it stated "in all fairness there is nothing in our assertions that say that the engineers and the 19 technicians in there absolutely identified the 20 thinnest locations . . . there is no guarantee that they absolutely found the thinnest." Hearing Tr. 328:17-24. Furthermore, AmerGen also failed to consider the uncertainty of the single point measurements. Thus two uncertainties make AmerGen's approach to estimating the margin about the 0.49 inch pressure criterion inadequate: the uncertainty in the measurement and the likelihood that the thinnest spot on the drywell was not actually measured.

One way to approach this problem to look at the lower 95% confidence limits on the results that have been obtained. Most obviously, if the 95% confidence interval for the individual points is plus or minus 0.1 inches, the established margin at 95% confidence would only be 0.602 minus 0.1 minus 0.49, which equals 0.03 inches. Slightly more subtly, another way of approaching this issue is to look at the statistics for the external data, divided into zones, which correspond to the interior wetted surface, the elevations beneath the interior floor, the elevations above the floor but below the curb, and the elevations above the interior curb. Ex. 9 at Figure 4-6. A statistical analyst for AmerGen suggested this approach. *Id.* Adopting this method, Dr. Hausler has shown that in Bay 1 the lower 95% confidence interval for Zone 3, which is above the interior floor, but below the curb, is 0.456 inches, considerably less than 0.49 inches. Citizens' Ex. 12 at 14.

Qualitatively, the view that some extremely thin points may not have been measured is reinforced by AmerGen's failure to locate certain thin points in 2006. In particular, point 2 in Bay 13 was measured at 0.615 inches in 1992, AmerGen Ex. 18 at 92, but the value of this measurement was wrongly recorded in various subsequent AmerGen documents and no reading at this point was taken in 2006. AmerGen Ex. 19 Attachment 4 at 14. Statistically, the rigorous way to determine the most likely thinnest point from a set of readings is to use extreme value statistics. Hearing Tr. 392:10-14, 395:3-12. Dr. Hausler used the Weibull distribution to show that if 37 measurements had been taken in Bay 13, it is likely that a point thinner than 0.49 inches, would have been observed. Hearing Tr. 395:13-13; 549:11-551:8, Citizens' Ex. 38 at 7-8 & Figure 4.

At the hearing, initially both AmerGen and NRC Staff complained that Dr. Hausler had not given sufficient details of his methodology to allow them to comment meaningfully. Hearing Tr. 390:20-391:3; 395:6-7. Dr. Hausler then showed the experts the spreadsheet he had used to estimate the extreme values off the record and then subsequently on the record explained in detail what he had done. Hearing Tr. 552:7-13; 543:19-24. After hearing the explanation neither AmerGen nor NRC Staff had any comment. Hearing Tr. 551:19-553:4. Furthermore, AmerGen's statistician even admitted he had thought extreme value statistics could be applied to the data and he had actually carried out such an analysis, but did not generate a report. Hearing Tr. 363:14-365:3. AmerGen has provided no written evidence regarding that data analysis. Thus, the evidence indicates that Dr. Hausler's analysis is correct and many academic papers confirm that Dr. Hausler's statistical technique is valid. *E.g.* AmerGen Ex. 57 at 24/6, T. Shibata, *Statistical and Stochastic Approaches to Localized Corrosion,* W. R. Whitney Award Lecture, Corrosion 52 (11) 813, 1996.

E. Margins For Local Areas Larger Than Two Inches In Diameter

The margins for the local area criterion are undoubtedly the most difficult to evaluate, because the uncertainty is high. The parties agree the external UT measurements must be used to compare with the local area acceptance criterion. Hearing Tr. 357:25-358:4; Citizens Ex. C1 at 5. At the hearing, AmerGen's statistical expert also clarified that the external results could be averaged or combined meaningfully, provided one took account of any bias. Hearing Tr. 363:3-10. Because the bias in the external results has been shown to be negligibly small, it is therefore valid to compare the external results with the local area acceptance criterion and derive a margin and an estimate of the uncertainty of that margin. Both Mr. Tamburro for AmerGen and Dr. Hausler for Citizens have combined the external reading using averaging techniques. Indeed, Dr.

Hausler has found that the method used by Mr. Tamburro is merely a very crude approximation of the contouring method used by Dr. Hausler. Citizens' Ex. C1 at A2; Citizens Ex. 61.

1. Need For Quantitative Estimates Of Margin Above The Local Area Acceptance Criterion

AmerGen has stated that the local area criterion should be regarded as "volumetric,", but has candidly admitted it cannot estimate the volume loss over localized areas of the drywell shell. Hearing Tr. 209:17-210:11. Although Dr. Hausler testified that a volume could be calculated, Hearing Tr. 211:22-212:16, that would compound the uncertainties in the data and would lead to a very uncertain estimate. Therefore, having a "volumetric" acceptance criterion would be pointless because the external measurements cannot be meaningfully compared to such a criterion. Thus, the local area acceptance criterion is best regarded as placing limits on the extent of areas thinner than certain critical values. For example, Citizens are assuming *arguendo* that LAC1 requires local areas that are thinner than 0.736 inches to be enclosed by a cut out tray that has a 1 foot by 1 foot area at the center that is 0.536" inches thick at the bottom and then transitions back to 0.736 inches over a linear foot around the center area. *See* AmerGen Ex. 11. Because the actual areas of corrosion are not shaped to idealized geometries, the most logical interpretation of LAC1 is that any area thinner than 0.736 inches must be enclosed by a 3 feet by 3 feet square and any area thinner than 0.536 inches must be enclosed by 1 foot by 1 foot square. LAC2 requires the same areas to be enclosed within a 1.5 feet by 3 feet square and a 0.5 feet by 1 foot square, respectively.

AmerGen has now testified that, although it can determine whether there is compliance with the local area acceptance criterion,[16] it cannot calculate the numerical margin above two of

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[16] This in itself shows that the criterion cannot be volumetric, because AmerGen has said it is unable to estimate the volume of corrosion.

its alleged thickness requirements for the thinnest 12 inch by 12 inch area on the shell and the thinnest 3 feet by 3 feet area on the shell. AmerGen Ex. C Part 3 at A38. In addition, it has testified it cannot calculate the margin above the alleged requirement that the largest contiguous area that is thinner than 0.736 inches is less than 3 feet by 3 feet. *Id.*

This approach is straightforwardly inadequate. As discussed below, even AmerGen's analysis shows, at best, marginal compliance with LAC1 and non-compliance with LAC2. Because it is likely that the margin above LAC1 would be smaller than the margin above the mean acceptance criterion for the best estimate, this margin should be used as the basis for the calculation of the necessary monitoring frequency. Thus, AmerGen's professed inability to estimate this margin means that it cannot select an appropriate UT monitoring frequency.

2. AmerGen's Assessment Of Existing Local Areas Thinner Than 0.736 Inches

AmerGen evaluated the 2006 external results in revision 2 of Calculation C-1302-187-5320-024. AmerGen Ex. 16. The new revision shows that AmerGen now estimates that over 20 square feet of the drywell shell in the sandbed region is thinner than 0.736 inches. *Id.* at 29, 64, 79, 89. This contrasts with the estimate contained in the previous version of the calculation that only 0.68 square feet of the drywell shell was thinner than 0.736 inches. Calculation C-1302-187-5320-024, Rev. 1, AmerGen Ex. 17 at 13. The expansion of the critically thin areas is caused in part by the reduction in measured thickness in 2006 and in part by a change of estimation technique.

The latest revision to Calculation C-1302-187-5320-024 also nominally shows a 9 square foot area in Bay 1 that is 0.696 inches thick. Calculation C-1302-187-5320-024, Rev. 2, AmerGen Ex. 16 at 26, 34. Looking at Figure 1-2 on page 29, there is no data just outside the boundaries of the 36 inch by 36 inch box used for the assessment. *Id.* at 29. In fact, this box could have been drawn considerably larger without including any more measurement points. In fact, close analysis of this Figure by Dr. Hausler has shown that the area shown on the Figure is actually approximately 36 inches by 42 inches. Citizens Ex. C1 at A7. Thus, based on AmerGen's own estimates, it is likely that an area exists in Bay 1 that is thinner than 0.736 inches but goes beyond the boundaries of the 3 feet by 3 feet square defined by LAC1.

Furthermore, in Bay19, AmerGen's assessment of the 2006 results shows a 3 foot by 3 foot area that is less than 0.736 inches in average thickness. AmerGen Ex. 16 at 92-93. Unless the sides of these areas are vertical, which is highly unlikely, AmerGen's own assessment shows that the severely corroded area in Bay 19 is also larger than 3 feet by 3 feet. Thus, according AmerGen's own assessment, Bays 1 and 19 probably fail even LAC1, which is the least stringent local area acceptance criterion. Furthermore, it appears that Bay 13 also contains a similar severely corroded area that is larger than 3 feet by 3 feet. AmerGen's assessment does not reach such a conclusion about Bay 13, because it makes use of a correction that is incorrect. Citizens' Ex. 39 at 11-14. A 3 feet by 3 feet area is shown in Bay 13 on Figure 13-2. AmerGen Ex. 16 at 64. By inspection, this area contains points 6, 7, 8, 11, 12, 15, and 16. *Compare id. with* Citizens' Ex. 61 at 16 (Figure 3). These points have values of 0.658 inches, 0.602 inches, 0.704 inches, 0.699 inches, 0.885 inches, 0.666 inches, and 0.814 inches, respectively. AmerGen Ex. 16 at 56-57. Averaging these points yields an average thickness of 0.718 inches. Thus, the raw UT data indicate that Bay 13 also contains an area thinner than 0.736 inches that is larger than 3 feet by 3 feet. In short, because the areas corroded to thinner than 0.736 inches in Bays 1, 13, and 19 are probably not enveloped by the trays of corrosion assumed by LAC1 and LAC2, they cannot be accepted.

In addition, the square that AmerGen has used is not the most critical geometry. A long narrow bathtub ring was noted visually. The measurements taken confirm that visual observation. For example, in Bay 1, the diagram taken from a previous revision of Calculation C-1302-187-5320-024. shows a bathtub ring that encompasses points 1 to 5, 10 to 13, and 20 to 21. AmerGen Ex. 16 at 28. This is an area that is approximately 78 inches by 10 inches or approximately 6.5 feet by 1 foot. *Compare id. with* Citizens Ex. 61 at 14 (Figure 1). Averaging the points encompassed by this area gives an average thickness of 0.734 inches. Because this area is way beyond linear dimensions permitted by LAC1, it cannot be accepted. Mr Tamburro identified a different area for the bathrub ring in Bay 1, AmerGen Ex. 16 at 29, but the essential problem remains the same. The area selected is approximately 5 feet by 1 foot and has an average thickness of 0.705 inches. Citizens Ex. 61 at 14 (Figure 1). As Judge Abramson noted in the hearing, it could be further extended to include points 2, 11 and 21, Hearing Tr. 242:18-24, which would produce an area that is approximately 6 feet by 1 foot and also has an average thickness of approximately 0.705 inches. *See* Citizens Ex. 61 at 14 (Figure 1). This is beyond the spatial envelope defined by LAC1. Similarly in Bay 13, the area defined by Mr. Tamburro as the bathtub ring is approximately 4.5 feet by 1 foot with an average thickness of 0.710 inches. Citizens Ex. 61 at 16 (Figure 3). This is similarly beyond the spatial envelope of LAC1.

In terms of the thickness profile AmerGen has shown that, at best, the margins are probably extremely narrow. *E.g.*, AmerGen Ex. 16 at 32, 97. In fact, if the uncorrected measurements are used, the thickness profile would go outside the tray profile in Bay 1. *See* AmerGen Ex. 16 at 22, 32 (uncorrected UT result for location 1 is 0.710 inches, which would be below required profile). Finally, the methods AmerGen has used to evaluate the size of the severely corroded areas were not established in the SER, because NRC Staff have stated that they did not consider AmerGen Ex. 16 during their review of license renewal. NRC Staff Ex. B at A.9; Hearing Tr. 140:18-20 and 145:7-10.

3. Dr. Hausler's Assessment Of Existing Local Areas Thinner Than 0.736 Inches

To take a more systematic approach than merely drawing idealized rectilinear shapes around data points, Dr. Hausler applied a contouring program to produce unbiased interpolations of the data without making an assumptions abut the shape of the corroded areas. This approach estimated that Bay 1 has two areas thinner than 0.736 inches. Citizens' Ex. 13 at Figure 3; Citizens' Ex. 61 at 14 & 15. The first area corresponds to the bathtub ring and is approximately 7.5 feet by 0.75 feet. Citizens' Ex. 61 at 14. The second is a smaller area that is around 6 inches by 10 inches in extent. *Id.* The actual extent of the first area could be considerably larger because it is not bounded by the data on the left hand side. *Id.* To try to provide some view on how far the first area could extend, Dr. Hausler then used an extrapolation to project the beyond the measured area. Citizens Ex. 61 at 4. This approach confirmed that the thin region appears to get wider and deeper as it moves towards the edge of Bay 1. Citizens' Ex. 61 at 15. Thus, the contouring work carried out by Dr. Hausler confirms that the data indicate the presence of a long thin bathtub ring that is not bounded by the tray shape assumed in LAC1.

Similarly, the measurements in Bay 13 show that on the top left, there could be a rectangular area which could be as large as 28 inches high by 84 inches wide (16.3 square feet) that has an average thickness of 0.692 inches. *See* Calculation C-1302-187-5320-024, Rev. 2, AmerGen Ex. 16 at 64; Citizens' Ex. 61 at 16 (Figure 3). The contouring program confirmed these findings. The best fit for the data show an area thinner than 0.736 inches that is around 28 inches by 16 inches square feet in extent, but is not bounded by the data. Citizens' Ex. 13 at Figures 4 and 5 (the thin area on the upper right of Bay 13 shown in in 1992 is not shown on the

2006 plot because AmerGen failed to repeat the measurement at point 2, which was 0.615 thick in 1992); Citizens' Ex. 61 at 16 (Figure 3) (the thin area is now included through the use of extrapolation). When Dr. Hausler extended this plot using the extrapolation technique, the area that is less than 0.736 inches expanded to 80 inches wide with a maximum height of approximately 30 inches on the lower left, sloping up to a minimum height on the right of approximately 6 inches. Citizens' Ex. 61 at 17 (Figure 4). The total area less than 0.725 inches on this plot is approximately 12 square feet. *Id.*

Finally, Bay 19 has an elongated area that is thinner than 0.736 inches, but is very poorly defined spatially. Calculation C-1302-187-5320-024, Rev. 2, Ex. 33 (AmerGen Ex. 16) at 95; Citizens' Ex. 13 at Figure 1. The extent of this area could range from around 3 square feet to more than 9 square feet. Citizens' Ex. 13 at 6.

4. Uncertainty In The Estimates Of Areas Less Than 0.736 Inches Thick

AmerGen and Citizens agree that the characterization of the severely corroded areas is highly uncertain. Citizens' Ex. 13 at 4-6; Citizens Ex. C1 at A28; AmerGen Ex. C at A31. This is partly because each individual UT measurement is uncertain to around plus or minus 0.1 inches. In addition, the area estimates are also highly uncertain because large areas of the sandbed have not been measured at all. Citizens Ex. C1 at A28. This means that the areas thinner than certain thresholds cannot be accurately estimated numerically because those areas are often not bounded by the data points. *See, e.g.,* AmerGen Ex. 16 at 29, 64, 95 (showing a lack of points to define the placement of the evaluation shapes). Thus, while Dr. Hausler has provided the best possible interpretation of the external data, AmerGen's complaints that this analysis is uncertain are correct, although AmerGen's simultaneous speculation that there is a significant bias in the external data is incorrect. AmerGen Ex. C at A31. However, the uncertainty does not mean that the situation is probably better than the contour plots show. In fact, the situation could be substantially worse.

For example, Figure 1-5 of Calculation C-1302-187-5320-024, Rev. 2 (AmerGen Ex. 16) applies the latest version of the local area acceptance criterion to the thickness measurements taken in the transition zone from the thinnest area and shows that, according to AmerGen, the margin at locations 1 and 5 in Bay 1 is around 0.01 inches. At the lower 95% confidence limit either of these readings could be 0.1 inches lower. Thus, AmerGen cannot show that Bay 1 even meets the latest applied version of the local area acceptance criterion with anything like 95% confidence. Figure 19-4 of Calculation C-1302-187-5320-024, Rev. 2 (Ex. 33 or AmerGen Ex. 16) shows a similar problem in Bay 19.

One way of testing the sensitivity of the predicted areas to the uncertainty in the data would be to run a Monte Carlo simulation by assigning a standard deviation to each data point and then randomly selecting different values and rerunning the contouring program. Multiple repeats of this procedure would show how uncertain the estimates of the dimensions of the area less than 0.736 inches actually are. Unfortunately, instead of trying to quantify the uncertainty and deal with it appropriately, AmerGen has not provided any analysis of this issue. The uncertainty could be narrowed considerably even without expanding the spatial scope of the monitoring program if a database of repeat measurements at each data point were assembled. The need to narrow uncertainty could have provided another driver for the monitoring frequency if the mid-range estimates of the extent of the areas less than 0.736 inches thick showed compliance with LAC1 or the appropriate more stringent criterion. However, because the mid-range estimates from both AmerGen and Dr. Hausler indicate non-compliance with LAC1, it is a little late to try to narrow the bounds of the uncertainty.

VII. There Is No Assurance That The ASME Code Is Met

During the course of the proceeding NRC Staff repeatedly changed their position with regards to the ASME code. Initially, on August 17, 2007, Dr. Hartzman of the NRC Staff stated baldly that "Based on the currently available corrosion data of the sand bed region, the Staff estimates that the EFS in the sand bed shell is 1.9." Affidavit of Mark Hartzman, dated August 23, 2007. However, on August 23, 2007, the Staff amended the testimony to read "Assuming that the corrosion is as extensive and severe as depicted by Dr. Hausler's contour plots in Citizens Exhibit 13, the Staff estimates that the EFS in the sand bed shell is 1.9." *See* NRC Staff Ex. C at A28. Subsequently on September 24, 2007, Dr. Hartzman testified orally that based on his expert interpretation of AmerGen's data that current factor of safety is "probably about two, even greater than two." Hearing Tr. 178:12-16.

It is difficult to make sense of Dr. Hartzman's testimony. NRC Staff have shown no errors in Dr. Hausler's contour plots. Indeed, on sur-rebuttal, Dr. Hausler showed that the plots he had presented previously did not show the full extent of corrosion because they were confined to the measured area. He then presented additional plots showing even more extensive corrosion. Citizens' Ex. 61 at 14-17. Thus, if Dr. Hartzman had continued to rely on Dr. Hausler's plots it appears that the predicted factor of safety should have been less than 1.9. Furthermore, Dr. Hausler showed that his plots were merely more refined versions of AmerGen's estimates regarding severely corroded areas. Citizens Ex. 61 at 4. Thus, it is unclear how Dr. Hartzman was able to estimate a factor of safety of greater than 2 using the AmerGen's latest analysis of the severely corroded areas, which NRC Staff have claimed they have not reviewed in detail. NRC Staff Ex. B at A9 (page 13); Hearing Tr. 140:16-21; Hearing Tr. 145:4-10. Somewhat similarly, Dr. Mehta of GE testified that the factor of safety coming out of the actual thicknesses would be "greater than two," but not much greater than two. Hearing Tr. 166:11-24.

Thus, it has become clear that at best, the factor of safety is right on the edge of what is required by the ASME code. In fact the uncertainty in the factor of safety stems in part from the uncertainty about what the actual thicknesses are. As the GE analysis has shown, small severely corroded areas of greater than 18 inches in extent can affect the factor of safety quite considerably. Hearing Tr. 200:14-202:20; 204:7-206:5. Indeed, using a fairly simplistic approach to simulating the measured degradation in 1992, Sandia National Laboratories showed that the corrosion had caused the factor of safety to decline by 44%. *See* NRC Staff Ex. 6 at 69, 72 (factor of safety associated with buckling during refueling in the sand bed region declined from 3.85 to 2.15). The Sandia model largely used average external data to characterize the sandbed. *Id.* at 49. However, two small 30 inch by 18 inch locally thin areas were placed directly under the ventline in Bays 1 and 13. *Id.* Sandia also warned that "the assessments performed here employ a uniform thinning of the drywell shell over large sections of the surface. The thickness assigned in each region were based on limited measurement data since a very small percentage of the shell has been examined." Citizens' Ex. 60 at 84. It is therefore not surprising that Sandia cautioned that the study could not produce absolute predictions of the factor of safety but instead showed the relative reduction in buckling strength caused by the corrosion of the drywell shell. NRC Staff Ex. 6 at 12.

Because Sandia used the 1992 external measurements for the basis of its evaluation, the results were on average approximately 0.02 inches thicker than those found in 2006. Citizens' Ex. 9 at 4-3. Indeed comparing the 1992 averages used by Sandia with the averages found in 2006, the 1992 averages appear consistently higher. *Compare* NRC Staff Ex. 6 at 49 (Table 2-7) *with* Table 1, *supra*. As a specific example, the area comprising half of Bay 1 and half of Bay 19 was assigned a thickness of 0.858 inches by Sandia, but in 2006 Bay 1 had an average thickness of 0.802 inches and Bay 19 had an average thickness of 0.801 inches. *Id.* Similarly the area comprising half of Bay 13 and half of Bay 15 was assigned a thickness of 0.842 inches by Sandia, but in 2006 Bay 13 had an average thickness of 0.786 inches and Bay 15 had an average thickness of 0.788 inches. *Id.* Furthermore, Dr. Hausler's extrapolated plots show larger locally thin areas than assumed by Sandia well away from the vent lines. Citizens' Ex. 61 at 14-17. Because it is universally acknowledged that severe corrosion away from the vent lines has more effect than areas of severe corrosion below those lines, the placement assumed by Sandia did not bound the effect of the severely corroded areas.

Thus, if the Sandia study were repeated using the Dr. Hausler's contour plots as inputs instead of averaged 1992 data, it is likely that it would predict a factor of safety of less than 2.0. At minimum, the Sandia study together with the testimony of Dr. Hartzman and Dr. Mehta shows that there is no reasonable assurance that the ASME code is currently met. This conclusion is reinforced by the discussion between the Board and AmerGen at the hearing regarding a future analysis of the factor of safety, which shows that AmerGen is not certain that the plant meets the ASME code requirement for a safety factor of 2.0 during refueling. Hearing Tr. 535:1-22. For example, Mr. Gallagher admitted that although AmerGen has an expectation that the analysis will show additional margin, it has also considered the "flip side" in formulating its commitment. Hearing Tr. 538:2-20.

The conclusion that there is no assurance that the ASME Code is met is also reinforced by the NRC Staff's attempt to argue that the degraded drywell shell does not need to meet the ASME code. NRC Staff Ex. C1 at 56. At the hearing, Dr. Hartzman confirmed that the ASME code applies to design, Hearing Tr. 155:4-156:11, modifications, *id.*; Hearing Tr. 477:5-19, and deviations. Hearing Tr. 477:13-25. He further conceded that the corrosion in the sandbed could be considered to be a deviation. Hearing Tr. 482:12-17. However, Dr. Hartzman tried to argue that because more is now known about the drywell shell than was known when it was built the ASME code requirement does not apply to the drywell shell. Hearing Tr. 156:12-158:2. This is flatly incorrect, because no measurements of the actual stresses have been carried out, Hearing Tr. 162:15-163:11, and the large amount of uncertainty about the spatial distribution of the corrosion in the sandbed actually means that less is known about the properties of the shell than was known on design, when thicknesses were at or close to nominal. Thus, based on Dr. Hartzman's logic a factor of safety of greater than 2.0 should now be required.

Finally, instead of suggesting a factor of safety that would be acceptable, Dr. Hartzman stated that the NRC Staff now no longer had a standard to apply, but nonetheless thought that the shell was not in danger of buckling. Hearing Tr. 161:21-24. In contrast, AmerGen has testified that "Compliance with the ASME code is the industry standard," AmerGen Ex. C Part 1 at 2, that the external measurements confirm that the drywell meets the applicable ASME code, AmerGen Ex. C Part 3 at A.39, and has confirmed that the ASME code requires a safety factor of 2.0 for the refueling load combination. AmerGen Ex. C Part 2 at A6. Thus, even AmerGen appears to believe that the NRC Staff is going too far when it suggests that there is no need to have a standard on which to base the buckling assessment. The Advisory Committee on Reactor Safeguards (the "ACRS") also appeared to believe that the intent of AmerGen's additional analysis should be required to demonstrate the margin above the "code required minimum" and called for sensitivity studies to determine how the uncertainties in the size of the thinned areas affect the calculated margin. NRC Staff Ex. 3 at 5-5. Thus, Citizens, AmerGen and the ACRS are all agreed that AmerGen is required to demonstrate compliance with the ASME code requirement for a safety factor of 2.0 during refueling. The evidence shows either that it is reasonably possible or it is likely that the drywell shell no longer meets the ASME code. Thus, there is no reasonable assurance of code compliance.

VIII. Potential For Exterior Corrosion

A. Life of The Epoxy Coating

Epoxy was applied to the shell in the sandbed region in two different ways. For most of the shell, a two-layer epoxy coating with a primer was painted onto the metal of the drywell. However, for a small potion of the shell just above the uneven concrete floor of the sandbed region, it was covered by epoxy poured upon the floor to direct any water reaching the sandbed region away from the drywell shell and into the drains. The epoxy coating on the floor was poured before the epoxy was painted on the rest of the drywell shell. *See* AmerGen Ex. 40 at 60 (Photograph of "Bay 5 before shell coating" provided by AmerGen as reference material to the ACRS). Thus, portions of the shell above the sandbed concrete floor, but below the level of the epoxy coating applied to the floor, are protected only by the epoxy coating on the floor.

Corrosion on the exterior of the drywell shell will occur if the epoxy coating is not intact and water is present. Looking first at the integrity of the coating, there are always holidays or pinholes present when coatings are installed that can provide sites for corrosion to develop. Here, the reactor operator did electrical testing of the coating in a mock-up outside the system, Transcript of ACRS Meeting on January 18, 2007, Ex. 15 at 135:15-17; Ex. 17 at OCLR13720, but failed to monitor the actual coating in a similar way relying instead on visual inspection. Transcript of ACRS meeting on October 3, 2006, Ex 16 at 60:20-61:2; Ex. 17 at OCLR13720. Because AmerGen's expert, Mr. Cavallo, acknowledged that "usually holidays are not visible," Transcript of ACRS Meeting on January 18, 2007, Ex. 15 at 144:21-22, it is likely that there were at least some pinholes in the coating from the start.

The next question is whether the coating could deteriorate over time. Mr. Cavallo in his affidavit for summary disposition did not dispute that deterioration of the coating could occur, indeed he admitted that it was possible that repair of the coating might be necessary at some point. Affidavit of Jon R. Cavallo, dated March 26, 2007, Citizens' Ex. 18 at ¶ 22. Furthermore, AmerGen has admitted that the epoxy coating has a limited life of between 10 and 20 years. Transcript of ACRS meeting on October 3, 2006, Citizens' Ex. 16 at 61:12-22. In its testimony, NRC Staff acknowledged that one element that led to it requiring UT monitoring during the extended period of operation was the "unknown duration of the effectiveness of the epoxy coating . . ." NRC Staff Ex. B at A.23. The coating was applied in 1992 and is now around 15 years old. Thus, it is reasonable to assume that the coating could fail at any time during any extended period of operation.

Showing that the potential for the epoxy coating to deteriorate is not mere speculation, since 1996, inspections have found that the epoxy coating on the floor was separating from the concrete underneath. Citizen' Ex. 19 at 1; AmerGen Ex. 24 at OCLR27365-67, OCLR27371-83, OCLR27387-88, OCLR27396-97, OCLR27401-09. The latest inspections showed separated seams and voids in Bays 3, 5, 7, 9, 11, 15, 17 and 19. *Id.* These defects meant that water could have penetrated the epoxy coating on the floor prior to its repair. Citizen' Ex. 19 at 2. This means that any water in the sand pocket would not necessarily have been directed to the drains and that water could have come into contact with the corroded shell in the sandbed region below the level of the epoxy floor since 1992. Hearing Tr. 508:17-509:5. This condition could obviously recur and indeed could become more frequent as the epoxy gets older and more brittle. Hearing Tr. 459:11-18.

B. Sources Of Water On The Exterior

With regard to the potential for water to be present, operating experience shows that much water entered the sandbed region in the past. For example, AmerGen found water in the sandbed drains as recently as March 2006. Citizens' Ex. 20, Letter from Conte to Webster, dated November 9, 2006, *available at* ML063130465. The source of this water was not determined. *Id.* At various times in the past there has been leakage onto the exterior of the drywell shell because the drywell cavity liner leaks and the trough that was provided to catch general leakage is very shallow, has only one drain, and was damaged. Citizens' Ex. 15 at 134-35; Citizens' Ex. 24 at 222-23; AmerGen Testimony Part 1 at A.20; AmerGen Testimony Part 3 at A.5. More recently, during the 1994 and 1996 refueling outages, the committed mitigation measures were not used and water leaked into the exterior sandbed region. AmerGen Testimony Part 4 at A.8-9; AmerGen Testimony Part 5 at A.14. Therefore, water could flow onto the exterior of the drywell shell in the sandbed region if a forced outage occurred that required the reactor cavity to be flooded without having the mitigation measures applied.

In addition, AmerGen has acknowledged that it has been unable to devise a means of stemming the leakage from the reactor cavity during refueling. Citizens' Ex. 24 at 219-21. In the 2006 outage around one gallon per minute of leakage was observed even after the required tape and strippable coating were applied to the fuel cavity liner, but water was not observed in the sandbed region. AmerGen Ex. B Part 4 at A.9. This does not prove that water could not penetrate into the sandbed region during future outages. In fact, there are a number of factors that could lead to further leakage. First, the 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 1996 outage. Citizens' Exs. 48-49. Second, serious leaks have been observed in the past even after taping and strip coating. Citizens' Ex. 50. Third, the intended function of the trough is to act as a backup for other components. Citizens' Ex. 24 at 220. Thus, if the trough degraded further, the mitigation measures were less effective than in 2006, or leakage occurred from other components, water could enter the drywell again, even without a forced outage. It is therefore entirely reasonable for all parties to assume that water may enter the exterior of the sandbed region during any extended period of licensed operation.

Moreover, AmerGen has found that statistically significant ongoing corrosion is occurring in the upper drywell. AmerGen Ex. 40 at 135. This is surprising since this area is subject to high temperatures and if water were not present, corrosion could not occur. The slow rate of corrosion (around 0.66 mils/year) does not provide an indication that the area is drying out because above 200 degrees the corrosion rate "drops dramatically." Hearing Tr. 510:14-21. The temperature at the upper drywell during operation is over 200 degrees. Hearing Tr. 513:11-13. Thus, the small rate of ongoing corrosion indicates that water may be leaking onto the exterior of the drywell shell, but the small corrosion rate is not an indication that the volume of water is small. Therefore, unless AmerGen is able to show at a later date that corrosion in the upper drywell has ceased, it is reasonable to assume that water leakage onto the exterior of the upper drywell occurs during reactor operations.

Finally, Dr. Hausler pointed out at the hearing that concrete chips that probably originated from the biological shield wall were found in the sandbed drains in 2006. Hearing Tr. 508:1-10. He then concluded that sufficient water had been present in the sandbed since the last cleaning to sweep those concrete chips into the drains. Hearing Tr. 508:11-16. AmerGen confirmed that concrete was removed from two of the sandbed drains in 2006. Hearing Tr. 516:19-520:16. After some discussion it was agreed that the drains had been cleaned in 1989 and so the concrete debris must have been swept into the drains between 1989 and 2006. Hearing Tr. 523:2-22.

C. Future Exterior Corrosion Rate

For the grid data taken from the inside of the drywell liner AmerGen established a statistical method to project the past corrosion rate to the future in situations where the corrosion rate was linear and significant. NRC Staff Ex. 1 at 4-60. It did this by trending the mean of the grid data and then projecting the lower 95% confidence limit of the projected thickness into the future. *Id.* This method worked well before the sand was removed from the drywell because the corrosion rates were quite high. For example, the mid-range estimates of the corrosion rate from mid-1989 to early 1990 were up to 0.069 inches per year. Ex. 28 at 7. Long term corrosion rates were lower, at up to 0.035 inches per year. *Id.* The estimates of the corrosion rate were quite uncertain, depending on how many results were used to generate the estimate. However, after 1992, where no trend was visually identifiable, AmerGen tried to use the established statistical method, but found it inapplicable because there was no significant slope. It then assumed the corrosion rate to be zero and failed to analyze the uncertainty in the data. Ex. 7 at 19-30.

In Calculation C-1302-187-E310-041 AmerGen took a different approach when considering the external data. AmerGen Ex. 20. It compared the points measured in 1992 with those measured in 2006 and found that the largest apparent corrosion rate was 0.034 inches per year. *Id.* at 49. It then calculated that at this rate the thinnest measured point would be 0.515

inches thick in 2008. *Id.* It therefore decided to take another round of external measurements in 2008.[17] *Id.*

At the hearing Mr. Gordon stated that he thought that the corrosion rate would be around 3 mils per year (0.003 inches per year) at 93 degrees F, if the coating failed and water reached the shell. Hearing Tr. 489:15-490:5. However, when questioned why this rate was so much lower than the rates measured when the sandbed was in place, which were up to 39 mils per year, Mr. Gordon said he thought the water would have lower levels of impurities because the sand was not present. Hearing Tr. 491:1-14. Mr. Gordon further stated that at 130 degrees the corrosion rate would be 5 mils per year, and at 160 degrees it would reach a maximum of 8 mils per year. Hearing Tr. 500:2-11.

In response, Dr. Hausler stated that the amount of corrosion depended the level of halides, such as chloride, in the water. Hearing Tr. 505:25-506:6. Dr. Hausler further pointed out that there are no good measurements of the amount of halides found in the water that reached the sandbed since the sand was removed. Hearing Tr. 504:13-505:3. AmerGen has testified that during operation the drywell temperature would be approximately 109 degrees during operation, Hearing Tr. 519:11-14, and 90 degrees during an outage. Hearing Tr. 515:3-16. Thus, if Mr. Gordon is correct, the corrosion rate would be around 3 mils per year during refueling and 4 mils per year during operation (as long as the water remained), but as Dr. Hausler pointed out, if chlorides were present, the corrosion rate could be considerably higher. In the absence of any

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[17] In fact, inspection of the results shows that the thinnest measurement at the location used to calculate the corrosion rate (point 2 in Bay 17) was 0.663 inches, not the 0.681 inches reported. Using the thinnest point measured at this location, as was apparently done in 1992, would therefore yield a corrosion rate of 0.04 inches per year. Applying this rate and a single point uncertainty of 0.09 inches to the thinnest measured result in Bay 13 of 0.602 inches would mean that the acceptance criterion for areas of less than 2 inches in diameter could be violated in 6 months. Citizens provide this analysis to illustrate the consequences of applying AmerGen's latest approach to any extended period of operation.

hard information on the potential levels of chlorides present, it is prudent to allow for an exterior corrosion rate of 10 to 20 mils per year.

Although on sur-rebuttal AmerGen speculated that there was a chimney effect during operation because air would be drawn in through the three inch gap between the ventlines and the concrete wall, AmerGen Ex. C1 at A8, this is purely a supposition with no supporting data. At the hearing, Dr. Hausler pointed out that the three inch gap could be blocked with sand and corrosion products. Hearing Tr. 432:1-16. Dr. Hausler believes this is a possibility because water flowing down the exterior of the shell could have been diverted down the vent lines and no coating is present in this area. Hearing Tr. 432:17-19. Finally, the fact that ongoing corrosion has been occurring in the upper drywell where temperatures are of the order of 200 degrees[18] shows that the postulated chimney effect cannot be occurring or there must be a major source of water during operation, which AmerGen has stated there is not. Hearing Tr. 524:10-13.

Thus, because all indications are that the postulated chimney effect does not occur, Mr. Hosterman has not used a reasonable approach to estimate the time in which any water on the exterior of the shell would evaporate, because he has used an equation which applies to pools or open ponds. AmerGen Ex. B Part 6 at A.19. Thus, the equation inherently assumes that the evaporation of the water does not affect the air into which it is evaporating. Citizens Ex. C at A22. This assumption is invalid for the exterior of the sandbed region which probably has limited air exchange. *Id.* It 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. *Id.* Thus, it would have very limited capacity to absorb moisture as the temperature increased with plant start up.

[18] Although AmerGen has made much of the fact that the ongoing corrosion rate in the upper drywell is small this is hardly surprising. As NRC Staff testified corrosion rates fall dramatically above 200 degrees. Hearing Tr. 510:14-21.

After the air becomes saturated at the operating temperature, it would not absorb more moisture unless air is being exchanged with the outside. *Id.* AmerGen has failed to establish how fast water would evaporate from the sandbed region. The record contains insufficient information to allow a quantitative estimate of the rate of evaporation to be made.

IX. Potential For Interior Corrosion

A. Presence of Water

In the October 2006 inspection, AmerGen unexpectedly found water in the interior trenches. Citizens' Ex. 25, Letter from NRC to C. Crane, dated January 17, 2007 enclosing summary of results of in-service inspection from October 16 to December 6, 2006 ("Inspection Report"), *available at* ML070170396 ("water was discovered in the drywell trenches . . . . The presence of water was not expected by AmerGen. . . . AmerGen determined that an environment/material/aging effect combination exists that had not been previously included in the Oyster Creek license renewal application. AmerGen's letter to the NRC (2103-06-20426), dated December 3, 2006 addresses this issue. . . ."); *see also* Citizens' Ex. 35 at 2 ("as a result of performing planned inspections [in October 2006] of the internal surface of the drywell shell trenches excavated in the concrete floor in 1986, AmerGen identified an environment/material/aging effect combination that was not included in the LRA.")

Comments by AmerGen presenters at the meeting of the ACRS on January 18, 2007 confirmed that the finding of the wet interior condition was unexpected. Mr. Gordon described it as "surprise water." Transcript of ACRS meeting on January 18, 2007, Citizens' Ex. 15 at 209:17-19. Mr. Polaski stated "we believe that the whole inside of the drywell below the floor has water in there," *id.* at 216:2-3, and then confirmed that AmerGen believes that "there's water in this lower part of the sphere . . .between the concrete and the shell." *Id.* at 216:4-9. In fact, the Inspection Report 05000219/2006013 revealed that contrary to AmerGen's assertions, this condition had been previously identified in 1992 and 1994, but not addressed:

> The inspectors noted that the presence of water in the bay 5 and bay 17 trenches inside the drywell had been reported in Structural Inspection Reports in 1992 and 1994. The Structural Inspection Report from 1994 (dated January 3, 1995) indicates that the rectification of the situation will require prevention of water from reaching the trenches with proven material(s). However, this condition and the evaluation were not addressed by the corrective action process in effect at the time.

Citizens' Ex. 25 at 9.

NRC Staff have stated that corrosion has occurred at other reactors in containment steel plates where wet concrete abuts the steel liner and there were voids or foreign objects in the concrete. SER at 4-51. Indeed, it was partly the possibility of "some insignificant corrosion" on the interior that led AmerGen to commit to further external UT monitoring in 2008. AmerGen Letter of Dec 3, 2007, Citizens' Ex. 35 at 14. Finally, AmerGen has tried to suggest that inerting of the atmosphere inside the containment during reactor operation would prevent a corrosive environment on the interior of the drywell. That is incorrect, because other similar Boiling Water Reactors have experienced corrosion *inside* their drywells. NRC Staff Ex. 1 at 4-67 (emphasis added). Even at Oyster Creek, some rust was observed when the trenches were opened in October 2006. Transcript of ACRS meeting on January 18, 2007, Ex. 15 at 222:8-10. In fact, the precise description was that the "surface had traces of red primer and gray sealant layer. Bare metal had a light oxide layer and areas of light to moderate pitting. . . . In areas of pitting no attempt was made to clean out or 'chase the pits.'" Citizens' Ex. 26 at OCLR 14454. Furthermore, Oyster Creek has experienced corrosion inside the drywell in the reactor building closed cooling water system. Citizens' Ex. 27 at OCLR13629. The observed corrosion can probably be explained because the specifications only require oxygen to be below 5% during operation, they do not require the drywell to be completely inerted. *Id.*

In summary, it is substantially certain that a potentially corrosive environment exists on the interior of the drywell liner in the sandbed region. The critical issue whether the corrosion rate could be significant.

B. Future Interior Corrosion Rate

Although AmerGen believes the rate of interior corrosion will generally be small, New Jersey has recently written to NRC providing cautionary expert comments. Citizens' Ex. 30, Letter from Lipoti to Kuo, dated April 26, 2007 attaching letter from R.M. Latanision, dated March 26, 2006. Mr. Latanision, an expert retained by New Jersey, warned that interior corrosion could be appreciable if voids are present in the concrete adjacent to the steel shell. In addition, he warned that if the water chemistry changed, corrosion could accelerate in the future. He therefore suggested that real time monitoring of the thickness of the drywell at the thinnest spots should be considered. *Id.*

Even the members of the ACRS recognized the dangers of interior corrosion. For example, Dr. Shack commented at the January 18, 2007 meeting:

> Well, the surprise for me today was the notion that we have water in the imbedded region. That concerns me a little bit. I mean, I fully agree with the argument that it's a fairly benign environment and the corrosion rates are low, and in a containment that didn't have the already substantial corrosion that this one does, I would sort of agree that its probably not a problem. But this is a containment where there isn't a whole lot of margin, and you know, the estimate was you had 41 mils lost and that was less than one mil per year. Well, I do the arithmetic and I get more like two mils per year.

Citizens' Ex. 15 at 356:4-17.

The 41 mils Dr. Shack is referring to came from an effort to measure corrosion in Bay 5 below both the exterior sandbed floor and the interior floor. The UT measurements at this location showed 41 mils of wall loss. Ex. 35 at 20. In this region the interior was wet from at least 1994 onwards. However, it is unclear whether the exterior was wet. Bay 5 was the bay with the least corrosion. Therefore, assuming negligible exterior corrosion, and that the wall loss occurred between 1994 and 2006, the average interior corrosion rate would be around 2 mils per year. This corrosion rate will also apply to the interior of the sand bed region below the 10 feet 3 inches level, which is the height of the interior floor. At minimum, this should be added to estimates of corrosion rate from the exterior to derive a combined corrosion rate.

In addition, it is possible that water chemistry could change in the future and accelerate the interior corrosion rate. Indeed AmerGen's own consultant has stated that AmerGen's assessment of negligible corrosion on the interior relies in part on the high pH of the concrete pore water in contact with the drywell shell, but at times the pH of that water drops significantly due to control rod drive maintenance. Citizens' Ex. 36, E-mail from Schlaseman to Ray, dated November 2, 2006. The consultant stated "the protective pH cannot be assumed to exist during outages anywhere below the 10'3" level in the DW [drywell]." *Id.* at 2. Mr. Gordon has admitted that although his e-mail stated that simple calculations could answer this questions, *Id.* at 1, he did not do those analyses. AmerGen Ex. C at A.13. Another potential source of water to the interior of the drywell shell is the containment spray, which could activate in the future and is not taken into account in Mr Gordon's assessment. To date, AmerGen's assessment of corrosion from the interior has failed to take account of the pH variation on the interior and the potential for the containment spray to add significant amounts of water.

Moreover, NRC Staff have acknowledged that corrosion of the drywell shell in the sandbed region from the interior could occur, NRC Staff Initial Testimony at A12(a), and estimated that the interior corrosion rate has been around 2 mils per year in the interior trenches located in Bays 5 and 17. *Id.* at A11. At the hearing Mr. Gordon broadly agreed with the estimate stating that future corrosion from the interior would be less than 3 mils per year. Hearing Tr. 497:11-21. Given the uncertainties involved, it is prudent to allow for at least 6 mils per year of interior corrosion.

X. Location Of Future Corrosion Is Uncertain And Largely Irrelevant

At the hearing Dr. Hausler stated that because water would more likely accumulate towards the bottom on the exterior of the sandbed region the corrosion rate on the exterior in the future would likely be higher at the bottom. Hearing Tr. 49:18-50:10. This testimony did not foreclose the possibility of corrosion towards the top of the sandbed region from the exterior or corrosion at the top of the sandbed from the interior. *Id.* The Board then enquired about the state of the lower drywell shell. In response there was much discussion of the data taken in the trench in Bay 17, which concluded that at the bottom of that Bay the readings are of the order of 0.94 inches. Hearing Tr. 76:2-4. However, Dr. Hausler cautioned that it is not possible to generalize from the Bay 17 trench findings to all Bays. Hearing Tr. 76:11-17.

A major problem in this discussion is that the lower part of the sandbed is poorly characterized by the measurements taken. AmerGen Ex. 28. The only Bays in which measurements within a foot of the sandbed floor have been taken are Bays 1, 17, and 13. *Id.* In Bay 1, the six measurements taken at the lowest elevations were in order of decreasing elevation, 0.669 inches, 0.731 inches, 0.783 inches, 0.821 inches, 0.846 inches, and 0.795 inches. Citizens' Ex. 61 at 14 (Figure 1). These readings indicate that there could is a severely corroded area towards the bottom of Bay 1 that could expand rapidly if further corrosion occurred. *Id.* There is also a reasonable possibility that there is a very local area at this lower level that is close to the pressure criterion of 0.49 inches making further corrosion in this area potentially highly significant.

Finally, the lower 95% confidence level of the estimates of the mean thickness of four of the ten Bays are within 0.01 inches of the acceptance criterion for the mean thickness and for Bay 13, the 95% lower confidence level is below the acceptance criterion. Thus, further corrosion on any part of the shell in most Bays could reduce the certainty of compliance with the acceptance criterion for mean thickness to below the acceptable level.

CONCLUSIONS OF LAW

I. AmerGen Failed to Satisfy Its Burden of Proof

A. AmerGen Cannot Show by a Clear Preponderance that it Will Maintain the CLB

In an operating license proceeding, the licensee generally bears the ultimate burden of proof. *Metropolitan Edison Co. (Three Mile Island Nuclear Station, Unit 1)*, ALAB-697, 16 NRC 1265, 1271 (1982) (citing 10 C.F.R. § 2.325). Similarly, in the present case the Board cannot renew Oyster Creek's license unless AmerGen demonstrates that its aging management program for the drywell shell provides reasonable assurance that the Current Licensing Basis ("CLB") will be maintained. 10 C.F.R. § 54.29. The Commission confirmed in *Florida Power & Light Co. (Turkey Point Nuclear Generating Plant, Units 3 and 4)*, 54 NRC 3, 10 (2001) that because corrosion and other effects become more severe over the extended license period, an applicant for license renewal must demonstrate that its programs are adequate to manage the effects of aging, including sufficient inspections and testing:

> Part 54 requires renewal applicants to demonstrate how their programs will be effective in managing the effects of aging during the proposed period of extended operation. . . . Applicants must identify any additional actions, i.e., maintenance, replacement of parts, etc., that will need to be taken to manage adequately the detrimental effects of aging. Adverse aging effects generally are gradual and thus can be detected by programs that *ensure sufficient inspections and testing*. [60 Fed. Reg. 22,462 (May 8, 1995)] at 22,475.

54 N.R.C. at 7 (emphasis added). Here, the admitted contention is that "AmerGen's scheduled UT monitoring frequency in the sand bed region is insufficient to maintain an adequate safety margin." LBP-06-22 at 9. One of the Staff's proposed license conditions is that AmerGen must conduct "full scope inspections" of the sand bed region of the drywell shell, including UT monitoring from inside and outside, once every other refueling outage (i.e. once every four years). NRC Staff Ex. 1 at 1-18, A-32-33.

Both licensing boards and courts have equated "reasonable assurance" with the evidentiary standard of "clear preponderance." For example, in a review of an initial licensing decision, the United States Court of Appeals for the District of Columbia found no error when the licensing board likened "reasonable assurance" to a "clear preponderance of the evidence" and rejected claims that reasonable assurance means "beyond a reasonable doubt." *North Anna Envtl. Coalition v. NRC*, 533 F.2d 655, 667-68 (D.C. Cir. 1976). The same "reasonable assurance" requirement must be met in the case of license renewal adjudications. Thus, at minimum, AmerGen must show by a clear preponderance of the evidence that it has margin and that the monitoring frequency it has selected is adequate to ensure ongoing compliance with the CLB. For the reasons discussed *infra*, AmerGen has not satisfied its burden of proof and the license renewal application should be denied.

B. The Use of 95% Confidence Intervals Is the Minimum Standard for "Reasonable Assurance" in a Highly Technical Hearing

In its ruling on July 11, 2007, the Board indicated that AmerGen bears the burden of showing that the drywell shell will not violate the minimum required thickness at 95% confidence. Board Mem. dated July 11, 2007 at 3-4. The Board's September 12, 2007, Memorandum and Order, however, suggested that questions remained about the issue of confidence and reasonable assurance. Citizens maintain that to have "reasonable assurance" of compliance with the CLB overall, licensees must demonstrate compliance with individual acceptance criteria contained within the CLB to at least 95% confidence. There are three main reasons for this. First, because there are multiple individual acceptance criteria contained within the CLB, allowing compliance to be demonstrated at less than 95% confidence for each criterion would lead to a statistical prediction that more than one out of forty individual parameters would be out of compliance. Second, courts, government scientists, and the NRC Staff have identified the 95% confidence level as one that scientists customarily require to show a result is reasonably reliable. Third, the former operator of Oyster Creek and the NRC Staff have identified the 95% confidence level as a reasonable standard to apply to the current situation.

1. AmerGen Must Demonstrate Compliance with Each Acceptance Criterion to at Least 95% Confidence

Dr. Hausler has testified that where normal statistics apply, if the lower 95% confidence limit exactly matches the acceptance criterion, there would be a one in forty chance that the individual parameter would not meet the acceptance criterion. Citizens Ex. C at A14. This is because 2.5% of the probability distribution population is outside the confidence limits on each side of the distribution. If a licensee demonstrates compliance with multiple numerical acceptance criteria to 95% confidence, therefore, one in forty of those criteria could be out of compliance. *Id.*

From a statutory and regulatory perspective, requiring 95% confidence may not produce the "reasonable assurance that the activities authorized by the renewed license will continue to be conducted in accordance with the CLB" required by 10 C.F.R. § 54.29. It is clear, however, that only proving compliance with an individual acceptance criterion contained within the CLB by showing that the mid-range prediction from the distribution of estimates of the parameter in question is equal to the acceptance criterion is inadequate because to do so only provides 50% confidence that the true value of the parameter is actually acceptable. Not only is this inadequate from a factual and scientific standpoint, it is also inadequate as a matter of law because *North Anna* confirmed that "reasonable assurance" requires more certainty than 50% confidence.

2. Courts Generally Require Individual Scientific Facts to Be Established to 95% Confidence

In the context of determining which scientific evidence to admit into court, the judiciary, supported by federal government scientists, has chosen 95% confidence as the minimum that is acceptable to prove each scientific fact in a case. For example, the Texas Supreme Court found that 95% confidence is normally the minimum necessary to scientifically prove causation:

> The generally accepted significance level or confidence level in epidemiological studies is 95%, meaning that if the study were repeated numerous times, the confidence interval would indicate the range of relative risk values that would result 95% of the time. *See DeLuca v. Merrell Dow Pharms., Inc.,* 791 F.Supp. 1042, 1046 (D.N.J.1992), *aff'd,* 6 F.3d 778 (3d Cir.1993); Linda A. Bailey et al., *Reference Guide on Epidemiology, in* FEDERAL JUDICIAL CENTER, REFERENCE MANUAL ON SCIENTIFIC EVIDENCE at 153 (1994) [other citations omitted].

Merrell Dow Pharms., Inc., v. Havner, 953 S.W.2d 706, 723-24 (Tex. Sup. Ct 1997). The Texas Supreme Court in *Havner* also approved of the Texas courts' use of the 95% confidence level as the minimum level acceptable for scientific testimony:

> We think it unwise to depart from the methodology that is at present generally accepted among epidemiologists. [citations omitted]. Accordingly, we should not widen the boundaries at which courts will acknowledge a statistically significant association beyond the 95% level to 90% or lower values.

Id. at 724.

Federal governmental scientists have also urged courts to adopt the use of 95% confidence intervals. *See, e.g.*, *U.S. v. Chase*, 2005 WL 757259, (Jan. 10, 2005 D.C. Super). The court found credible "the testimony of the government's experts that the use of 95% confidence interval is a standard approach that is generally accepted in the scientific community." *Id. at *6*; *See generally,* Frederika A. Kaestle, et al., *Database Limitations on the Evidentiary Value of Forensic Mitochondrial DNA Evidence*, 43 Am. Crim. L. Rev. 53 (2006).

The Supreme Court in *Daubert v. Merrell Dow Pharmaceuticals* set the relationship between the admissibility of scientific evidence and the standard of proof required by the jury in civil proceedings. *Daubert v. Merrell Dow Pharms.*, 509 U.S. 579, 592 (1993). "Since Daubert seeks to exclude scientifically unreliable evidence, the scientific evidence must conform to the accepted convention of 95 percent probability to be admissible." David W. Barnes, *Too Many Probabilities: Statistical Evidence Of Tort Causation*, 64 Law & Contemp. Prob. 191, 207 (2001). The preponderance of the evidence standard is generally accepted to be "more likely than not" or a 51% probability.

The elementary procedure for determining aggregate probability of independent data sets is to multiply the individual probabilities together. *Abbott Labs. v. TorPharm, Inc.*, 309 F. Supp. 2d 1043, 1053 (D. Ill. 2004). For example, when using an 80% probability, it only takes four elements to drop below the 51%. Thus, use of a 95% confidence level is compatible with the preponderance of the evidence standard.

In this case, AmerGen offers many independent elements of proof claiming they show, in the aggregate, that the drywell meets the CLB. They further claim they do not need to meet the 95% confidence level required for admissibility of scientific evidence in federal court, and do not purport to meet it. This claim runs afoul of aggregate probability theory and legal precedent. Because the applicant offers many independent probability elements, the aggregate probability will be far lower than that for each element. Lowering the threshold below the 95% confidence level enhances the effect. Furthermore, the 95% confidence threshold is mandated by *Daubert* and is essential to insuring that the aggregated data meets the clear preponderance standard the Board must apply here.

Plaintiffs seeking redress through monetary damages must establish their scientific theories with greater than 95% confidence before courts will admit those theories into evidence, because that is the liability standard generally required by the scientific community. As a corollary, the cases show that a scientific conclusion that is less than 95% certain is generally not fit to present to a jury. Because a scientific assessment with less than 95% certainty would not be legally sufficient to allow a single injured plaintiff who has already suffered an injury to seek redress in federal court, it cannot be sufficient to avert nuclear accidents that could harm thousands of people and cause devastating contamination. It is essential, therefore, that the NRC require AmerGen to prove their scientific theories about compliance with the CLB to at least the 95% confidence required by federal courts and scientists. Because AmerGen cannot make the required showing, the NRC should deny the license.

Finally, to meet the "not inimical" to public safety mandate of the AEA, the NRC must only permit licensees to use reliable scientific evidence. Federal courts have already determined that scientific proof to less than 95% confidence is unreliable. A licensee must be able to show, therefore, with 95% confidence that it has margins over minimum requirements to establish reasonable assurance of compliance with the CLB. Again, because AmerGen cannot make this showing, it cannot meet the statutory mandate of the AEA and the license should be denied.

3. The 95% Confidence Standard Has Been Accepted and Applied by the NRC as the Measure of "Reasonable Assurance"

The definition of reasonable assurance has proved somewhat elusive because it is dependent on context and is a legal term, which needs to be translated into technical terms to give it meaning and to stop it from dissolving into a meaningless platitude. An example of this translation can be found in a 2001 meeting of the ACRS. Transcript of ACRS Meeting (Sept. 6, 2001), Citizens' Ex. 62 at 3. The ACRS asked the NRC Staff whether a model that predicted results with 95% confidence would provide reasonable assurance. *Id.* In response, the NRC Staff confirmed that the Staff are in favor of more quantification of the term reasonable assurance and that 95% confidence in a modeled result is adequate to provide reasonable assurance:

> MR. CARUSO: Dr. Wallis, this is Ralph Caruso from the staff. . . . I think that your question is what does reasonable assurance mean, and I think that the ACRS has had this discussion with the Commission in the past about what reasonable assurance means, and I don't think there has ever been any definition that everyone has agreed to. This is an eternal question that we try to deal with, and it comes out of judgment to a large extent at this point. When we can quantify it, for example, and say setting safety limit MICPRs, we try to do that. We are trying to do our regulation in a more risk-informed manner, and that is another attempt to do it in a more quantifiable way. But right now these are the words that the law requires us to use to make a finding. So those are, unfortunately, the words that we use and they are not well defined.
>
> DR. WALLIS: But the law requires you to make a finding with 95 percent confidence.
>
> MR. CARUSO: No, the law requires us to make a reasonable assurance finding.

> DR. WALLIS: If your criterion is 95 percent confidence, then the fact that they have evaluated these uncertainties enables you to make that assessment.
>
> MR. CARUSO: We could say that a 95 percent confidence does define reasonable assurance, . . .

Id.

In the more specific context of ongoing corrosion at Oyster Creek, both the reactor operator and the NRC Staff have regarded the 95% confidence level as the equivalent of reasonable assurance. The NRC Staff stated in 1991 that the reactor operator "has repeatedly claimed" that the condition of the Oyster Creek drywell "is fully understood with a 95% confidence level. On the basis of this claim, the staff has requested GPUN [the former operator] to determine the extent of each corroded area." Review attached to Letter from Dromerick to Barton (Nov. 19, 1991), Citizens' Ex. 53. Maintaining this approach, the reactor operator used a statistical method to demonstrate ongoing operability that involved calculating the lower 95% confidence limit and projecting it forward. NRC Ex. B at A.22, p. 27. The exact method of doing this projection has varied, depending on whether statistically significant ongoing corrosion has been observed. *E.g.* Citizens' Ex. 10 at 2; AmerGen Ex. 20 at 49; AmerGen Ex. 23 at 11-20. Most recently, AmerGen has erroneously claimed it has actually calculated the minimum margins based on the lower 95% confidence limit. AmerGen Ex. 3 at 6-15 to 6-16; AmerGen Ex. 12 at 13-14. AmerGen has now acknowledged that it did not take into consideration the uncertainty in this manner. AmerGen Ex. C1 Part 3 at A.8. Finally, in June 20, 2006, AmerGen stated that it would compare the "mean *and the variance* [of the mean]" to the mean acceptance criterion. NRC Staff Ex. 1 at 4-55. Thus, AmerGen has consistently sought to give the impression that it is going to consider uncertainty in its evaluation of the limiting margin, but it has consistently failed to do so.

In short, both the general considerations and the site-specific history of the corrosion issue show that the NRC Staff and AmerGen adopted a standard that requires AmerGen to demonstrate compliance with the acceptance criteria with 95% confidence. This is not surprising or unusual. As discussed above, using the mean of a number of measurements to demonstrate compliance with a deterministic parameter, like the required thickness of the drywell shell, would only provide 50% confidence that the shell was actually thicker than the requirement. In the context of initial licensing, it would be wholly unacceptable to put forward a design that would only assure compliance with the ASME code requirements for half of the independent design parameters, which is what would be most likely to happen if the design called for the *mean* of each parameter to meet, but not exceed, ASME code requirements. Indeed, it is customary to design with considerable margin above ASME code requirements to ensure compliance. Similarly, in the context of license renewal, the applicant could not provide reasonable assurance if it relied, as AmerGen purports to do, on the mean of a set of samples to demonstrate compliance with a particular parameter, because compliance could not be assured in 50% of instances. Given the multitude of parameters that must be estimated and then checked against acceptance criteria at each nuclear power plant, using any other standard would allow significant non-compliance and would virtually assure that the CLB could not be met. In legal terms, using the mean of a set of samples to show compliance for each individual parameter would equate to a mere preponderance of the evidence that an individual parameter meets the acceptance criterion, but does not establish compliance by a clear preponderance. In addition, because multiple parameters must be in compliance to provide reasonable assurance that the CLB is met, each of those individual parameters must comply with its acceptance criterion with a high degree of certainty. Because AmerGen must establish must establish compliance with the

CLB in the aggregate by a clear preponderance, it is unclear whether 95% confidence is sufficient. However, it is clear that anything less than 95% would be inadequate.

II. Oyster Creek Does Not Now and Cannot in the Future Meet the Current Licensing Basis

To date, the question of what exactly constitutes the CLB has remained murky. The CLB is defined in the Code of Federal Regulations as:

> the set of NRC requirements applicable to a specific plant and a licensee's written commitments for ensuring compliance with and operation within applicable NRC requirements and the plant-specific design basis (including all modifications and additions to such commitments over the life of the license) that are docketed and in effect. The CLB includes the NRC regulations contained in 10 CFR Parts 2, 19, 20, 21, 26, 30, 40, 50, 51, 54, 55, 70, 72, 73, 100 and appendices thereto; orders; license conditions; exemptions; and technical specifications. It also includes the plant-specific design-basis information defined in 10 CFR §50.2 as documented in the most recent final safety analysis report (FSAR) as required by 10 CFR §50.71 and the licensee's commitments remaining in effect that were made in docketed licensing correspondence such as licensee responses to NRC bulletins, generic letters, and enforcement actions, as well as licensee commitments documented in NRC safety evaluations or licensee event reports.

10 C.F.R. §54.3.

The CLB, therefore, incorporates requirements of the license and certain elements of other documents such as the FSAR and formal commitments made in licensing correspondence. Amendments to the CLB may be made through amendments to the license and through licensing correspondence. The evidence in the record shows that that no license amendment was made to change the requirements the drywell has to meet. Additional conditions, however, were incorporated into the CLB as a result of formal correspondence between NRC and the reactor operator. In particular, in 1992 the licensee undertook to meet the requirements of ASME Code Section III and undertook to demonstrate that the areas corroded to less than 0.736 inches were "highly localized."

More specifically, by examining the correspondence between NRC and the reactor operator, it becomes clear that many claims and caveats stated during the NRC review of the safety of the drywell shell seem to have become lost in the mists of time. For example, the 1992 Safety Evaluation Report confirms that the licensee used ASME Code Section III and then treated the corroded areas as "highly localized" in order to justify an increase in the allowable stress. Safety Evaluation Report attached to Memorandum from Stolz to Bagchi (Apr. 9, 1992), Citizens Ex. 55 at 2-3 ("1992 SER"). The NRC Staff specifically stated that they had "reviewed the licensee's adoption of ASME Code Section III Subsection NE . . . and found it acceptable." *Id.* at 2. The staff also rejected a proposal by the licensee to allow a 10% increase in the allowable stress throughout the drywell shell. *Id.* The 1992 SER also confirmed that the stresses modeled by GE exceeded the allowable stresses by 3% to 6%, but found that this was acceptable provided the areas corroded to 0.736 inches were "highly localized." *Id.* at 4-5. The NRC Staff reported buckling margins of 24.5% for refueling and 14% for post accident, but also stated that "the extent of the reduction in thickness due to corrosion should be reasonably known." *Id.* at 3. The Staff also noted that the "buckling analyses of the drywell were performed in accordance with ASME Code Case N-284". *Id.* at 4. Code Case N-284 requires various factors of safety, including a factor of safety of 2.0 during refueling. AmerGen Ex. 42 at 7. Indeed, AmerGen has testified that the "relevant ASME code requirements . . . include a safety factor of two . . . for the refueling case." AmerGen Ex. B Part 2 A.10. Finally, a colloquy between Dr. Hartzman of the NRC Staff and Judge Abramson during the hearing confirms that ASME Code Case N-284 is part of the CLB:

> DR. HARTZMAN: The ASME Section 3 is a design code. Those sections and the code case and 284 are requirements under design stage of a structure. In checking or verifying a particular structure that's already built, in the as built conditions, where the loads are

already well known, the code case is not a requirement, it's a specification. It is in that sense that I wrote my testimony.

JUDGE ABRAMSON: So do I correctly understand then, that the code case is not part of the current licensing basis?

DR. HARTZMAN: The code case is part of the current licensing basis for new construction.

JUDGE ABRAMSON: For the as built. But

DR. HARTZMAN: No, not for the as built. For new, for –

JUDGE ABRAMSON: For design.

DR. HARTZMAN: For design and for proposed modifications.

Hearing Tr. at 155:16-25 to 156:1-11. Thus, there is little doubt that the CLB requires compliance with the ASME code buckling requirements.

The supporting analysis by Brookhaven National Laboratories ("BNL") attached to NRC's 1992 SER sounded a more careful note. It stated that "great caution" should be exercised in allowing the licensee to exceed allowable stresses. Technical Evaluation Report, Citizens' Ex. 55 at 4. It then stated that for the buckling analysis the licensee may have double-counted the favorable "hoop stress," but found the predicted margin (minimum 14%) and the use of factors of safety of 2.0 for refueling and 1.67 for post-accident was sufficient to compensate for this. *Id.* at 5. It concluded that "if the actual thickness at 14R is close to the projected 0.736 inches there may not be adequate margin left for further corrosion . . . ." *Id.* at 6. Thus, AmerGen's and the NRC Staff's current claims of excessive conservatism in requiring a factor of safety of 2.0 and claims that the GE uniform thickness analysis is conservative are contrary to the NRC's accepted analysis.

Thereafter, the NRC made its acceptance of the GE uniform thickness analysis contingent upon subsequent inspections of the then-inaccessible areas. *See* Letter from Dromerick to

Barton, dated Apr. 24, 1992, Citizens' Ex. 56 (writing that the NRC required reactor operator to "confirm that the thickness of the corroded areas are as projected [using the interior data] and the corroded areas are localized"). The reactor operator responded by committing to take the external measurements after the sand had been removed from the sandbed region. Letter from DeVine to NRC, dated May 26, 1992, Citizens' Ex. 57. NRC agreed to this approach in June 1992, before the sand was actually removed. Letter from Dromerick to Barton, dated June 30, 1992, Citizens' Ex. 58. Thus, the correspondence to this point reflects a change in the CLB that allowed continued operation, provided the areas of the drywell that were 0.736 inches thick or less were "highly localized" and the thicknesses found in the external UT study confirmed that the interior grid measurements were representative of the state of the shell. This is confirmed to some extent by the relicensing SER, which refers to the GE analyses of January 1992 as "the current applicable analysis for the drywell." NRC Staff Ex. 1 at 4-55.

However, some significant changes occurred after this point. As noted above, the original GE study accepted by NRC in April 1992 predicted a minimum safety margin above the buckling requirements of 14%. However, in 1993, the reactor operator revised the calculations to show that a uniform shell thickness of 0.736 inches yields no margin above the ASME requirement. AmerGen Ex. 17 at 42; Citizens' Exhibit 60 at 77. GE confirmed the lack of margin at 0.736 inches by a letter from to GPU, which referred to "0% margin in the base case calculation." Letter from Mehta to Tumminelli, dated December 11, 1992, AmerGen Ex. 39 at 4. It is unclear whether the NRC Staff reviewed and accepted the revised model at the time, or whether the NRC Staff would have imposed more stringent conditions in 1992 had they known that the model predicted no margin, as opposed to a 14% margin.

Furthermore, in order to investigate the effects of localized degradation beyond 0.736 inches, the reactor operator commissioned GE to predict the effect of a 9 feet by 4.5 feet cut-out tray-shaped area in each Bay of a uniformly thick 0.736 inch shell. On December 11, 1992, GE showed that the effect of these areas was to reduce the buckling capacity by an amount that depended on the minimum thickness of the cut-out area. AmerGen Ex. 39. Again, it is unclear whether NRC Staff reviewed and accepted these calculations as clarifying what "highly localized" meant.

It is reasonably clear that the relicensing SER's favorable safety review was not contingent on a change to the CLB. Instead, it was based upon a conservative interpretation of the tray model, which required contiguous severely corroded areas[19] to be less than 12 inches by 12 inches in size. NRC Staff Ex. 1 at 4-56; AmerGen Ex. 13 at 6-7. In addition, the NRC accepted AmerGen's estimate that the extent of the severely corroded areas was 0.68 sq. ft., *id.* at 4-58, even though AmerGen has subsequently estimated that the extent of these areas is over 20 square feet. Calculation C-1302-187-5320-024, Rev. 2, Ex. 33 (AmerGen Ex. 16) at 29, 64, 79, 89. At this juncture, it is clear that the basis upon which the NRC approved the 1992 change in the CLB has now been undermined because: 1) the 14% margin that NRC believed the model showed was reduced to zero after NRC had accepted it; 2) AmerGen has now shown that the severely corroded areas are not "highly localized" as required; and 3) AmerGen has concluded that for some Bays the results from the interior grids in are not representative of the corrosion in those Bays. Thus, the conditions that NRC explicitly established in 1992 to accept that the GE model showed compliance with the ASME code have been violated.

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[19] This brief uses the term "severely corroded areas" to refer to areas that are thinner than 0.736 inches.

AmerGen argues that this is not an issue. The logic is that the CLB includes "plant-specific design-basis information defined in 10 C.F.R. §50.2 as documented in the most recent final safety analysis report (FSAR)." 10 C.F.R. § 54.3. The 2003 updated FSAR contains a reference to AmerGen Ex. 27, which in turn contains a reference to AmerGen Ex. 39, which is an updated analysis prepared after the 1992 CLB amendment. AmerGen Ex. C1 Part 2 A3. This logic fails to note the severe restriction in the licensee's ability to change the CLB through updating the FSAR. First, the FSAR may only contain information and analyses that have been submitted to the Commission or have been prepared at the request of the Commission. 10 C.F.R. § 50.71(2)(e). Second, design-basis information only includes "the specific values or ranges of values chosen for controlling parameters as reference bounds for *design*." 10 C.F.R. § 50.2 (emphasis added). Third, the design-basis information incorporated into the CLB must be "as documented" in the FSAR. Last, the change to the CLB must not require a license amendment. 10 C.F.R. § 50.71 (2)(e).

Taking the points in the previous paragraph in order, there is no evidence to suggest that GE sensitivity analysis contained in AmerGen Ex. 39 was submitted to the Commission before 2003 or was carried out in response to a request from the Commission. Thus, the GE sensitivity analysis cannot be "as-documented" in the 2003 FSAR. Second, the local area acceptance criterion is not a design criterion, it is a criterion for accepting a deviation from the design. Thus, it is not design basis information, and so cannot be incorporated into the CLB through updating the FSAR. Third, and most obviously, it is a stretch to maintain that an analysis was documented in the FSAR when all the FSAR actually contains is a reference to a reference. Any changes to the CLB should be made explicitly and openly. Sliding in an opaque, second-hand reference is hardly sufficient to make the change "as-documented" in the FSAR. Fourth, a licensee is not permitted to make a change to the FSAR without obtaining a license amendment if the change would a) "result in more than a minimal increase in the likelihood of occurrence of a malfunction of a structure, system, or component (SSC) important to safety previously evaluated in the final safety analysis report," or b) "result in a departure from a method of evaluation described in the FSAR (as updated) used in establishing the design bases or in the safety analyses. 10 C.F.R. § 50.59(c)(2). Here, the change to FSAR resulted in a departure from the analysis required previously, which was to verify that areas less than 0.736 inches were "highly localized." It also resulted in a material increase in the chance of malfunction because for the first time the evaluation permitted the licensee to violate the ASME Code and continue to operate with a factor of safety that could go as low as 1.8, if the corrosion corresponded to the worst case assumptions made in the GE sensitivity study. For all of the reasons given above, the reference to a reference to the GE sensitivity study contained in the 2003 FSAR did not incorporate the GE sensitivity study into the CLB. Instead the CLB requirements are that the areas of severe corrosion must be highly localized, which they are not.

Moreover, AmerGen's claim that the GE sensitivity analysis, which is dated December 11, 1992, is the analysis incorporated into the CLB is contradicted by the relicensing SER which states that the GE *January* 1992 analysis is actually the "current applicable analysis for the drywell." NRC Staff Ex. 1 at 4-55. Finally, AmerGen does not claim even claim that the CLB requirement for it to prove that the internal grid results are representative was changed. As discussed above, AmerGen has in fact concluded that the internal grid results in certain Bays are not representative of corrosion in these Bays. Thus, AmerGen has actually shown that it will not be able to comply with this part of the CLB and must now seek a change to the CLB, at least in this regard. For this reason, AmerGen cannot demonstrate that it meets the CLB now or will continue to do so in the future, and the license renewal application should be denied.

III. Abandonment of the Requirement to Meet the ASME Code Would Be Illegal

The Atomic Energy Act, 42 U.S.C. § 2011 *et seq.*, ("AEA" or "the Act") authorizes the NRC to renew licenses for nuclear power plants after an affirmative showing by the applicant that the plant satisfies technical specifications established by the NRC, by rule or regulation, and "will provide adequate protection to the health and safety of the public." 42 U.S.C. § 2232. Prior to the NRC renewing a license, it designates a licensing board, in the present case—this Board—to conduct hearings, when requested, to determine whether the license renewal is authorized by the Act and the regulations. 10 C.F.R. § 2.104(c). Among other things, the Board must find whether "there is reasonable assurance that the activities to be authorized by the operating license can be conducted without endangering the health and safety of the public...." 10 C.F.R. § 2.104(c)(3).

Ascertainable standards in administrative proceedings are the cornerstone of a functional administrative law system. *Environmental Defense Fund, Inc. v. Ruckelshaus*, 439 F.2d 584, 5597-98 (D.C. Cir. 1971). In the current context, where the Board is charged with adjudicating whether AmerGen's license renewal application satisfies applicable standards and should, therefore, be authorized to the NRC, the importance of adhering to standards becomes even more important because fundamental due process and public health and safety considerations are implicated. *Id.* at 598; *see also Holmes v. New York City Housing Authority*, 398 F.2d 262, 265 (2d Cir. 1968) ("due process requires that selection among applicants be made in accordance with 'ascertainable standards'"); *Hornsby v. Allen*, 326 F.2d 605, 612 (5th Cir. 1964) (enjoining denial of liquor store licenses in the absence of ascertainable standards and due process protections). Furthermore, without ascertainable standards, there can be no meaningful administrative review of license renewal applications, or subsequent judicial review of agency actions on those applications. "The court has an obligation to ensure that the administrative standards conform to the legislative purpose, and that they are uniformly applied in individual cases." *Environmental Defense Fund, Inc. v. Ruckelshaus*, 439 F.2d 584, 596 (D.C. Cir. 1971); *see also Bence v. Beier*, 501 F.2d 1185, 1190 (7th Cir. 1974) (finding that administrative and judicial review is a "meaningless gesture" where a rule contains no ascertainable standards for enforcement).

NRC, in an attempt to identify when an license application provides "reasonable assurance" of safety has incorporated into its regulations standards that, when met, are deemed to constitute such assurance. One of those standards is the inclusion of the ASME Code, discussed above in Section II of the Conclusions of Law. During the course of the hearing on the pending license renewal application for Oyster Creek, however, the NRC retreated from the long-established standards set forth in the ASME code in favor of what appears to be some intuitive notion about reasonable assurance in this case. Moreover, the NRC Staff failed to offer a valid reason for this departure.

Although the NRC may change its standards and rules from time to time in accordance with applicable laws, having chosen to adopt ASME standards, it may not now deviate from those standards in the context of the license renewal proceeding currently pending before the Board. Having chosen to promulgate standards, the NRC must follow them. *Nat'l Ass'n of Home Builders v. Norton*, 340 F.3d 835, 852 (9th Cir. 2003) ("Having chosen to promulgate the DPS Policy, the FWS must follow that policy."); *Steenholdt v. FAA*, 314 F.3d 633, 639 (D.C. Cir. 2003) ("Courts, of course, have long required agencies to abide by internal, procedural regulations...even when those regulations provide more protection than the Constitution or relevant civil service laws."); *Paralyzed Veterans of America v. West*, 138 F.3d 1434, (Fed. Cir. 1998) ("It is axiomatic that an agency must act in accordance with applicable statutes and its regulations.").

It may be the case that the NRC now wishes to develop standards in an *ad hoc*, piecemeal fashion. That, however, is not the course the NRC opted to take when it availed itself of the rulemaking process and developed regulations to which parties would adhere and courts would generally defer. Additionally, even if the NRC were to develop standards in this context in a piecemeal manner, it would not be relieved of its "obligation to articulate the criteria that [it] develops in making each individual decision." *Environmental Defense*, 439 F.2d at 596. In this case, the NRC Staff treated the ASME Code like an á la carte menu, selecting and requiring standards they like, ignoring or rejecting those they do not. This is an unabashed abuse of agency discretion. As legal philosopher Lon Fuller concluded, "A law that changes every day is worse than no law at all." Lon Fuller, *The Morality of Law* 37 (1964).

Perhaps much like obscenity, the NRC staff does not need an objective standard because they simply know a safe structure when they see one. *Cf. Jacobellis v. Ohio*, 378 U.S. 184, 197 (1964) (Stewart, J. concurring) ("But I know it when I see it, and the motion picture involved in this case is not that."). This approach, however, does little to assure the judiciary, the citizens who live close to Oyster Creek, or the public at large that nuclear facility operators plan, construct, and maintain their structures with an adequate margin of safety.

IV. AmerGen Has Not Met Its Burden to Define the Existing Margins and Account for Uncertainty

In its Order dated June 19, 2007, the Board stated that it expected parties to address whether the "extant pattern of corrosion" could result in susceptibility to buckling failure either now or in the future. *Id.* at 9 n. 11. To accomplish this, AmerGen must assess whether the existing pattern of corrosion could result in a violation of the ASME Code. The Board further stated that it expected AmerGen to show to a known confidence level that the drywell shell will not violate the minimum thickness requirements in the interval between UT inspections, taking into account the variance of the data. Board Order dated July 11, 2007 at 4. To do this, AmerGen needed to evaluate margins, the variance of the data used to calculate those margins, and the confidence intervals for the derived estimates of the margins. However, AmerGen has failed to even evaluate margins for many acceptance criteria and has failed to account for the uncertainty in the margins it has derived.

Specifically, although AmerGen claims it has set acceptance criteria that involve evaluating at least five separate parameters for the sandbed region: (1) the mean thickness of the shell; (2) the thinnest point on the shell; (3) the thinnest 12 inch by 12 inch area on the shell; (4) the thinnest three feet by three feet area on the shell; and (5) the largest contiguous area that is thinner than 0.736 inches, it has affirmatively stated that it cannot evaluation the margin for the last three criteria. *E.g.* AmerGen Ex. C Part 3 at A37-38. Thus, it has only attempted to evaluate the margin for the mean thickness of the shell and the thickness of the thinnest point.

As discussed above in Section VI. of the Proposed Findings of Facts, because AmerGen refuses to use the external data for margin evaluation purposes, it has only been able to evaluate the margin above the mean criterion for six of the ten Bays using two of the three available data sets.[20] For the thickness of the thinnest point, AmerGen has simplistically derived margin by subtracting the thinnest measured point from the acceptance criterion. Furthermore, it has largely failed to evaluate the uncertainty in the margin above the mean thickness criterion and it has completely failed to evaluate the uncertainty in the margin above the thinnest point criterion.

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20 As acknowledged by AmerGen in Citizens' Ex. 45, the internal data cannot be used to evaluate margin for Bays 1, 3, 7, and 15.

As a matter of law, therefore, AmerGen has failed to meet its burden in this proceeding. Furthermore, the Board simply cannot evaluate the merits of the contention because AmerGen has not supplied it with the evidence to show what the limiting margin actually is. Because AmerGen must carry the burden of proof, these omissions are fatal to its case and the Board must conclude, by default, that AmerGen has failed to establish that its monitoring frequency is sufficient.

V. The Evidence Presented Shows that the Acceptance Criteria Are Probably Violated or Are Not Met With 95% Certainty

A. The ASME Code Requirement for a Safety Factor of Two Is Probably Violated

As discussed in detail in Section VII of the Proposed Findings of Facts, the Sandia Report shows that the ASME code requirement for a safety factor of two during refueling is probably violated. As discussed in that same section, Dr. Hartzman's testimony actually indicates that the factor of safety could now be below 1.8 because Dr. Hausler's extrapolated plots show considerably larger areas of severe corrosion. This is reinforced by AmerGen's admission at the hearing that it cannot be certain that any new analysis that is required to be carried out by a license condition will demonstrate compliance with the ASME Code requirements for a factor of safety of 2.0 during refueling. Hearing Tr. 535:1-22. Finally, as detailed in Section VII of the Proposed Findings of Facts, although Dr. Mehta testified that the ASME Code might be met in his judgment, he refused to say it would meet the code by a substantial amount. Hearing Tr. 166:11. He also failed to state which interpretation of the thickness measurements he was relying upon to make his evaluation. *Id.* Finally, NRC's illogical testimony regarding whether ASME Code Case N-284 requirements must be met shows that NRC Staff at least suspects that the code may not be met.

At minimum, AmerGen has failed to show by a clear preponderance of the evidence that ASME Code Case N-284 requirements for a safety factor of 2.0 during refueling will be met during any period of extended operation. Thus, this Board cannot conclude that there is reasonable assurance that the CLB would be met if the plant were relicensed. Furthermore, the possibility that the plant now has a factor of safety of below 1.8 for buckling during refueling raises real concerns about whether relicensing of Oyster Creek would violate the AEA standard requiring reasonable assurance of public safety. This Board must therefore find that, based on the record before it, AmerGen has failed to meet its burden to show reasonable assurance of compliance with the CLB and reasonable assurance that public safety is protected.

B. Acceptance Criteria Derived From The ASME Code Requirements Are Probably Violated Or Are Not Met With 95% Certainty

As discussed above, 95% confidence is required to provide reasonable assurance. Thus, AmerGen bears the burden of evaluating the current margins using the estimated lower 95% confidence limits for the various required parameters and showing that they comply with the acceptance criteria. AmerGen has failed to do this. Instead the clear preponderance of the evidence shows that the drywell probably fails some of the acceptance criteria and does not meet any of the acceptance criteria with 95% confidence.

C. The Drywell Shell Probably Fails The Local Area Acceptance Criterion

Citizens showed that AmerGen was inconsistent in the way it stated the local area acceptance criterion, related the various criteria used, provided evidence that the inconsistency resulted in part from AmerGen's concerns about the validity of past practice, and suggested that of the criteria used, the most justifiable is to limit areas that are less than 0.736 inches thick to be both smaller than 12 inches by 12 inches and thicker than 0.636 inches on average. Citizens Ex.

37. In addition, Citizens presented contour plots based on the external measurements in direct response to the Board's expectation that the parties would present evidence on whether the pattern of corrosion on the drywell shell could make it susceptible to buckling at the start of any period of extended operation or thereafter. Citizens' Ex. 13 at 5-23; Citizens Ex. 61 at 14-17.

All parties agree that the external measurements are the only measurements that can be used to determine compliance with the local area criterion. *See* Section V, Proposed Findings of Facts. AmerGen's latest approach to the task of showing that the corroded areas are localized is presented in Revision 2 of the 24 Calculation (AmerGen Exhibit 16). This calculation is inadequate on its face because it fails to show that the severely corroded areas are localized, fails to predict how the severely corroded areas would change if the shell got thinner, and fails to take account of uncertainties in the measurements and the methods used to estimate the severely corroded areas. AmerGen's testimony also failed to address these issues. Thus, AmerGen has not met its burden to show that the CLB will be maintained during any extended period of operation.

AmerGen has effectively alleged that the effect on buckling of severely corroded localized areas would be insignificant, provided the corrosion is within the spatial envelope of LAC1. However, Dr. Hausler noted that GE actually modeled an area that was half the size that AmerGen has alleged (the dimensions of that cut-out are incorporated into LAC2) and that this model showed a reduction in the factor of safety of 9.5%, which is not insignificant. *See* Section V.A., Proposed Findings of Fact. NRC Staff agreed with AmerGen on the dimensions of the criterion, but made no mention of the criterion being volumetric and noted that AmerGen has more recently used a value of 0.636 for the thinnest one square foot. NRC Staff Ex. B at A.9. Strangely, NRC Staff also agreed with Dr. Hausler that the GE sensitivity model relied upon by

AmerGen only modeled a severely corroded area that was half the size of LAC1 in each Bay. *See* Section V.A, Proposed Findings of Facts. Because Citizens maintain that compliance with the ASME Code is a CLB requirement, and because LAC2 could allow the factor of safety to drop as low as 1.8, while LAC1 could allow the factor of safety to drop considerably below 1.8, neither of these acceptance criteria are appropriate. Instead, the local area criterion must be designed to ensure that any reduction in the factor of safety caused by local buckling is offset by additional margin about the general thickness criterion. Thus, as the general thickness criterion is approached, the acceptance criterion for local severe corrosion should get more stringent.

The methods AmerGen has used to evaluate the size of the severely corroded areas were not established in the SER, because NRC Staff have stated that they did not consider AmerGen's Exhibit 16 during their review of license renewal. NRC Staff Testimony at A.9; Hearing Tr. 140:18-20 and 145:7-10. Instead, the NRC Staff approved the application based upon AmerGen's unjustified assertion that the total area of the drywell thinner than 0.736 inches was 0.68 square feet. NRC Staff Ex. 1 at 4-58. Thus, the SER found reasonable assurance only because NRC Staff erroneously thought that the severely corroded areas were actually "highly localized" as required by the CLB.

As discussed in the Proposed Findings of Facts, analyses by Citizens and AmerGen show that it is likely that the drywell shell fails even the least stringent local area acceptance criterion proposed by AmerGen (LAC1) because the areas thinner than 0.736 inches in Bays 1, 13, and 19 are too large or are irregularly shaped to fit within the envelope of the tray. It follows logically that the shell violates the various more stringent acceptance criteria used by AmerGen to an even greater degree.

Furthermore, AmerGen has taken an inherently contradictory position regarding the external measurements. It argues that the external measurements do not allow margins to be determined, because the points are biased thin, but that it can use those same measurements to conservatively determine whether the shell complies with the acceptance criteria. This position is unsustainable because to determine compliance with numerical criteria, AmerGen must be able to provide an estimate of the amount by which those criteria are exceeded. The solution to the bias issue is to estimate the level of bias in the external measurements, not to refuse to evaluate the margins. In fact, Citizens have shown definitively in Table 1, *supra*, and through careful analysis of AmerGen's contradictory and misleading testimony in this regard that the level of bias in the external measurements is, at most, minimal. Thus, AmerGen's reasoning is specious. At best, AmerGen's refusal to carefully analyze and interpret the external measurements demonstrated an unwillingness or inability to tease the most information out of its own data. At worst, AmerGen's erroneous, but loudly stated, position regarding the bias in the external measurements was a convenient smoke-screen to cover up the reality that the limiting margin is non-existent or, at most, much smaller than the 0.064 inches claimed by AmerGen.

Finally, AmerGen and Citizens agree that the characterization of the severely corroded areas is highly uncertain. Thus, the 95% confidence intervals on the locations of the edge of these areas are very wide. This is illustrated qualitatively by the lack of points to define the edge of the areas marked for evaluation by AmerGen. AmerGen Ex. 16 at 29, 64, 95. AmerGen has therefore failed to provide reasonable assurance that the existing severely corroded areas on the drywell shell are within the bounds required by LAC1 even if that version of the criterion defines the CLB requirement that those areas be "highly localized."

D. The Drywell Shell Probably Fails the Acceptance Criterion for the Thinnest Point on the Drywell

AmerGen offers only conclusory testimony in support of its statement that the thinnest local measurement is 0.602 inches and thus meets the acceptance criterion. AmerGen Ex. B Part 3 at A.5, A.32. This does not provide reasonable assurance that the criterion is being met because of the uncertainty in the measurement and the uncertainty that the thinnest spot on the drywell was actually measured. At the hearing, the inherent difficulty with AmerGen's approach of comparing the acceptance criterion of 0.49 inches with the thinnest point measured was admitted by Mr. Polaski, who candidly stated: "in all fairness there is nothing in our assertions that say that the engineers and the 19 technicians in there absolutely identified the 20 thinnest locations. . . .there is no guarantee that they absolutely found the thinnest." Hearing Tr. at 328:17-24. To avoid this problem, Citizens have shown using extreme value statistics that in Bay 13 the thinnest point is probably thinner than 0.49. Citizens have also shown that there is less than 95% confidence that these areas meet this criterion.

In response, AmerGen offered very little and even acknowledged that the use of extreme value statistics was reasonable. Hearing Tr. 363:14 to 365:3. Neither AmerGen nor the NRC Staff had any comment about the methodology used by Dr. Hausler to carry out the extreme value analysis. Thus, there is a clear preponderance of the evidence showing that the criterion for the thinnest point on the drywell shell is probably violated.

E. AmerGen Has Failed to Show that There Is Any Margin Above the Mean Thickness Acceptance Criterion

Contrary to the requirements and the established statistical method, AmerGen has failed to state the margin above the mean thickness criterion to 95% confidence. Instead, AmerGen has compared the mean of the interior grids to the acceptance criterion. In fact, the lower 95%

confidence limit in grid 19A for the 2006 results was 0.788 inches. AmerGen Ex. 20 at Appendix 10, Sheet 4. Subtracting an allowance of 0.01 inches for systematic error, as proposed by AmerGen, Citizens' Ex. 10 at 2, yields an estimate of the lower 95% confidence limit taking into account both random and systematic error of 0.778 inches. Comparing this to the acceptance criterion of 0.736 inches shows that AmerGen's estimate of the existing margin above the mean acceptance criterion would be 0.042 inches if it applied the established statistical methods to the 2006 data from the internal grids. Thus, at minimum, the assured margins are less than AmerGen has alleged.

As shown in Section VI.A above, AmerGen has admitted that reliable estimate of a representative mean thickness for certain Bays cannot be obtained from the internal grid data within those Bays. In addition, Bays in which the pattern of corrosion is highly variable are unlikely to be properly characterized by a measurement taken over 0.25 sq. ft. of a 70 sq. ft. Bay. AmerGen should also use the external data to determine compliance with the mean thickness criterion, but without any correction for potential systematic error, recognizing that the external data may be slightly biased towards the thin side.

AmerGen has also alleged that the external data do not provide sufficient information to allow comparison with the mean thickness criteria. AmerGen Ex. B Part 3 at A.29. If true, this would mean that AmerGen would have no systematic means of deriving a representative mean thickness for a number of Bays and so could not meet its burden to show compliance with the mean thickness criterion to 95% confidence. Notwithstanding the lack of "sufficient information," AmerGen has boldly alleged that comparing the mean of the external measurements in each Bay with 0.736 inches demonstrates compliance with the acceptance criterion. *Id.* at A.30. This is incorrect, because it only demonstrates compliance with the mean thickness requirement at the 50% confidence level, not the required 95% confidence level. *See* Table 1, *supra.* In fact, the estimate of the means for Bay 13 derived from the external data does not comply with the acceptance criteria at the 95% confidence level. *Id.* Thus, AmerGen has failed to meet its burden of showing compliance with the acceptance criterion for mean thickness with 95% confidence.

VI. A Corrosive Environment Could Exist on the Exterior of the Sandbed Region

AmerGen has acknowledged that circumstances exist which could cause water to be present on the exterior of the shell in the sandbed region. It has also acknowledged that the coating could deteriorate. Finally, AmerGen has presented no evidence on how fast future corrosion could occur but did not provide estimates for the uncertainty in those estimates.

A. Water Could Access the Sandbed Region

Section VIII.B of the Proposed Findings of Facts shows that there are circumstances in which water could flow onto the exterior of the shell in the sandbed region, such as failure of the strippable coat and the tape to prevent leakage from the reactor cavity, leakage from sources other than the reactor cavity or deterioration of the trough that catches that water that continues to leak from the reactor cavity during refueling, even after AmerGen has taken measures to reduce the leakage. In addition, the statistically significant ongoing corrosion in the upper drywell shows that AmerGen cannot rule out the possibility that water leakage onto the exterior of the drywell shell during operation. Finally, AmerGen acknowledges that use of the drywell chillers, which are used during refueling and other outages when access to the drywell is needed, could lead to condensation. AmerGen Testimony Part 4 at A.15. The potential for condensation is apparently confirmed by an analysis of water that had drained from the exterior of the sandbed region before March 2006, which showed no activity. Citizens' Ex. 23. This is consistent with the source being condensation.

B. The Exterior of the Drywell Shell Could Be Unprotected by the Coating

Based on unpublished data, AmerGen has alleged that the epoxy coating could last for thirty years without serious deterioration. AmerGen Testimony Part 5 at A.9. At the ACRS hearing, however, AmerGen stated that its internal estimates of coating life had ranged from ten to twenty years and it had been in contact with the coating manufacturer, who could provide no guaranteed coating life. Citizens' Ex. 16 at 61. In its testimony, the NRC Staff acknowledged that one element that led to it requiring UT monitoring during the extended period of operation was the "unknown duration of the effectiveness of the epoxy coating . . ." NRC Staff Testimony at A.23. Thus, based on the testimony to date, there is general agreement that the coating could fail during the period of extended operation, but it is uncertain exactly when it might fail. Given the potential presence of water, it is therefore reasonable to conclude that a corrosive environment could come into existence during the period of extended operation and further corrosion of the exterior of the drywell shell in the sandbed region could result.

C. Estimates of Exterior Corrosion Rate

As shown in Section VIII.C of the Proposed Findings of Fact, if Mr. Gordon is correct, the corrosion rate would be around 3 mils per year during refueling and 4 mils per year during operation (as long as the water remained). Dr. Hausler pointed out, however, that if chlorides were present, the corrosion rate could be considerably higher. In the absence of any hard information on the potential levels of chlorides present, it is prudent to allow for an exterior corrosion rate of 10 to 20 mils per year.

VII. Corrosion Could Occur from the Interior of the Sandbed Region

As discussed in Section IX of the Proposed Findings of Facts, NRC Staff has acknowledged that corrosion of the drywell shell in the sandbed region from the interior could occur, NRC Staff Ex. B at A12(a), and estimated that the interior corrosion rate has been around 2 mils per year in the interior trenches located in Bays 5 and 17. *Id.* at A11. AmerGen's expert on this issue acknowledged that the corrosion rate from the interior could be of the order of 3 miles per year.

No analysis of the uncertainty attached to these corrosion rates has been provided. Clearly, the time base for the corrosion is extremely uncertain. In addition, the estimate is based on the subtraction of the mean of the trench data in 1986 from the mean of the trench data in 2006. The difference in the means is 0.038 inches. NRC Staff Testimony at A11. The error in each mean is approximately plus or minus 0.005 at 95% confidence. Thus, the error in the subtraction is very roughly around plus or minus 0.01 inches, translating to an error in the estimated corrosion rate of plus or minus 25%. Mr. Gordon's estimated rate is also an average that, as Dr. Hausler pointed out, will vary with temperature and the level of contaminants in the water in contact with the interior shell.

The interpretation of these results is very difficult. it is likely that the 2 to 3 mils per year estimated corrosion rates assume a situation where interior corrosion occurred sporadically over the years due to variation in the pH of the water on the interior of the drywell. A considerably higher short term corrosion rate, however, could occur. In 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, use of the containment spray, or other sources.

A. Minimum Monitoring Frequency Is More Than Once Every Four Years

The total corrosion rate could range from 3 mils per year from each side (the interior and the exterior) to 20 mils per year from the exterior and 10 mils per year from the interior. Assuming that the highest rates do not happen simultaneously yields a reasonably conservative estimate of approximately 20 mils per year for the upper range of the total corrosion rate. Although exterior corrosion is probably limited to periods after refueling, the time taken for the evaporation to occur has not been properly estimated.

Finally, even if the Board accepts AmerGen's erroneous argument that the mid-range estimate of the limiting margin is currently 0.064 inches, using AmerGen's own statistical methods, this translates into a margin of 0.044 inches at the lower 95% confidence limit if an allowance of 0.01 inches for possible systematic error is made. Future corrosion rates after refueling outages are up to 0.02 inches per year. This means that, at minimum, a UT monitoring frequency of greater than once every four years is required.

VIII. Required Future Analysis of Drywell Safety Will Not Narrow Uncertainty And May Not Be Considered By The Board

A. Required Future Analysis of Drywell Safety Will Not Narrow the Uncertainty

At the hearing there was some discussion about a license condition that requires AmerGen to carry out a new study of drywell stability. Hearing Tr. 380:24 to 385:20; 569:5 to 577:3. However, the essential problem with this study was also highlighted. Because the study will be based on existing measurements, the inputs are highly uncertain. Furthermore, instead of contouring all the available date to get the best estimate of the appropriate inputs, AmerGen has suggested that it should use averages for large portions of each Bay. Additionally, in some cases AmerGen has based those averages on data that was not even taken in the Bay in question.

Citizens Ex. 45 at 5. Because the buckling is sensitive to small areas of severe corrosion, this approach will yield an excessively optimistic view of the current factor of safety.

An additional issue contributing to uncertainty is that Brookhaven National Laboratories and Sandia National Laboratories have both stated that the GE study took too much credit for hoop stress when it applied an enhanced capacity reduction faction for the refueling condition. For example Sandia stated that "the lack of an internal pressure load for the refueling Code Case prevents the justified use of an increased capacity reduction factor." Citizens' Ex. 60 at 77. Thus, even if the additional AmerGen study shows additional margin using the enhanced capacity reduction factor, it will not definitively show what the factor of safety actually is. That argument can only be settled by measuring the actual shape of the drywell and modeling the shape as is, rather than as an idealized geometry.

At best, AmerGen could use the additional study as an opportunity to define a probability density function for the factor of safety by making repeat runs of the model based on Monte Carlo simulation of the inputs. This would be an interesting, but resource intensive exercise, that would likely show that there is already a considerably greater than 5% chance that the plant does not meet the ASME code. Such a result would only confirm that relicensing of Oyster Creek would violate 10 C.F.R. § 52.29 because there is no reasonable assurance that the plant meets the CLB. Thus, this planned exercise probably would not have changed the outcome of this proceeding, even if it had been done in time for it to be considered by the Board.

B. Required Future Analysis of Drywell Safety May Not Be Considered in this Hearing

Here, the admitted contention to be litigated is "AmerGen's scheduled UT monitoring frequency in the sand bed region is insufficient to maintain an adequate safety margin." LBP-06-22 at 9. The Commission confirmed in *Florida Power & Light Co. (Turkey Point Nuclear*

Generating Plant, Units 3 and 4), 54 NRC 3, 10 (2001) that because corrosion and other effects become more severe over the extended license period, an applicant for license renewal must demonstrate that its programs are adequate to manage the effects of aging, including sufficient inspections and testing. 54 N.R.C. at 7. And it is undisputed that the Commission must make an ultimate finding in the licensing proceeding that "there is reasonable assurance that the activities to be authorized by the operating license can be conducted without endangering the health and safety of the public...." 10 C.F.R. § 2.104.

When a statute requires a "hearing" in an adjudicatory matter, such as the license renewal proceeding in this case, the NRC must generally provide an opportunity for submission and challenge of evidence as to any and all issues of material fact. *Union of Concerned Scientists v. NRC*, 735 F.2d 1437, 1444-45 (D.C. Cir. 1984); *see also General Motors Corp. v. Federal Energy Regulatory Commission,* 656 F.2d 791, 795 & n. 7 (D.C.Cir.1981); *Public Service Co. v. Federal Energy Regulatory Commission,* 600 F.2d 944, 955 (D.C.Cir.), *cert. denied,* 449 U.S. 990 (1979); *Independent Bankers Association of Georgia v. Bd. of Governors of the Federal Reserve System,* 516 F.2d 1206, 1220 (D.C.Cir.1975); *see also Siegel v. NRC,* 400 F.2d 778, 784 (D.C.Cir.1968) ("the hearing granted by the [NRC] presumably must embrace all relevant matters"). There is no issue more relevant and material than whether the aging management program for the drywell shell provides reasonable assurance that the CLB will be maintained throughout any extended license period. 10 C.F.R. § 54.29.

During the hearing, there was a great deal of discussion about one of AmerGen's license conditions, which requires it to perform additional analysis of the available safety margins of the drywell shell. Hearing Tr. 380:24 to 385:20; 569:5 to 577:3. This analysis has not yet been performed. As a consequence, the results have not been submitted by AmerGen to the Board, the NRC Staff and Citizens, and they were not subject to challenge. Because the analysis has not yet been done and the results were not submitted to the Board and subject to challenge by Citizens, they are clearly not part of the record created as part of the proceeding. Therefore, AmerGen cannot rely on the additional analysis as part of its required demonstration that its age management programs are adequate, and the Board cannot rely on it when determining whether there is reasonable assurance that the plant will meet safety requirements. Indeed, the intense interest of the Board in the future analysis and the fact that it is being conducted at all suggests that there are data gaps and that the Board cannot find that public health and safety will be ensured during the license renewal period.

Although section 189(a)'s hearing provision does not specifically state that the hearing is "on the record," there is little doubt that sections 554, 556 and 557 of the Administrative Procedure Act (APA) relating to "on the record" procedures apply in this context. *See Union of Concerned Scientists*, 735 at 1445 n.12; *see also Porter County Ch. of the Isaak Walton League v. NRC,* 606 F.2d 1363, 1368 n. 12 (dicta stating that "on the record" procedures apply); *see also City of West Chicago v. NRC,* 701 F.2d 632, 642 (7th Cir.1983) (dicta stating that the legislative history of section 189(a) indicates that formal proceedings are required for issuing a nuclear power plant license, but not for issuing a material handling license). Not only have courts interpreted the AEA in this manner, but Congress has also considered whether the safeguards associated with "on the record" proceedings found within the APA apply in the context of adjudications under the AEA. For example, in 1961, the AEC asked Congress to abolish the requirement that the agency conduct "on the record" hearings under section 189(a) of the AEA. *See generally* Staff of the Joint Committee on Atomic Energy, 87th Cong., 1st Sess., *Improving the AEC Regulatory Process, Vol. 1* (Comm. Print 1961), ["JCAE Report"]. Instead of disposing of these due process safeguards, instead Congress amended the AEA to allow the agency to grant a license without a hearing when none is requested. Notably, however, Congress did not change the manner in which hearings were conducted. *See* S.Rep. No. 1677, 87th Cong., 2d Sess. 6-7 (1962) U.S.C.C.A.N. 1962, p. 2207. In later amendments to the AEA, Congress again maintained the "on the record" safeguards, but allowed the agency discretion to hold hearings after a license amendment, provided the material issues did not present significant hazards. *See, e.g.,* H.R.Rep. No. 22, Part 2, 97th Cong., 1st Sess. 9 (1982). The NRC itself has "taken the position that section 189(a) of the AEA calls for "on the record" hearings in adjudications. *See* JCAE Report at 48-49 (1961) (Commission views statute, as amended in 1957, as requiring formal procedures); *Philadelphia Newspapers, Inc. v. NRC,* 727 F.2d 1195 at 1199-1202 (D.C.Cir., 1984) ("Commission apparent[ly] interpret[s] ... Section 189(a) as requiring formal hearings in licensing proceedings").

The AEA requires the NRC to offer the opportunity to request an adjudicatory hearing on all material aspects of any NRC proposal to renew a license. 42 U.S.C. § 2239(a). One court has held that "while the Commission has discretion to relegate ministerial issues to post-hearing resolution, these issues do not include matters that require a decisionmaker's consideration and weighing of many people's observations, questions of credibility, conflicts, and sufficiency." *Union of Concerned Scientists*, 735 F.2d at 1449-1450. The Commission also addressed this issue in *In the Matter of Hydro Resources, Inc.*, CLI-00-8, 51 NRC 227 (May 25, 2000).

In *Hydro Resources*, the Commission considered whether 10 C.F.R. Part 40, Appendix A, Criterion 9 relating to financial assurance could be considered by the NRC Staff after the issuance of a license. In that case, the Commission generally ruled that decommissioning funding issues may not be the subject of a post-hearing resolution. *Id.* at 240. There, the

Commission stated that "This does not mean that some matters may not be left for post-licensing action, particularly activities that are simply ministerial or by their very nature require post-licensing verification by our Staff, but we do not consider the financial assurance plan among them." *Id.* The Commission justified its decision in the following way:

> Not only is our interpretation sensible from the perspective of sound regulatory policy, but also it ensures a meaningful hearing opportunity on all substantive issues material to the agency's licensing decision...A sensible and efficient process requires us to insist that those questions be addressed in connection with the initial application and license.

Id. Finally, the Commission concluded that "the long and short of the matter is that, at this writing, the record before us reveals no final estimates, no final plan, and no final NRC staff review." *Id.* at 241.

Just as the Board cannot consider the additional analysis in connection with its decision on AmerGen's license renewal application, it cannot relegate the important safety issues that are the subject of the admitted contentions in this proceeding to a post-hearing resolution. To do so would run afoul of the Commission's regulations setting forth what license applicants are required to show. Furthermore, to consider after the close of the hearing on the renewal application the results of additional analysis that were not part of the record would violate the NRC's hearing requirements under both the AEA and the APA and make a mockery of the due process protections those provisions are designed to protect. In the present case, the record does not include the additional analysis. Therefore, it cannot be the basis for any decision by the Board.

To the extent that the Board determines that the results of the additional analysis should be considered before making its decision, it must be done in a manner that preserves Citizens' rights to a hearing.

IX. Citizens Witness Was Fully Candid, While Some of AmerGen's Were Not

Citizens and Dr. Hausler strongly object to AmerGen's intimation that he "manipulated" the data improperly to try to show that the drywell is worse that it really is. Hearing Tr. 596:15-17. In fact, as stated in Citizens' Ex. 61 at 13, the reason that Dr. Hausler had to interpolate the data for a severely corroded area that was measured in 1992 was that it was not re-measured in 2006. The source of the 20 mils correction applied was actually AmerGen's own consultant, who stated that the average degree of thinning observed between 1992 and 2006 was 20 mils. Citizens Ex. 9 at 4-3. Thus, while it is true that Dr. Hausler has manipulated the data in a skillful manner, any allegation that Dr. Hausler did anything improper with the data borders on the malicious and is merely an attempt to distract attention from the weakness of AmerGen's case.

Somewhat ironically AmerGen has argued, and may argue again, that Dr. Hausler is not qualified to opine on corrosion issues when many of its own experts are far less qualified than he. Dr. Hausler, as his CV indicates, earned a Masters Degree (Diploma) in Chemical Engineering and a PhD in Technical Sciences from the Swiss Federal Institute of Technology. A degree in Chemical Engineering involves studying a combination of Chemistry and Engineering while Technical Sciences refers to a broad spectrum of sciences in general. In pursuing his education, Dr. Hausler studied under several Nobel Prize recipients: Vladimir Prelog (basic organic chemistry) Lepold Rusziska (advanced organic chemistry of natural substances), Paul Karrer (advanced organic chemistry), Paul Scherrer of Debey-Scherrer fame (physics), in addition to mathematics, statistics, mineralogy, inorganic chemistry and electrolyte chemistry, physical chemistry (incl. electro chemistry) and a number of courses in inorganic and organic technical chemistry. Dr. Hausler completed 5 Master's theses prior to embarking on his PhD thesis which was in the field of inorganic solid state catalysis. Dr. Hausler has acquired a broad well-rounded technical/scientific education which he continued to enhance during his long career, which has been replete with publications, lectures, patents and awards. In contrast to AmerGen's witnesses who have merely sought to obscure what the data actually show about the state of the drywell shell, Dr. Hausler has produced the only good visualizations available of the trench data, the external data, and the comparison between the data sets. Had AmerGen's witnesses been forthcoming with some affirmative data analysis, rather than just criticism of Dr. Hausler's analyses, the Board might not have had to keep posing questions for the parties to answer during the submission of the various rounds of pre-filed testimony.

During this proceeding, Citizens have noted a tendency for AmerGen to be satisfied with a convenient argument even when it is unsupported by any data, or is even contradicted by the available records. A number of examples of this tendency arose at the hearing. Most obviously, when Mr. Tamburro was asked a straightforward question about whether corrosion in the upper drywell could occur in the absence of a corrosive environment, he stalled and then tried to avoid the question by suggesting that even though the statistical tests employed by AmerGen suggest that there is ongoing corrosion in the upper drywell, there really is no such corrosion. Hearing Tr. 527:7-529:30. This type of wishful thinking was again demonstrated when Mr. Gallagher suggested that the concrete chips that were recently found in the sandbed drains were "historical," even though he should have known that those drains had been cleaned out at least once in 1989. Hearing Tr. 520:17-21; 523:4-25.

The readiness of AmerGen to provide glib, plausible sounding explanation was again exhibited when Mr. Polaski suggested that the amount of material ground from the measurement points on the drywell was approximately 100 mils based on micrometer measurements. Hearing Tr. 329:2-330:10. This was inconsistent with AmerGen's pre-filed testimony in which AmerGen conceded that the grinding did not cause significant bias in the external results. AmerGen Ex.

C1 at A17. AmerGen's pre-filed testimony should be credited because the micrometer readings cited by Mr. Polaski were designed to characterize the depth of the observed "dimples" in Bay 13. AmerGen Ex. 17 at 39. Obviously without measurements before and after grinding they cannot provide a comparison of the amount of material that was removed at the thinnest local point, if any. Similarly, the photographs shown by AmerGen at the hearing only serve to show that material around the local minimum was removed, not that the local minimum was lowered. In fact, as far as Citizens are aware the only evidence for "over-grinding" is a suggestion that in Bay 13, the external points were "heavily ground." AmerGen Ex. 17 at 25. It is unclear what this means. Because Bay 13 is the roughest Bay, an area that was ground to just its local minimum could have given the impression of being over-ground when it was in fact only ground to the local minimum. Finally, and definitively, Table 1 illustrates that there the external results agree with the internal results in Bays 17 and 19, suggesting there is no significant bias in the way they are taken.

Mr. Polaski's misleading testimony in this regard may have misled members of the Board at the hearing. In particular, Judge Abramson seemed to believe that it had been established that the grinding had introduced significant bias in the external measurements and based many questions upon that premise. This is unfortunate because a thorough examination of the record shows that Mr. Polaski's testimony was unfounded, speculative, and contradicted by AmerGen's own pre-filed testimony. Thus, the Board's time could have been better spent examining other issues.

Other less important examples of AmerGen's misleading testimony are:

- Mr. Gallagher testified the GE sensitivity analysis modeled a 9 sq, ft. severely corroded area straddling every Bay boundary, Hearing Tr. 131:11-15, whereas Dr. Hartman clarified that the assumed symmetry actually placed such an area at every alternate Bay boundary. NRC Staff Ex. C1 at A.48.

- Mr Ouauo suggested that the vent pipe was not part of the GE model, Hearing Tr. 434:23-25, but after objections from Citizens' counsel, Dr Mehta confirmed the ventpipe was considered in the model. Hearing Tr. 435:1-8.

- Mr. Hawkins testified that an apparently corroded area in the background of a photograph was a concrete wall, Hearing Tr. 441:10-442:9; Hearing Tr. 443:3-8, but an NRC witness later corrected Mr. Hawkins and stated the corroded area on the photograph was actually a steel tendon. Hearing Tr. 444:11-445:4.

In short, Dr. Hausler's testimony was carefully considered, scrupulously implemented, and rigorously correct. In contrast AmerGen's was at times inconsistent, at variance with the record, and misleading.

CONCLUSION

For the foregoing reasons, AmerGen's application to relicense the Oyster Creek Nuclear Generating Station should be denied. In the alternative, should the Board decide to allow the relicensing to proceed, conditioned upon a future analysis showing compliance with the CLB for any period of extended operation, it must carefully specify the nature of the analysis required to ensure that inputs are specified as realistically as possible and the uncertainty of the model predictions are properly evaluated. Should it adopt this course, this Board must hold this proceeding open until the modeling study is complete, allow the current contention to be fully litigated based upon the new study, and must afford Citizens the opportunity to base a contention upon the new information that will be generated by the future analysis.

Respectfully submitted

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Dated: October 10, 2007

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges
E. Roy Hawkens
Dr. Paul B. Abramson
Dr. Anthony Baratta

In the Matter of	)	
	)	Docket No. 50-0219-LR
AMERGEN ENERGY COMPANY, LLC	)	
	)	ASLB No. 06-844-01-LR
(License Renewal for the Oyster Creek	)	
Nuclear Generating Station)	)	
	)	

NOTICE OF APPEARANCE

Notice is hereby given that the undersigned attorney enters an appearance in the above-captioned matter. In accordance with 10 C.F.R. § 2.314(b), the following information is provided:

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Name of Party: Nuclear Information and Resource Service, Jersey Shore Nuclear Watch, Inc., Grandmothers, Mothers and More for Energy Safety, New Jersey Public Interest Research Group, New Jersey Sierra Club, and New Jersey Environmental Federation ("Citizens")

Respectfully submitted,

Julia LeMense
Counsel for Citizens

Dated at Newark, New Jersey
this 10th of October 2007

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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	)	

CERTIFICATE OF SERVICE

I, Karen Hughes, of full age, certify as follows:

I hereby certify that on October 10, 2007, I caused Citizens' Post-Hearing Proposed Findings of Fact and Conclusions of Law to be served via email and U.S. Postal Service (as indicated) on the following:

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