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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
OFFICE OF THE SECRETARY

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:
E. Roy Hawkins, Chair
Dr. Paul B. Abramson
Dr. Anthony J. 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)	)	October 1, 2008

CITIZENS' SUPPLEMENTAL BRIEF REGARDING COMMISSION QUESTIONS ON STRUCTURAL ANALYSIS AND BOARD FOLLOW UP QUESTIONS

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TEMPLATE = SECY-021

DS-03

This Brief is filed on behalf of 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"). On September 18, 2008, the Atomic Safety and Licensing Board (the "Board") heard oral argument concerning the modeling that will be conducted to determine whether the drywell shell at the Oyster Creek Nuclear Generating Station ("Oyster Creek"), which comprises the containment vessel, meets and will continue to meet the requirements of the Current Licensing Basis ("CLB") with reasonable assurance. This is the post-argument Brief on that issue.

RELEVANT FACTS

In an attempt to fulfill a license condition, AmerGen Energy Co. LLC ("AmerGen") has proposed to model the drywell shell at Oyster Creek using a base case that is best explained by Figure 1 attached to the affidavit of Dr. Hausler, dated October 1, 2008 ("Hausler Aff.") (Ex. CR 6). The diagram, which AmerGen presented at oral argument, provides specific information on the locally thin areas to be used in the base case, which AmerGen omitted from Mr. O'Rourke's June 11, 2008 affidavit ("O'Rourke Aff."). These areas are identical to those described in Citizens' Ex. 45, Transcript of hearing held on September 18, 2008 ("Tr.") at 932:13-16, which AmerGen extracted from AmerGen Ex. 16. In addition, AmerGen has proposed to do two sensitivity analyses. The first would reduce the thickness of the locally thin area in Bay 1 thinner by 0.1 inches to 0.596 inches, while holding all other thicknesses constant. O'Rourke Aff. at ¶ 19. The second would reduce the modeled thickness of an area of Bay 19, which is below 11" in elevation and is also within 8.5 feet on either side of the vent line by 0.05 inches, while holding all other thicknesses constant. *Id.* at ¶¶ 21-23. It is unclear whether the thinner area covers the full width of the Bay, because on other diagrams AmerGen shows the sandbed region of each Bay as approximately 168 inches or 14 feet wide. *See e.g.* AmerGen Ex. 16 at 19.

ARGUMENT

I. AmerGen Must Use A Conservative Capacity Reduction Factor Or Eliminate The Capacity Reduction Factor From The Proposed Analysis

AmerGen has stated that it intends to multiply the result derived from its proposed model by 0.326 (the enhanced capacity reduction factor) to take account of the imperfections in the shape of the sphere. Transcript of ACRS Meeting on January 18, 2007 ("Tr1") *available at* ML070240433 at 292:25-293:9. However, experts at both Brookhaven National Laboratory and Sandia National Laboratories have stated clearly that an enhanced capacity reduction factor should not be applied to the result of a sophisticated computer simulation of the drywell, because such an approach double-counts the so-called hoop-stress, which tends to smooth imperfections in the shape.[1] Citizens' Ex. 55, Attachment at 5; NRC Staff Ex. 6 at 67; E-mail from Hessheimer to Ashley, dated February 9, 2007 *available at* ML070430292. Thus, the output of the model should actually be multiplied by 0.206. NRC Staff Ex. 6 at 67. Citizens' experts agree with this approach. Citizens Ex. CR 5, Attachment at 2.

This means that at present AmerGen is overestimating the resistance to buckling of the drywell shell by approximately 60% and it intends to continue to do so in its proposed analysis. This is clearly unacceptable. At minimum, the uncertainty in the capacity reduction factor must be included in the sensitivity analysis and, to show that it meets code, AmerGen must show that the safety factor during refueling remains above the required 2.0, even when a capacity reduction factor of 0.206 is used and the major uncertainties regarding the estimation of drywell thickness are taken into account. If this is done, it is highly likely that the modeling will show that compliance with the safety factor requirements cannot be demonstrated because the model would show that there is a considerable chance that the safety factor is below 2.0. In such circumstances, further analysis would be needed. AmerGen could then greatly reduce the uncertainty associated with the capacity reduction factor by actually measuring the shape of the vessel, as Citizens' experts have stated is the state-of-the-art. Citizens' Ex. CR 5 at 3-4. In addition, AmerGen could further reduce the current uncertainties by taking more thickness measurements to characterize the drywell surface more completely.

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[1] This is also a problem with the analysis of record upon which the Commission is relying to show reasonable assurance of current safety.

Finally, Brookhaven stated the "great caution must be exercised" with regard to excess stress in locally thin areas. Citizens' Ex. 55, Attachment at 3-4. The NRC reviewers concluded that external measurements of the drywell were needed to measure the parts of the drywell that could not be accessed from the inside.[2] Citizens' Ex. 56 at 5. These additional measurements were to confirm that the areas of severe corrosion were "as projected" and "localized." *Id.* In fact, as discussed below, the results showed unexpectedly large areas of severe corrosion in Bays 1 and 13. It remains unclear why the NRC Staff did not revisit this issue after the first set of external measurements were completed.

II. AmerGen's Proposed Approach Is Unrealistic, Inconsistent, And Inappropriate,

AmerGen's proposed approach is obviously unrealistic because it suggests that in each Bay there are two distinct regions of corrosion in the sandbed, above 11' and below 11', and that these regions are smooth. However, the data show that the pattern of corrosion is highly irregular regular. In some cases, such as Bay 19, interior measurements taken from 11" to 11'6" match closely with the exterior measurements taken below that level. Citizens' Ex. CR 4 at Table 1. In other cases, such as Bay 1, the interior measurements at 11'3" are clearly taken above the corroded area. *Id.* Indeed, some grids, such as grid 17A, show that corrosion starts abruptly between 11'6" and 11'. Citizens' Ex. 61 at 18. Photographs confirm that the start of the corrosion is not a horizontal line, indicating that the sand may not have been leveled after it was placed. E.g. AmerGen Ex. 40 at 91.

The photographs also confirm what has been consistently observed, that the exterior of the drywell shell is very rough and dimpled "like a golf ball." *Id.;* Citizens' Ex. 44 at 1. This is confirmed by the interior trench data. *E.g.* Citizens' Ex. 12 at Figure 2. Furthermore, the visual observations all indicate that there are circumferential rings of more severe corrosion just below the vent pipe openings. *See e.g.* Citizens' Ex. 44 at 1 (reporting "two strips around the vessel . . . which are slightly thinner than the general area of the shell); AmerGen Ex. 27 at 21 (reporting a "bathtub ring" of corrosion in Bay 1 that is thinner than the general thickness below 11' of 0.800" and similar rings of varying height and

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[2] The configuration of the concrete on the interior of the drywell means that for half the circumference no measurements can be taken of the sandbed from the interior and for the other half, measurements can only be taken above the 11' level. Citizens' Ex. CR-4 at Figure 2.

prominence in all other Bays). In addition to the bathtub ring and the dimples, the visual assessments indicate that in every Bay there are "thin spots" that are thinner than the general area, which range in size from a foot to 18" in diameter, and cover around 20% of the area of each Bay. Citizens' Ex. 44 at 2. In Bay 13, the thin spots are more apparent, are spread throughout the Bay, and the centers of the thin spots are 2 to 2.5 feet apart near the vent pipes and further apart towards the edges. *Id.* This variation makes it impossible to visually determine where the thinnest spots actually are. *Id.*

AmerGen claimed that it included consideration of the visual assessments when deciding which locally thin areas to include in the base case. Tr. at 940:10-941:5. This is largely incorrect. In fact, the locally thin areas in the base case are based on extracts from AmerGen Ex. 16. AmerGen Ex. 45 at 8-12; Citizens' Ex. CR 6 at Figure 1. The summaries of the visual assessments in AmerGen Ex. 16 are simplistic and self-serving. For example, the document states that the locally thin areas in Bay 13 are "located in the middle of the sandbed," AmerGen Ex. 16 at 56, not spread throughout the Bay, as was actually observed. Furthermore, the bathtub ring features in Bays 1 and 13 were actually included in AmerGen Ex. 16 (*e.g.* pages 34 & 69), but were omitted from the base case without any explanation. *See* AmerGen Ex. 45. Thus, AmerGen's modeling proposal is totally inconsistent with the visual observations and AmerGen's own assessment of the locally thin areas.

Citizens have previously shown that the contour plots generated by Dr. Hausler use a more sophisticated averaging technique than the manual method used by AmerGen to produce AmerGen Ex. 16. *E.g.* Citizens Ex. 61 at 14, 16. Dr. Hausler's plots are also more consistent with the visual observations, because they capture the prominent bathtub ring in Bay 1 and the large areas of severe corrosion observed in Bay 13. *E.g.* Citizens' Ex. 61 at 14-17. However, contrary to the assertions of the Staff and AmerGen at the hearing, Citizens are not arguing that only the external data should be used to generate the base case using contour plotting. Instead, as envisaged by Judge Baratta, all the data, including the external data, the trench data, and the internal grid data should be used. While this would

not provide a very certain estimate of the buckling strength, it would be a useful exercise provided the full range of uncertainty is also estimated through Monte Carlo simulation or manual sensitivity analysis.[3]

AmerGen's approach is inappropriate for four main reasons. First, it omits the external data entirely, makes scant use of the trench data, and uses interior data taken above 11' in Bays 5, 9, 11, 13, 17, and 19 to characterize the entire sandbed region below 11', even though the pattern of corrosion is unpredictable and highly variable. Second, it uses data from adjacent and even non-adjacent Bays to try to generate estimates for thickness in bays for which the internal data show close to nominal thickness. For example, the thickness for Bay 3 below 11' is taken as the average of Bay 5 and Bay 19 measured between 11" and 11'6", when Bay 19 is not even adjacent. Third, the areas of averaging are too large to capture stress concentration effects, which were of considerable concern when the NRC provisionally approved the drywell as fit for service in 1992. Citizens' Ex. 55, Attachment at 3-4. Finally, Dr. Mehta, AmerGen's structural expert, has clearly stated that locally thin areas with that are over 15 inches long or wide could affect the buckling capacity. Transcript of ASLB Hearing on September 24, 2007 at 479:4-480:24. Thus, the strength of the drywell needs to be assessed in a manner that takes full account of the presence of all the locally thin areas over this size, which have been observed in every Bay.

AmerGen's failure to use the external measurements is particularly puzzling because on February 7, 2007, Mr. O'Rourke proposed to use the wall thicknesses contained in AmerGen Ex. 17, which were based on the external measurements, as the base case for the modeling. Citizens' Ex. 65 at 1. However, 21 days later, AmerGen changed approaches completely and based the modeling primarily on the internal data. Citizens' Ex. 46. At the hearing AmerGen repeated the claim that it used the external points to check whether the average derived from the external points matched with that derived from the internal points. Tr. at 947:17-948:3; Citizens' Ex. 46 at OCLR29744. However, this assurance was rendered meaningless when AmerGen could not answer how many standard deviations of difference would be

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[3] In this brief Citizens are unable to address the method AmerGen used to select the range of variation for the sensitivity analysis because AmerGen has not articulated any basis for its proposed sensitivity analysis beyond "engineering judgment." Citizens believe that further analysis of the uncertainty of the base case is required and that Amergen's current proposal is wholly inadequate because it does not come close to capturing the full range of uncertainty about the actual state of the drywell shell in the sandbed region.

regarded as excessive. *Id.* at 948:10-14. Moreover, this claim is directly contradicted by AmerGen's own sworn testimony and other actions. Even though the Board ordered AmerGen to present means and 95 percentiles for the all the data contained in AmerGen Ex. 20, which included the external data, Board Memorandum and Order, dated August 9, 2007, AmerGen only presented averages of the internal data. AmerGen Ex. C Part 3 at A. 21; AmerGen Ex. 25. It did this because it claimed that it did not statistically treat the external data. AmerGen Ex. B Part 3 at A. 27; AmerGen Ex. C Part 3 at A. 37. It first presented this testimony on July 20, 2007, five months after it sent Citizens' Ex. 46 to the modeling contractor. The inescapable conclusion therefore is that AmerGen either erred when it stated that it did not statistically treat the external data, or erred when it stated that in deriving the proposed thickness estimates for the model it took account of the statistical distribution of the external data.[4] Finally, at the hearing AmerGen stated that it has assumed the external data were normally distributed, Tr. at 947:19-21, but in pre-filed testimony in this proceeding AmerGen swore the external points were not normally distributed. AmerGen Ex. C Part 3 A.48-49.

AmerGen's claim that the average thickness estimates it proposes match the external data is also directly contradicted by the data. For example, in Bay 1 averaging the external points in the corroded region outside the included locally thinner area yields an average thickness estimate of 0.759 inches, 0.67 inches less than 0.826 inches, AmerGen's selected average for the lower part of Bay 1. Hausler Aff. at 4. All Bays except Bays 7 and 19 have inconsistencies between the external data and the proposed thicknesses of similar or greater magnitude. The worst mismatch is 0.147 inches in Bay 15. Hausler Aff. at 4. Another concern with Bay 1 is that location 5, which was on the far edge of the measured area, has a thickness of 0.68 inches. As illustrated by Dr. Hausler's extrapolated plot, Ex. 61 at 15, it is likely that there is a locally thin area of unknown extent on the left side of this Bay moving toward Bay 19. AmerGen has failed to make any allowance for such an area either in the base case or the sensitivity analysis. This uncertainty alone is likely to have a major effect on the outcome of the modeling. Finally,

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[4] If AmerGen's testimony was in fact incorrect on this point and AmerGen actually did statistically treat the external data, Citizens believe this error would be prejudicial. Citizens therefore request that the Board enquire further into this issue.

as previously discussed, AmerGen has failed to include the locally thin bathtub ring in the model or the sensitivity analysis. Thus, AmerGen's claim that its proposed model is consistent with the external data is without merit.

AmerGen has also claimed that the external data should not be used to characterize the drywell because they are biased for two reasons. According to AmerGen, some points were overground and the approach of visually identifying locally thin areas when taking the measurements introduced selection bias. Neither of these claims withstands serious scrutiny. The record shows the only points for which there was even a suspicion that overgrinding might have occurred were nine locations Bay 13. AmerGen Ex. 27 at 17, 37. Even for these nine points, there are no measurements to determine whether the points were indeed overground, and it is impossible to determine whether a point was overground by inspection after the grinding has occurred. Moreover, because there is no hard evidence showing that any overgrinding took place, the theory of such bias in the Bay 13 measurements is unproven.[5] Confirming that this is not even an issue beyond Bay 13, the record shows that no overgrinding occurred in Bay 1. Hausler Aff. at 3. Indeed, AmerGen 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.

The other purported source of bias is that only visually thin points were selected for external measurements. However, this is actually not the case in many Bays. For example, in Bay 1, two points where the red lead coating was still on the drywell were included in the external measurement points. AmerGen Ex. 27 at 8, 20. In addition, when AmerGen retook the external measurements in 2006, it did not take data at many thin points in Bay 13 because they could not be found. Citizens Ex. 61 at 13. This shows how difficult it is to see where the thin spots actually are, given the generalized corrosion in each Bay. Furthermore, the trench data in Bay 17 is in agreement with the external data for Bay 17, showing that there is little to no inherent bias in the external measurements. Citizens' Ex. 61 at 18. Finally, even if all the points were selected to include the most corroded areas, which they were not, the surface

[5] The micrometer readings in Bay 13, AmerGen Ex. 17 at 39-40, cannot demonstrate overgrinding because there was no assessment of whether excess metal was removed. In fact, consistent with the trench data, the micrometer measurements show a surface roughness of approximately 0.1 inches in Bay 13, which is the roughest Bay. Citizens Ex. C1 at A23.

roughness of the shell is approximately 0.1 inches or less. Citizens Ex. 12 at Figure 2. Thus, at most, the average of the external points could only have 0.05 inches of bias in comparison to the actual mean thickness and all the indications are that any bias was much less than that. Hausler Aff. at 3.

Finally, the external data are the only data available below the 11' elevation in all Bays, except Bays 5 and 17, which have trenches cut into the interior floor. If it is at all biased, the external data could only be biased thin by a few hundredths of an inch. Given, the major uncertainties about the locations and extent of the severely corroded areas, this is insignificant. *Id.* This data should therefore be utilized, along with all the other data, to derive the best possible estimate of the base case.

III. AmerGen's Proposal Fails to Achieve Its Stated Purpose

AmerGen's model is supposed to quantify the available margin above the CLB requirements for various safety factors under various load conditions, including the safety factor of 2.0 during refueling. Tr. at 920:19-21. Because the current acceptance criteria could allow this safety factor to drop below 1.81,[6] it is highly likely that this margin is the most limiting. As AmerGen previously recognized, the limiting margin must be defined in terms of the amount of corrosion that might be permissible. Citizens Ex. 65. This is required because the measurement frequency for the aging management program is derived by dividing the estimate of the limiting margin by a conservative estimate of the potential for corrosion. Unfortunately, AmerGen has now dropped the proposal to try to determine the limiting margin in terms of thickness. Thus, the modeling proposal cannot meet its stated purpose.

IV. Most Of AmerGen's Claims On Rebuttal Were False

On rebuttal AmerGen made a number of erroneous points, which Citizens were not permitted to rebut orally. First, AmerGen alleged that Citizens were merely restating previous arguments, using "an

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[6] The GE sensitivity analysis found that using a more sophisticated analysis eliminated the margin for a shell with a uniform sandbed thickness of 0.736 inches, showing that a load factor of 6.141 equates to a safety factor of 2.0 if GE methods are valid. AmerGen Ex. 39 at 3-4. Inserting the thinned cutouts at the junction of every other Bay reduced the load factors to 5.91 and 5.562, reductions of 3.9% and 9.8%. *Id.* at 3. This leads to predicted safety factors of 1.93 and 1.81. NRC Staff Ex. C1 at A54. Because the acceptance criteria are based upon the thinnest cut out modeled and allow the shell to thin to an average thickness of 0.736 inches and have the cutouts present at full size in each Bay, they theoretically allow the safety factor to drop below 1.81. Thus, they overestimate the available margin and fail to maintain the CLB. As Judge Baratta recognized this means that further modeling is essential to quantify the limiting margin.

extrapolation scheme based on extreme value statistics," misinterpreting micrometer readings and were arguing that the internal data should be neglected. Tr. at 1023:15-1024:3. All of these allegations are flatly wrong. The extrapolation scheme proposed by Dr. Hausler extrapolates from the *measured* data and involves no prior processing of the data. As discussed above in footnote 5, the micrometer readings simply have no bearing on bias from over-grinding and merely reaffirm that at most the selection bias could have been around 0.05 inches, if the sampling protocol had been rigidly followed, which it was not. Lastly, Board question 11 in the September 10, 2008 Order clearly states that Citizens asserted that both the internal and external data should be used to characterize the shell.

AmerGen then accused Dr. Hausler of getting the location of the internal grid relative to the external points wrong. In fact, Dr. Hausler has re-examined this issue and has found that AmerGen's relative placement of the grids to the external points is erroneous and all the external points were taken below the level of the bottom of the vent-pipe ring, which is just above 11'. Hausler Aff. at 1-2. Thus, as indicated, the diagrams presented by Dr. Hausler are approximately correct, while AmerGen Ex. 44 is not.

AmerGen also alleged that proof that the external data was normally distributed was in the record. Tr. 1025:17-1026:5. In fact, the document cited by AmerGen merely *assumed* that the external data are normally distributed, but AmerGen's experts have sworn that these data are not normally distributed. Thus, AmerGen's "engineering judgment" is based on at least one erroneous assumption.

AmerGen also alleged that the "bathtub ring" did not run around the whole vessel, because there were some Bays that have essentially no corrosion. Tr. 1032:13-21. This reasoning is based on a false premise and is contradicted by the record. The exterior measurements show that there was significant corrosion in all Bays. The least corroded Bay is Bay 5, where the average of the external measurements is 0.960". AmerGen Ex. 16 at 5. This is approximately 0.2 inches below the nominal thickness of 1.154". Furthermore, as shown above the contemporaneous accounts of the visual inspections appear to indicate that the bathtub ring is present throughout each Bay and in every Bay to varying extents of prominence.

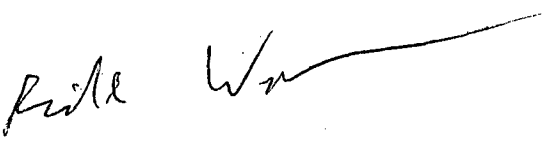
When asked about Bay 15, AmerGen failed to explain why the locally thin area assigned is and 18 inch diameter ring of thickness 0.711 inches. Tr. at 1029:2-1030:17. In fact, the proposed locally thin area is too small and the estimates of average thickness used by AmerGen in this Bay do not agree with the external measurements, contrary to AmerGen's claims. Hausler Aff. at 4.

Finally, AmerGen alleges that this Board need not consider whether additional measurements are necessary to adequately quantify the margin about the CLB factor of safety requirements. Tr. 1026:6-18. This is a transparent effort to cabin the authority granted to this Board by the Commission. In fact, the the Commission is asking about Judge Baratta's additional statement and what would be required to fully satisfy Judge Baratta that there is reasonable assurance that the drywell meets all the CLB requirements. Thus, this Board has broad authority to consider whether further analyses of the existing measurements are needed and to consider whether more measurements of the drywell shell could be necessary.[7]

CONCLUSION

For the foregoing reasons, the Board should inform the Commission that AmerGen's modeling proposal is inadequate, that more computational analysis is needed, and that if that analysis fails to show that the drywell meets all the CLB requirements for factors of safety with a high degree of certainty, more measurements would be required to reduce the uncertainty regarding CLB compliance to an acceptable level.

Respectfully submitted,



Richard Webster, Esq
Julia LeMense, Esq.
Eastern Environmental Law Center
Attorneys for Citizens

Dated: October 1, 2008

[7] Contrary to AmerGen's allegations, the finality doctrine does not apply at this point of the proceeding because the Commission has neither affirmed nor reversed any part of the Initial Decision. See *Virginia Electric and Power Co.* (North Anna Nuclear Power Station, Units 1 and 2), ALAB-551, 9 N.R.C. 704, 705-707 (1979) (finality does not attach to Board findings that have not been affirmed by the appellate body).

EXHIBIT CR 6

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

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

In the Matter of	)	
	)	
AMERGEN ENERGY COMPANY, LLC	)	Docket No. 50-219-LR
(Oyster Creek Nuclear Generating Station)	)	
	)	
	)	
	)	

AFFIDAVIT OF DR. RUDOLF HAUSLER

1. My name is Dr. Rudolf Hausler. Citizens have retained me as an expert witness in proceedings concerning the application of AmerGen Energy Company LLC to renew its operating license for the Oyster Creek Nuclear Generating Station ("Oyster Creek") for twenty years beyond the current expiration date of April 9, 2009.

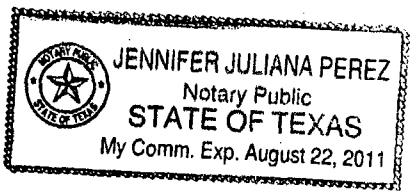
2. The attached memorandum dated October 1, 2008 represents my current opinion regarding the topics it covers.

5. I declare under penalty of perjury that this affidavit and the attached memorandum are factually accurate to the best of my knowledge, information and belief.

Dr. Rudolf H. Hausler

Sworn to me this 1st day of October , 2008

Notary Public



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Memorandum

To Richard Webster, Esq. October 1, 2008

Subject: Comments On AmerGen's Modeling Proposal

- AmerGen actively and consciously biases the data inputs to be non-conservative.
- AmerGen's overlay of the external and internal points is based on the wrong choice of the reference point for locating the external points and is erroneous.
- AmerGen uses the average of the averages of the internal measurements from adjacent Bays to make corrosion in the center bay look less severe than it actually is.
- AmerGen categorically states *that "the area between the measured points is thicker"*. This has never been substantiated.
- In view of the fact that corrosion in the sandbed area was demonstrably non-uniform, and subject to variation between and within individual bays, the sensitivity analysis proposed by AmerGen is deplorably inadequate.

I. Introduction

Figure 1 attached provides AmerGen's proposed inputs to the required 3D analysis of the drywell shell. Using the visual observations and direct measurements of the residual wall thicknesses, this memo shows that this proposal is entirely inadequate because it results in a surface that is unrealistically smooth and excessively thick. In addition, the proposed sensitivity analyses completely fail to capture the full range of uncertainty regarding the thickness of the sandbed region.

II. Visual Observations

These uncertainties are already implicit in the original inspection report of December 22, 1992, and again in January 21, 1993[1)].

- *"The shell is characterized by an outside surface full of dimples similar to the outside surface of a golf ball," which are mostly most are less than ½ inch in diameter.*
- The thinnest points were impossible to spot.[2]
- A reference point for external UT measurements was defined as about 6 inches below the reinforcement ring of the vent pipe weld to the shell[3)]. The exact elevation of this ref point

[1)] See Citizen's Exhibit 44: Inspection of drywell sandbed region and access holes, Jan. 28, 1993

[2]) In the thinnest Bays the investigation was conducted in repeat rounds of measurements, which tended to show thicker results each time. For example in Bay 1, the first found of meansurements from points 1 to 9, had an average thickness of 0.713 inches in 2006. *See* AmerGen Ex. 18 at 71; Citizens' Ex. 61 at 12. Subsequent rounds of confirmatory found less thin areas, which means the selection protocol to only measure the visually identified thinnest points was probably not followed in practice. *See* AmerGen Ex. 18 at 73, 75. ; Citizens' Ex. 61 at 12.

[3)] AmerGen EX 40 at 91

was never clearly defined, but from Fig. 1 (attached) It is clear that if the ref. point was 6 inches below this weld, it would have been right around 11 ft elevation. Therefore the diagram produced by AmerGen, which overlays the external measurements on the internal ones is completely wrong[4]. As a consequence one cannot make the argument that the internal grid measurements are reasonable representations of the external spot measurements. The positioning of the internal grids relative to the external measurements as shown in Citizen's Ex CR 4 (see Figures) is closer to reality[5]. Relevance of this comment is discussed below.

- *There are two strips around the vessel just below the vent pipe which are slightly thinner than the general area of the shell.* ***These strips have been described as "bathtub rings"[2].*** No reference is made to specific bays, nor is the extent of the bathtub rings in the horizontal direction limited in any way.
- *In addition to the dimples, there are spots that appear to be thinner than the general area. The dimples occur in these thin spots to the same degree as in the rest of the corroded portion of the shell. These thin spots are typically 18 inch in diameter, separated from each other by 2.5 feet – center to center, and probably comprise about 20% of the corroded area. In general, except in Bay 13 these spots are not readily apparent[2].*
- *The thin spots spread throughout Bay 13 but are closer together (about 1 ft apart) in the vicinity of the vent pipe and further apart toward the frames.*

The ACRS presentation by AmerGen of Jan. 18, 2007 contains various revealing photographs of the corrosion of the drywell prior and after cleaning[6]. The picture on page 57, for instance, which is not assigned to any particular bay, clearly shows that at least in this case heavy corrosion (judged by the thickness of the remaining scale) occurred over the entire depth of the sandbed and was in this case particularly heave near the sandbed bottom. The Figure on page 62 shows a similar feature where a thin strip of corrosion damage appears to be visible between the shell and the caulking.

The pictorial view of Bay 7 (apparently one of the least corroded, see UT measurements) is particularly revealing[7]. The UT measurement locations 5 and 7 are indicated with a residual wall thickness of 1000 and 1002 mils respectively. From the photographs one might conclude that the corrosion nearer to the sandbed floor would have been more severe. However the measurements for some non specified reasons stopped at the relative elevation coordinate of -21 inches, or just about in the center of the sandbed. (It is possible that the slant of the shell surface relative to the sandbed floor would not allow accommodation of the probe at still lower elevations and still sit flat on the metal surface.)

In view of these observations and comments, it is clear that that the UT results of the internal grid measurements taken above the 11' level are not representative of the state of the entire sandbed region. In addition, although the external measurements and the trench data are very sparse, they must be used to derive the current best estimate of the state of the shell in the sandbed region. This estimate will necessarily be very uncertain.

III. UT Measurements

The internal UT measurements by means of either the 1 x 7 grids or the 7 x 7 grids were carried out in the curb cutouts below the vent pipes. The 7 x 7 grids at this location were centered at 11 ft 3 inch elevation[8].

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[4] AmerGen Ex 40 at 101
[5] Citizen's Ex CR 4 Figures 2 through 13
[6] AmerGen Ex 40
[7] AmerGen Ex 40 at pg 90
[8] ibid at 50

The external UT measurements were sometimes made where visually the most severe corrosion was observed and where access with the UT probe was easily accomplished. The results depend on a number of factors not very well identified in the record. The probe, we believe had a diameter of 1 inch and needed to be placed flat on the corroded surface to generate reliable results. Of the 116 externally selected points for UT measurements only 28 were ground flat according to the original data sheets reported in AmerGen Exh 18 at 76, 88, 94. The operators had explicit instruction to remove as little metal as possible. It is therefore highly unlikely that the deepest spot in the pit was reduced by as much as 0.1 inch or 2.5 mm. I therefore think that the bias attributed to the grinding is not justified (and has never been substantiated).

Since in Bay 1 only half the points identified for UT measurement had been ground and since the non-ground ones were in part equally deep these latter ones would have biased the UT measurement in 1992 toward the thicker side. In 2006 a newer probe was used which could compensate for the presence of the coating. Therefore in 2006 the non-ground pits should have been found deeper than the ground ones in comparison to the older data. No such bias was seen after careful analysis of all the Bay 1 data. It is concluded that it is unlikely that grinding biased the residual wall thickness to the thin side.

The other bias toward excessive pit depth (wall thinning) claimed by AmerGen was the stated intent to determine the minimum residual wall thickness. However, again careful analysis of the data shows an even distribution of residual wall thicknesses from nominal to as much as 40% wall loss. This fact, together with careful examination of the contemporaneous records of the work and the visual observations indicate to me that the sampling protocol of selecting the thinnest points was not carefully followed. This is confirmed by the agreement between the tranch data in Bay 17 and the external data. Moreover, given a surface roughness of less than 0.1 inches, any bias would have been less than 0.05 inches if the protocol had been followed. However, my assessment is that any bias induced by sample selection was much less than this theoretical maximum and, given the major uncertainties present, this is negligible.

Because the external data had not been collected to support the structural analysis two serious uncertainties are no introduced into the modeling and the sensitivity analysis:

- The spatial extent of the corrosion in the sandbed area is actually unknown, The areas examined are smaller than the areas characterized visually.
- The areas of excessive corrosion cannot be defined and are likely larger than specified in the input to the model (18 and 51 inch in diameter).

On this basis I want to discuss the individual Bays in detail and bring perspective to AmerGen's proposed base study and sensitivity analysis[9)].

IV. Corrosion in Individual Bays

AmerGen's currently proposed model shows two horizontal rings. The higher elevation is essentially defined by the grid measurements, and the lower one in the sandbed region defined by the some adjusted estimate of the average of either the internal or external UT measurements. The data are summarized in Figure 1.

General Comments

The average and locally thin areas selected by AmerGen shown in the Figure 1 are not consistent with the external data. For example, in Bay 1 points 14 and 15 were chosen to confirm that no corrosion had

[9)] Graphical representation of AmerGen's input to the new modeling study: see AmerGen's Initial Brief in Response to CLI-08-10

occurred above the sand bed. AmerGen Ex. 17 at 8. The measured thicknesses in Bay 1 are illustrated on a scaled plot provided in Citizens' Ex. 61 at 14. Area III on that plot corresponds to the area AmerGen is modeling as a locally thin area in Bay 1. Citizens' Ex. 45 at 12. Averaging the rest of the results taken in the sandbed region (i.e. omitting points 14 and 15), yields a estimate of 0.759 inches for the average thickness. This is 0.67 inches less than 0.826 inches, the selected average for the lower part of the sandbed region, which was based upon data taken in the upper part of the sandbed region in Bay 19. As show in Table 1, all Bays except Bays 7 and 19 have inconsistencies between the external data and the proposed thicknesses of similar or greater magnitude. The worst mismatch is 0.147 inches in Bay 15, where the average of the external points in Bay 15 is 0.788 inches, AmerGen Ex. 16 at 70, while AmerGen has assigned an average thickness of 0.935 for the lower part of the sandbed. Figure 1, attached. This discrepancy confirms that the estimates of average thickness used by AmerGen do not agree with the external measurements.

Bay 1

AmerGen's base case assigns 826 mil to both rings. The average from grid data is 1068 mil and from the external measurements 767, if point 14 and 15 are omitted because they were chosen to be uncorroded. AmerGen's proposed avaerage is simply the grid averages from the adjacent Bay 19. AmerGen then also places a circle of lower than average corrosion in the lower part of Bay 1 with an average of 696 mil vs. the average of 767 mils from the external UT data. The 51 inch diameter however does not even cover the measured area of severe corrosion. Furthermore, a detailed analysis shows that the extent of corrosion is in all likelihood much larger than the 51 inch circle would suggest. See also Citizen's Exh CR 4, Figs 2 through 13 discussed above. The data therefore suggest that the average for the lower area is 767 vs. 826 mils and the documented history suggest strongly that the corroded area is much larger than covered by the 51 circle.

Bay 15

Regarding Bay 15, it is unclear why the locally thin area in Bay 15 is an 18 inch diameter ring of thickness 0.711 inches. The area previously delineated by AmerGen as locally thin contains 4 points and is 36 by 36 inches. AmerGen Ex. 16 at Figure 15-3 (p76). The average of these 4 points is 0.768 inches, while a single point in the middle is 0.711 inches thick. Thus, it appears that the proposed locally thin area is too small. In addition, there is a single point with thickness 0.720 inches, which is outside the locally thin area. *Id.* at Figure 15-2 (p75).

Table 1

Bay No	AmerGen Model Input Averages		Measured Data Averages		Difference AmerGen Input vs Measured Averages	
	Upper Area (mils)	Lower Area (mils)	Upper Area (mils)[1)]	Lower Area (mils)	Upper Area (mils)	Lower Area (mils)
1	**826**	***826***	**1068**	***801***	**0**	**25**
3	**1180**	***950***	**1180**	***865***	**0**	**85**
5	**1185**	***1074***	**1185**	***960***	**0**	**114**
7	**1133**	***1034***	**1133**	***1007***	**0**	**27**
9	**1074**	***993***	**1164/985**	***905***	**10/89**	**88**
11	**860**	***860***	**1142/846/898**	***783***	**-282/14/-38**	**77**
13	**907**	***907***	**1121/846/968**	***784***	**-214/61/-61**	**123**
15	**1062**	***935***	**1054/1121**	***788***	**8/-92**	**147**
17	**863**	***963***	**1015/833**	***890***	**-100**	**73**
19	**826**	***826***	**822/847/839**	***801***	***4/-21/-13***	**25**

[1)] Multiple values refer to multiple internal grid measurements

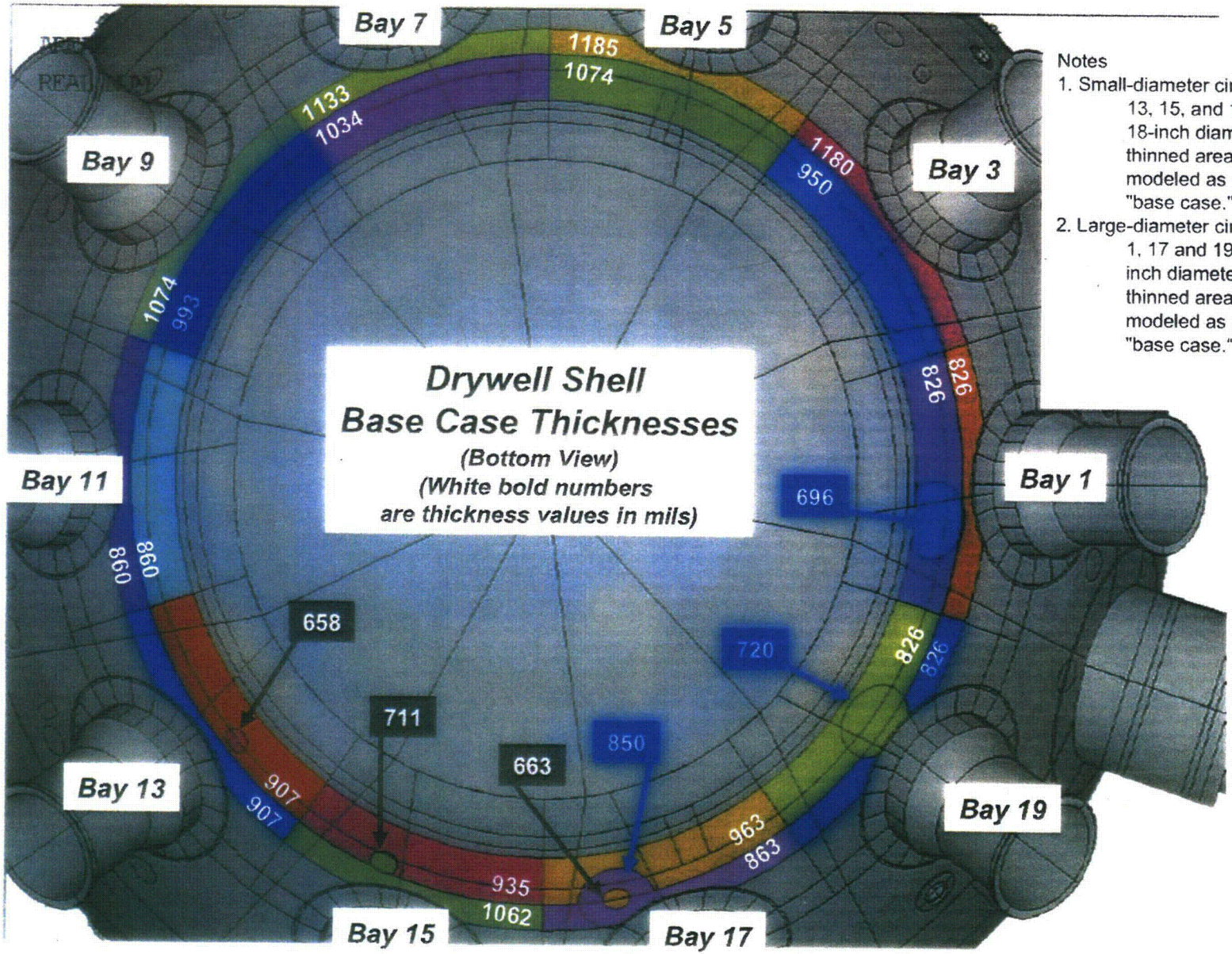
Bay 7
Bay 5
Bay 9
Bay 3
Bay 11
Bay 1
Bay 13
Bay 19
Bay 15
Bay 17
Drywell Shell
Base Case Thicknesses
(Bottom View)
(White bold numbers
are thickness values in mils)
1185
1074
1133
1034
1180
950
1074
993
826
826
696
860
860
658
720
826
826
711
850
663
907
907
963
863
935
1062
Notes
1. Small-diameter circles in Bays 13, 15, and 17 represent 18-inch diameter locally-thinned areas that were modeled as part of the "base case."
2. Large-diameter circles in Bays 1, 17 and 19 represent 51-inch diameter locally-thinned areas that were modeled as part of the "base case."

Figure 1

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
OFFICE OF THE SECRETARY

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:
E. Roy Hawkins, Chair
Dr. Paul B. Abramson
Dr. Anthony J. 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)	)	October 1, 2008
	)	

CERTIFICATE OF SERVICE

I, Richard Webster, of full age, certify as follows:

I hereby certify that on October 1, 2008, I caused Citizens' Supplemental Brief Regarding Commission Questions on Structural Analysis and Board Follow Up Questions and Affidavit of Rudolph Hausler to be served via email and U.S. Postal Service (as indicated) on the following:

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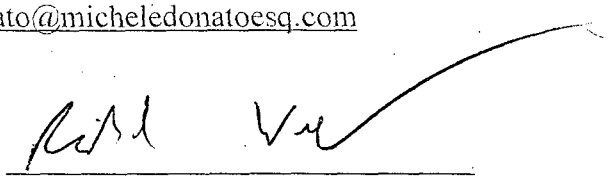
Signed: 

Richard Webster

Dated: October 1, 2008