UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:

E. Roy Hawkens, Chairman
Dr. Paul B. Abramson
Dr. Anthony J. Baratta

In the Matter of	Docket No. 50-0219-LR
AMERGEN ENERGY COMPANY, LLC	ASLBP No. 06-844-01-LR
(License Renewal for Oyster Creek Nuclear Generating Station)	October 29, 2008

MEMORANDUM
(Addressing The Issue Referred By The Commission Regarding The Adequacy Of AmerGen's Proposed 3-D Finite Element Structural Analysis Studies)

I. INTRODUCTION

On January 14, 2008, the intervenors ("Citizens")[1] petitioned for Commission review of this Board's decision in LBP-07-17 (Dec. 18, 2007). In that decision, we rejected Citizens' challenge to the application of AmerGen Energy Company, LLC ("AmerGen") for a twenty-year renewal of its operating license for the Oyster Creek Nuclear Generating Station ("Oyster Creek"). On August 21, 2008, while Citizens' petition for review was pending, the Commission referred the following issue to this Board for expeditious resolution: whether the structural analysis that AmerGen has committed to perform on the Oyster Creek drywell shell matches or bounds the sensitivity analysis that Judge Baratta discussed in his "Additional Statement" that accompanied our decision in LBP-07-17. This Board – informed by the briefs and affidavits filed

[1] The intervenors in this case – who refer to themselves collectively as Citizens – consist of the following six organizations: 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.

by the parties, as well as the oral arguments presented by counsel – is satisfied that AmerGen's proposed approach to performing the structural analysis will likely – subject to the suggestions discussed in Part IV of this Memorandum – match or bound the sensitivity analysis contemplated by Judge Baratta in his Additional Statement. However, we recommend that the Commission direct the Staff to ensure that an in-depth review of AmerGen's completed analysis is performed to verify its adequacy.[2]

II. BACKGROUND

1. This Board's Initial Decision In our decision in LBP-07-17, we rejected Citizens' contention that AmerGen's plan to take ultrasonic testing ("UT") measurements in the sand bed region of the drywell shell every four years during the twenty-year renewal period is not sufficiently frequent to ensure an adequate safety margin is maintained between measurements due to the uncertain condition of the drywell shell, the uncertain corrosive environment, and the uncertain corrosion rate.[3] More precisely, we concluded that AmerGen demonstrated by a preponderance of the evidence that: (1) the sand bed region of the drywell shell will satisfy the acceptance criteria at the beginning of the renewal period, and it will likewise satisfy the acceptance criteria throughout the renewal period because it will not experience significant corrosion; and (2) even assuming the sand bed region experiences measurable corrosion during the renewal period, AmerGen's plan to take UT measurements every four years is

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[2] To be clear, this Board ruled in LBP-07-17 that AmerGen has demonstrated that its aging management plan will ensure that the drywell shell maintains an adequate safety margin during the renewal period. Pursuant to that ruling, AmerGen's decision to perform a structural analysis of the drywell shell prior to the renewal period – albeit sensible for purposes of providing a model that better quantifies the available margin and enhances public confidence in the continued safe operation of the plant – was not essential to the granting of its renewal application.

[3] We assume the parties' familiarity with the background of this case, which is discussed in detail in LBP-07-17.

sufficient to ensure the bounding available shell margin is not exceeded. See LBP-07-17, 66 NRC 327, 371 (2007).

Judge Baratta, who is one of the two technical judges on this Board, included an Additional Statement with our decision in which he stated that, although he "concur[red] with the majority['s] . . . findings of fact" (LBP-07-17, 66 NRC at 376), he believed that it was nevertheless "essential to have a conservative best estimate analysis of the drywell shell before entering the period of extended operation" (id. at 375). Judge Baratta noted that AmerGen already had committed to perform a three-dimensional ("3-D") finite element structural analysis of the drywell shell prior to the renewal period.[4] This 3-D analysis will use "modern methods and current drywell shell thickness data to better quantify the margin that exists above the Code required minimum for buckling. The analysis will include sensitivity studies to determine the degree to which uncertainties in the size of thinned areas affect Code margins" (id. at 367 n.55). If the 3-D analysis reveals that the drywell shell does not satisfy the thickness values required by the Code, AmerGen must notify the NRC Staff (ibid.). Judge Baratta stated that, given the "limited

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[4] AmerGen's commitment, which was made to the NRC Staff on February 15, 2007, is contained in AmerGen Exh. 10, Letter from Michael P. Gallagher, AmerGen, to U.S. NRC (Feb. 15, 2007), Enclosing Additional Commitments Related to the Aging Management Program for the Oyster Creek Drywell Shell Associated with AmerGen's License Renewal Application, Commitment 27(18). The NRC Staff included AmerGen's commitment in Appendix A (Commitment Table) of the Safety Evaluation Report. See AmerGen's Initial Brief in Response to CLI-08-10, Affidavit of John F. O'Rourke ¶¶ 6, 8 (June 11, 2008) [hereinafter O'Rourke June 11, 2008 Affidavit].

Pursuant to AmerGen's commitment, the "sensitivity analyses [for its 3-D analysis] will use, as input, conservative thickness estimates for areas between UT thickness measurement locations, thereby producing a conservative assessment of the performance capability of the drywell shell" (Letter from Michael P. Gallagher, AmerGen, to NRC Staff regarding Commitment Clarifications Related to the Aging Management Program for the Oyster Creek Drywell Shell at 2 (Jan. 14, 2008) (ADAMS Accession No. ML080160540)). Further, "[i]f the analysis determines that the drywell shell does not meet the Code-specified safety factors (i.e., 2.0 for the refueling load case and 1.67 for the post-accident load case), the NRC will be notified in accordance with 10 C.F.R. Part 50 requirements" (id., encl. at 1). See also NRC Staff's Brief Responding to the Commission's Order, Affidavit of Hansraj G. Ashar ¶ 7 (June 11, 2008).

data set of thickness measurements" in the sand bed region of the drywell shell, he would impose an additional requirement on AmerGen to "perform a series of sensitivity analyses, at least one of which includes the use of an extrapolation scheme to determine the thicknesses between the measured locations" (id. at 376).

2. Citizens' Petition For Review Of LBP-07-17, And The Commission's Referral Of The Issue In CLI-08-10 To This Board On January 14, 2008, Citizens petitioned the Commission to review LBP-07-17. See Citizens' Petition for Review of LBP-07-17 and the Interlocutory Decisions in the Oyster Creek Proceeding (Jan. 14, 2008). AmerGen and the NRC Staff filed answers opposing Citizens' petition, and Citizens replied to those answers. See AmerGen's Answer Opposing Citizens' Petition for Review of LBP-07-17 and the Interlocutory Decisions in the Oyster Creek Proceeding (Jan. 24, 2008) [hereinafter AmerGen's Jan. 24, 2008 Answer]; NRC Staff's Answer to Citizens' Petition for Review of LBP-07-17 (Jan. 24, 2008); Citizens' Consolidated Reply Regarding Petition for Review of LBP-07-17 and the Interlocutory Decisions in the Oyster Creek Proceeding (Jan. 29, 2008).

In its answer to Citizens' petition, AmerGen stated, inter alia, that it had committed to perform a 3-D structural analysis of the drywell shell prior to the renewal period, and this 3-D analysis would "includ[e] sensitivity analyses that Judge Baratta refers to in his Additional Statement" (AmerGen's Jan. 24, 2008 Answer at 9).

On May 28, 2008, the Commission issued an order (CLI-08-10) directing the parties to submit briefs that address the following topic: "Explain whether the structural analysis that AmerGen has committed to perform, and that is reflected in the Staff's proposed license condition, matches or bounds the sensitivity analysis that Judge Baratta would impose. In any event, explain whether additional analysis is necessary" (CLI-08-10, 67 NRC __, __ (slip op. at 3) (May 28, 2008)).

In compliance with the Commission's order, on June 11, 2008 and June 18, 2008, the parties filed briefs addressing the specified issue. See AmerGen's Initial Brief in Response to CLI-08-10 (June 11, 2008) [hereinafter AmerGen's June 11, 2008 Brief]; NRC Staff's Brief Responding to the Commission's Order (June 11, 2008); Citizens' Response to Commission Order Dated May 28, 2008 (June 11, 2008) [hereinafter Citizens' June 11, 2008 Brief]; AmerGen's Reply to Citizens' Response to CLI-08-10 (June 18, 2008); NRC Staff's Reply in Response to Citizens' Response to Commission Order Dated May 28, 2008 (June 18, 2008); Citizens' Reply to NRC Staff and AmerGen Responses to Commission Order Dated May 28, 2008 (June 18, 2008) [hereinafter Citizens' June 18, 2008 Brief].

By order dated August 21, 2008, the Commission referred the issue specified in CLI-08-10 to this Board "for resolution as expeditiously as is practicable" (Commission Order (Aug. 21, 2008) at 2 (unpublished)).

On September 18, 2008, this Board held oral argument in Toms River, New Jersey, and on October 1, 2008, the parties availed themselves of the opportunity to file supplemental briefs. See AmerGen's Supplemental Brief Following Oral Argument (Oct. 1, 2008) [hereinafter AmerGen's October 1, 2008 Supplemental Brief]; NRC Staff's Supplemental Brief on Commission-Referred Question (Oct. 1, 2008) [hereinafter NRC Staff's October 1, 2008 Supplemental Brief]; Citizens' Supplemental Brief Regarding Commission Questions on Structural Analysis and Board Follow Up Questions (Oct. 1, 2008) [hereinafter Citizens' October 1, 2008 Supplemental Brief].[5]

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[5] Prior to the oral argument, this Board provided the parties with a list of topic areas and questions that would be the focus of the Board's interest at the argument. See Licensing Board Order (Topics for Discussion and Procedures for Oral Argument) (Sept. 10, 2008) (unpublished).

III. ANALYSIS

To address the issue referred to us by the Commission, this Board reviewed AmerGen's proposed model and planned analysis as described by the parties in their briefs and at the September 18 oral argument. Based on this review, we conclude that AmerGen's proposed approach for its 3-D model and analysis will likely, subject to our recommendations discussed in Part IV infra, "match[] or bound[] the sensitivity analysis that Judge Baratta would impose" (CLI-08-10, 67 NRC at __ (slip op. at 3)).

As AmerGen describes, the model and analysis "consist[] of a finite element structural 'base case' analysis and sensitivity analyses" (O'Rourke June 11, 2008 Affidavit ¶ 12). We discuss these components of AmerGen's proposed analysis – the base case and the sensitivity analyses – in turn. We then discuss the NRC Staff's plan to review AmerGen's completed analysis.

1. The Base Case In his Additional Statement, Judge Baratta raised the concern that the current model used to understand the state of the drywell shell did not realistically capture the condition of the drywell shell such that it could be used to determine the actual value of the safety factor and ensure that the factor of safety required by the ASME Code will be met throughout the entire period of extended operation. See LBP-07-17, 66 NRC at 373, 375-76. The current model is based on an analysis conducted by General Electric ("GE") in the 1980s and early 1990s. The analysis used an axisymmetric model that, while state of the art at the time, did not model the three-dimensional characteristics of the shell. The model assumed a uniform thickness in the sand bed region. To compensate for the inability to model the shell in three dimensions, GE developed models of sectors that had locally thinned areas and determined the reduction in load carrying capability caused by the locally thinned regions. See AmerGen Exh. 37, NRC Safety Evaluation: Drywell Structural Integrity, OCNGS, at 3 (Apr. 24,

1992); AmerGen Exh. B, AmerGen's Pre-filed Direct Testimony Parts 1-7 (July 20, 2007), Pt. 2, A.10, A.12, A.13.

Judge Baratta recognized that AmerGen committed to perform a more modern, 3-D analysis of the drywell shell as a license condition. See LBP-07-17, 66 NRC at 376. However, he recommended that sensitivity analyses be performed on the 3-D analysis "[t]o account for the very limited data set of thickness measurements" (ibid.). Before discussing AmerGen's sensitivity analyses, the Board first examines AmerGen's proposed 3-D model, or the base case.

The base case model of the drywell shell is described in Table 1 of the O'Rourke Affidavit and depicted in a diagram that was prepared at the Board's request and provided to counsel for all of the parties prior to oral argument on September 18. See O'Rourke June 11, 2008 Affidavit at 7-8; E-mail from Raphael P. Kuyler, Counsel for AmerGen (Sept. 16, 2008) (enclosing diagram entitled "Drywell Shell Base Case Thicknesses") [hereinafter AmerGen Diagram]. See also Errata to Affidavit of John F. O'Rourke Dated June 11, 2008 (Sept. 12, 2008).[6]

Each of the ten bays in the sand bed region is divided into two regions of constant thickness. AmerGen stated that the rationale for dividing the bays horizontally into two regions was engineering judgment (Tr. at 933) (Polonsky). AmerGen took this approach based on the observation that some of the internal UT thickness data was not representative of the thickness in the bay because the corrosion did not occur uniformly at the same height around the drywell since the top of the sand in the sand bed was not even. The top surface of the sand bed was essentially an undulating surface with the highest level of corrosion occurring at that sand-air

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[6] A copy of the AmerGen Diagram may be found in Citizens' October 1, 2008 Supplemental Brief as an attachment (Figure 1) to the Affidavit of Dr. Hausler dated October 1, 2008. For ease of reference, we have appended the diagram to this Memorandum.

interface. If UT thickness data were taken slightly above that interface, or right at that interface, it would suggest a non-conservative thickness for the whole bay.

To compensate for this, AmerGen split the bays in a horizontal way by modeling in the 3-D model a different thickness in some cases for regions above the 11 foot, versus below the 11 foot elevation. In each of these regions, a general thickness was assigned to each of the bays – one for above the 11 foot level, and another for the region below the 11 foot level. As AmerGen explained at the September 18 oral argument, "[e]ach bay was handled uniquely and independently based on the data that was available for that bay" (Tr. at 940) (Polonsky). The data used included not only the UT measurements but also visual observations of the corrosion in each bay. See id. at 933-35, 938-40 (Polonsky).

In some cases, stated AmerGen, visual observation of the bay revealed that the bay UT data was not representative of the bay's thickness. For example, the UT data in Bay 1 showed nominal thickness, whereas visual observation showed considerable corrosion. In such cases, AmerGen applied engineering judgment and used adjacent bay UT data to model bay thickness (Tr. at 940-41) (Polonsky).

Locally thinned areas that exist in some bays were identified using the external UT data. The areas included regions in five bays: Bays 1, 13, 15, 17, and 19. To account for these areas, the base case includes locally thinned areas represented by the small and large diameter circles. See AmerGen Diagram. The small diameter circles in Bays 13, 15, and 17 represent 18-inch diameter locally thinned areas, and the large diameter circles in Bays 1, 17, and 19 represent 51-inch diameter locally thinned areas. See ibid. AmerGen concluded that modeling these thinned areas in this manner was conservative, because "this amount of thinning does not

actually exist" (Tr. at 931 (Polonsky) (quoting O'Rourke June 11, 2008 Affidavit ¶ 15)). Accord Tr. at 950-51, 1031-32.[7]

The external data was also used as a check on the thickness assigned to bays where the internal UT data was not thought to be representative of the bay thickness or where no internal data was available. See Tr. at 946 (Polonsky). This was done by comparing the external UT data in the bay in question to the internal UT data in the adjacent bay used to obtain the thickness of the bay in question. If the external data was encompassed by the distribution of the internal data, then AmerGen judged the choice appropriate. See id. at 947-48 (Polonsky). For example, the general thickness for Bays 3, 7,[8] and 15 below the 11 foot level was assigned using the average of the adjacent bays (id. at 946) (Polonsky). In cases where the external data did not suggest a locally thinned area, the points were treated as part of the general thickness for that bay (id. at 949) (Polonsky).

AmerGen stated that the process used to assign thicknesses where little or no data exists is an extrapolation scheme in several respects. As discussed, the general thicknesses in some bays used extrapolated data from adjacent bays. The locally thinned areas used the limited data to extrapolate both a thickness and size of the locally thinned region resulting in what AmerGen believes to be a conservative and bounding thickness for the thinned regions. See Tr. at 950-51 (Polonsky).

Citizens, on the other hand, assert that AmerGen's proposed approach for the base case model does not match or bound what Judge Baratta would impose. For example, they argue that AmerGen's approach to creating a 3-D model fails to properly account for external

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[7] In the old analysis, these locally thinned areas were modeled as trays. See Tr. at 945-46 (Polonsky).

[8] For Bay 7, no UT thickness data external or internal is available below the 11 foot level (Tr. at 946) (Polonsky).

data or the trench data. See Citizens' October 1, 2008 Supplemental Brief at 5; Tr. at 981-82 (Webster). Citizens also criticize the approach used by AmerGen in developing the general thickness estimates, averring that one point that is close to the original drywell thickness could bias the calculated average on the high side. See Tr. at 985 (Webster). In an affidavit filed after the September 18 argument, Citizens' expert provided additional support for this argument. He compared the external measurements with the thicknesses that AmerGen plans to use in its proposed model. He argued that these measurements show that AmerGen has overestimated the thicknesses and ignored the external data, thereby biasing the proposed thicknesses on the high side. See Citizens' October 1, 2008 Supplemental Brief, Affidavit of Dr. Rudolf Hausler tbl. 1 (Oct. 1, 2008) [hereinafter Hausler October 1, 2008 Affidavit].

Citizens also contend that the regions of constant thickness selected by AmerGen should be reduced to a smaller area. Specifically, these regions should, according to Citizens, be sized to an area that is smaller than would make a difference structurally (Tr. at 993) (Webster).[9] AmerGen's use of such large areas allegedly fails to capture the detailed geometry of the corrosion pattern and results in over-averaging. See Citizens' October 1, 2008 Supplemental Brief at 5; Tr. at 993-94 (Webster).

Finally, Citizens criticize the capacity reduction factor used by AmerGen and consider it "far too high" (Tr. at 995) (Webster). See also Citizens' June 11, 2008 Brief at 6-7. The capacity reduction factor has been used to take account of the beneficial effects of hoop stress in the drywell shell. See Citizens' June 11, 2008 Brief at 6. Citing the Sandia National Laboratories (Sandia) Report (NRC Staff Exh. 6, Excerpts of the Structural Integrity Analysis of

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[9] At the evidentiary hearing, the NRC Staff expert stated that the region of influence may be determined by the square root of the radius of the drywell divided by the thickness. In the case of the Oyster Creek drywell shell, this equates to eighteen inches. The effect of any thickness variations on the ability of the drywell shell to withstand buckling within such a distance would be averaged out by the material itself and need not be modeled. This places a lower bound on the size of the regions in the model. See Tr. at 475-78 (Mehta).

the Degraded Drywell Containment at OCNGS (The Sandia Report) (Jan. 2007)), which used a lower capacity reduction factor, Citizens assert that AmerGen's use of the higher factor results in double counting the hoop stress. See Citizens' June 11, 2008 Brief at 6-7; Tr. at 995 (Webster).[10]

In our judgment, notwithstanding Citizens' arguments to the contrary, AmerGen's proposal for creating the base case model appears to use modern methods and sound engineering judgment to generate a 3-D model of the drywell shell that will better quantify the available margin in a manner that is consistent with what Judge Baratta recommended in his Additional Statement in LBP-07-17. Rather than assuming uniform thickness, AmerGen treated each bay "uniquely and independently" (Tr. at 940) (Polonsky), resulting in a base case that "models the drywell shell thickness realistically, with some conservatism . . . using an extrapolation scheme to develop general area thicknesses as well as the thicknesses for five, locally-thinned areas" (AmerGen's October 1, 2008 Supplemental Brief at 2).

To be sure, Citizens raise a number of alternative ways that AmerGen might have elected to use the available data to develop a 3-D model. For example, Citizens suggest that AmerGen should instead have employed the "objective interpolation and extrapolation techniques" proposed by their expert, Dr. Rudolf Hausler (Citizens' June 18, 2008 Brief, Memorandum attached to Declaration of Dr. Rudolf Hausler (June 17, 2008) at 2 [hereinafter Hausler June 17, 2008 Declaration]). However, there is a permissible range of engineering

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[10] AmerGen argues that to the extent Citizens seek to challenge the capacity reduction factor, they are exceeding the scope of the limited issue that the Commission referred to this Board to resolve (AmerGen's October 1, 2008 Supplemental Brief at 7). This argument ignores that the Commission charged this Board with the task of examining the adequacy of AmerGen's proposed 3-D model and associated sensitivity study. To the extent AmerGen's 3-D model relies on a capacity reduction factor, the adequacy of that factor is encompassed in the referred issue. Moreover, we believe that the Commission's broad request that we determine "whether additional analysis is necessary" provides us with sufficient latitude to consider whether further analyses relating to the capacity reduction factor may be advisable. See infra Part IV.

judgment that is involved in developing any model. As the authors of Citizens' Exhibit CR 3 (which is attached to their June 11, 2008 brief to the Commission) state, "models may use different assumptions, and require different inputs" (Citizens' June 11, 2008 Brief, Exh. CR 3, Joshua Reinert & George Apostolakis, Including Model Uncertainty in Risk-Informed Decision Making, 33 Annals of Nuclear Energy 354, 358 (2006) [hereinafter Reinert & Apostolakis Article]).

AmerGen, in its briefs and representations at oral argument, outlined the rationale for its engineering judgment in developing the base case and pointed out areas where it has put this judgment to the test. See, e.g., AmerGen's October 1, 2008 Supplemental Brief at 2, 4-5; Tr. at 933-34, 939-41 (Polonsky). Considering the additional steps that AmerGen is taking, this Board is satisfied that – subject to several recommendations we discuss in Part IV infra – AmerGen's proposal for the base case will likely provide a conservative best estimate analysis of the actual conditions of the drywell shell consistent with the view expressed in Judge Baratta's Additional Statement.

2. The Sensitivity Analyses In Judge Baratta's Additional Statement, he suggested that AmerGen conduct sensitivity studies in order to understand the consequences of the uncertainties that exist in the 3-D model. See LBP-07-17, 66 NRC at 376. In particular, he exhorted AmerGen to "perform a series of sensitivity analyses, at least one of which includes the use of an extrapolation scheme to determine the thicknesses between the measured locations" (ibid.).

To account for uncertainty introduced by the limited data available, AmerGen has planned two sensitivity analyses: (1) an analysis that looks at the uncertainty in locally thinned areas; and (2) an analysis that looks at the uncertainty in general thickness areas (Tr. at 951) (Polonsky). AmerGen states that "the first sensitivity analysis matches or bounds Judge Baratta's sensitivity analysis recommendation because it models a locally-thinned area as much

larger and thinner than actually measured" (AmerGen's June 11, 2008 Brief at 2), and "[t]he second sensitivity analysis matches or bounds Judge Baratta's sensitivity analysis recommendation because it models the general area in a bay as thinner than actually measured" (ibid.).

Describing the first sensitivity analysis, AmerGen states that it "assesses the sensitivity of the base case to uncertainties in the thickness of locally-thinned areas. . . . It uses a hypothetical, locally-thinned area in Bay 1 (i.e., a 51-inch diameter circle with an average thickness of 696 mils), and reduces the thickness of that area by 100 mils, to 596 mils" (O'Rourke June 11, 2008 Affidavit ¶ 18). The intent is "to see what the sensitivity of the model is for that kind of high-level change" (Tr. at 951) (Polonsky). There are no measurements or observations to suggest that the shell was as thin as 596 mils in any of that region, and this region was chosen since it represents the largest locally thinned area and should thus provide a bounding estimate of the effect. See id. at 952-53 (Polonsky).

For the second sensitivity analysis, AmerGen will examine the effect that a reduction of the general area thickness has on the model. In this case, AmerGen will reduce the general thickness area in Bay 19, which was chosen because it has the thinnest general area thickness, from 826 mils to 776 mils, a 50 mil reduction. See O'Rourke June 11, 2008 Affidavit ¶¶ 21-22. In addition, AmerGen states that "[t]his sensitivity analysis . . . models a locally-thinned area of 51-inches in diameter with a conservative average thickness of 720 mils, which had been modeled into the base case analysis and remains unchanged for the sensitivity analysis" (id. ¶ 23).

Citizens, for their part, argue that AmerGen has not provided a justification for the reductions used in the first and second sensitivity analyses, and that they are unrealistic. See Hausler June 17, 2008 Declaration at 1. Citizens instead recommend that, after taking into account their view of how the base case should be modeled, AmerGen should perform a Monte

Carlo calculation to determine the uncertainties in the model. See Citizens' June 18, 2008 Brief at 4. Citizens essentially assert that because AmerGen is not using Citizens' proposed methodology to determine the uncertainties in the model, AmerGen's proposed sensitivity analyses do not match or bound what Judge Baratta would impose. See id. at 1-2.

In the Board's judgment, AmerGen's proposed sensitivity analyses appear to match or bound what Judge Baratta would impose. In elaborating in his Additional Statement on the types of sensitivity analyses that might be useful, Judge Baratta suggested that "[t]he technique might be similar to the one suggested by Citizens' expert, Dr. Hausler, that uses contour plots generated from known thicknesses both interior and exterior" (LBP-07-17, 66 NRC at 376) (emphasis added). Judge Baratta thus identified Dr. Hausler's proposed sensitivity analysis as an example of what AmerGen might undertake. That AmerGen elected to use a technique that differs from the technique championed by Dr. Hausler does not compel the conclusion that AmerGen's proposed sensitivity analysis fails to match or bound what Judge Baratta would impose.

The article that Citizens attached to their June 11, 2008 brief to the Commission discusses various methodologies for accounting for uncertainties. The authors state:

> Methods to deal with model uncertainty include prediction expansion and model set expansion. . . . In prediction expansion, a single model is chosen as the best one to represent the system. However, it is recognized that this model has uncertainties and may model some characteristics of the system better than others. Sensitivity studies are performed on various assumptions to analyze the effects of the choice of assumptions on the model output. This uncertainty is dealt with by applying an adjustment factor to the model results.

Reinert & Apostolakis Article at 357-58. The authors continue: "In model set expansion, the characteristics of the system under consideration are analyzed and models are created in an attempt to emulate the system based on goodness-of-fit criteria. The models may use different assumptions, and require different inputs" (id. at 358). It appears to this Board that the

approach and models proposed by AmerGen are consistent with the approaches described in Citizens' exhibit and, moreover, that they comport with sound engineering judgment.

We nevertheless find that some of Citizens' concerns about the sensitivity studies ought to be accommodated, and we provide the Commission with specific recommendations in Part IV infra.

3. The NRC Staff's Review Of The Planned Analysis When AmerGen completes the structural analysis of the drywell shell, it will submit a comprehensive summary of the analysis to the NRC Staff for its review. It is expected that the summary will be several hundred pages in length, will not contain any proprietary material, and will be available to the public through the NRC's Agencywide Documents Access and Management System. See Tr. at 1026-27, 1034, 1036 (Polonsky); AmerGen's October 1, 2008 Supplemental Brief at 8. It will "identify the inputs, assumptions, and methods that AmerGen used to conduct the 3-D structural analysis, and will therefore be sufficiently detailed such that a qualified structural engineer could perform an in-depth review of the results" (AmerGen's October 1, 2008 Supplemental Brief at 8).

The NRC Staff stated that although its review of AmerGen's analysis will be more than cursory (Tr. at 1040) (Baty), it did not plan to perform an in-depth review unless the analysis shows the drywell shell does not meet code requirements. Rather, the Staff stated it "will be reviewing the summary report that [it] receive[s] in considering whether the analysis looks rigorous, whether it [i]s consistent with good engineering practice, and whether it's compliant with various codes and standards" (id. at 962) (Baty). See also NRC Staff's October 1, 2008 Supplemental Brief at 6 (Staff plans to review AmerGen's analysis "in accordance with Inspection Procedure 71003").

Given the unique circumstances of this case, including the Commission's apparent interest in the adequacy of AmerGen's analysis, we believe that an in-depth review of AmerGen's completed analysis is warranted (see infra Part IV). AmerGen, for its part, appears

to expect as much, stating that "the results of [its] 3-D analysis will receive an in-depth review [from the NRC Staff]" (AmerGen's October 1, 2008 Supplemental Brief at 9).

IV. RECOMMENDATIONS OF THE LICENSING BOARD

As discussed supra Part III, based on the record before us, we conclude that AmerGen's approach in developing the 3-D model is tailored toward obtaining a conservative best estimate of the margin. We also conclude that the sensitivity studies planned by AmerGen should likely provide a bounding of the uncertainties. These conclusions, however, are subject to the following suggestions.

1. We believe that Citizens' comment concerning the size of the regions in the model is consistent with good engineering practice and has sufficient merit to warrant further action by AmerGen in its development of a conservative best estimate model of the drywell shell. Some of the bays exhibit regions that show little or no corrosion, yet these are modeled as thinned regions in the proposed AmerGen model. For example, visual observation in Bay 1 determined that there are areas approaching original thickness that are adjacent to thinned areas. See Tr. at 940-41 (Polonsky). While this may seem conservative, it may or may not be depending on how the thicknesses of these regions were used. Because there are visual observations of the corrosion, it should be possible to estimate the size of these regions and – informed by engineering judgment – to further subdivide the model where warranted to account for them. We believe this should be done to better capture the true margin.

2. Regarding Citizens' comments on the capacity reduction factor, the NRC Staff stated (Tr. at 1044) (Baty) that in a letter to the ACRS Chairman from the Director of License Renewal (ADAMS Accession No. ML070650376), the Director of License renewal recounted communications with Sandia where Sandia stated it did not have access to the test results used to justify modification of the capacity reduction factor and had no position on whether the data shared during the February 1, 2007 ACRS meeting satisfies use of the modified capacity

reduction factor. We suggest that the Commission consider directing the Staff to have Sandia review the test results and report whether use of the modified factor is justified.

3. It is unclear as to how AmerGen factored into the averaging process UT data that show near-original thickness in development of the average thicknesses used for bays that have heavily corroded areas. We suggest that a sensitivity study be performed to assess the impact of any outlier data on the averages used in the model as outlier data might cause the averages to be biased thick or even thin.

4. The proposed general area reduction of 0.050 inch in the lower half of Bay 19 does not appear to encompass the uncertainty introduced when the external points are compared with the thicknesses proposed by AmerGen in its second sensitivity study. To evaluate the sensitivity of the results, we suggest the reduction in thickness should be increased to 0.075 inch. This value is about equal to the average value of the differences between AmerGen's proposed lower area model input averages and the lower area measured data averages as calculated by Citizens for all ten bays. See Hausler October 1, 2008 Affidavit tbl. 1 (indicating the average value of the differences in the lower area (last column) is 0.078 inch).

5. We recommend that AmerGen not limit the second sensitivity study to just one bay, Bay 19. Rather, AmerGen should also look at the effect of decreasing the thickness in at least one of the other corroded bays, such as Bay 1. It should then look at the combined effect of decreasing the thickness in both Bays 1 and 19 to determine what effect reducing the thickness has on the safety factor.

6. Although the NRC Staff initially stated that it did not intend to perform an in-depth review of the completed AmerGen model and analysis (Tr. at 962) (Baty), it subsequently clarified that it would review the results of AmerGen's 3-D analysis in accordance with Inspection Procedure 71003 (id. at 1040-41) (Baty). In the Board's judgment, AmerGen's structural analysis should, upon completion, be subjected to a more rigorous review. We

recommend that the Commission require the Staff to perform, or have performed, a comprehensive and in-depth review of the work done by AmerGen to confirm that it provides, with reasonable assurance, an estimate of the amount of margin that exists, and to confirm that the analysis, as performed, is in fact a conservative best estimate analysis.

THE ATOMIC SAFETY
AND LICENSING BOARD *

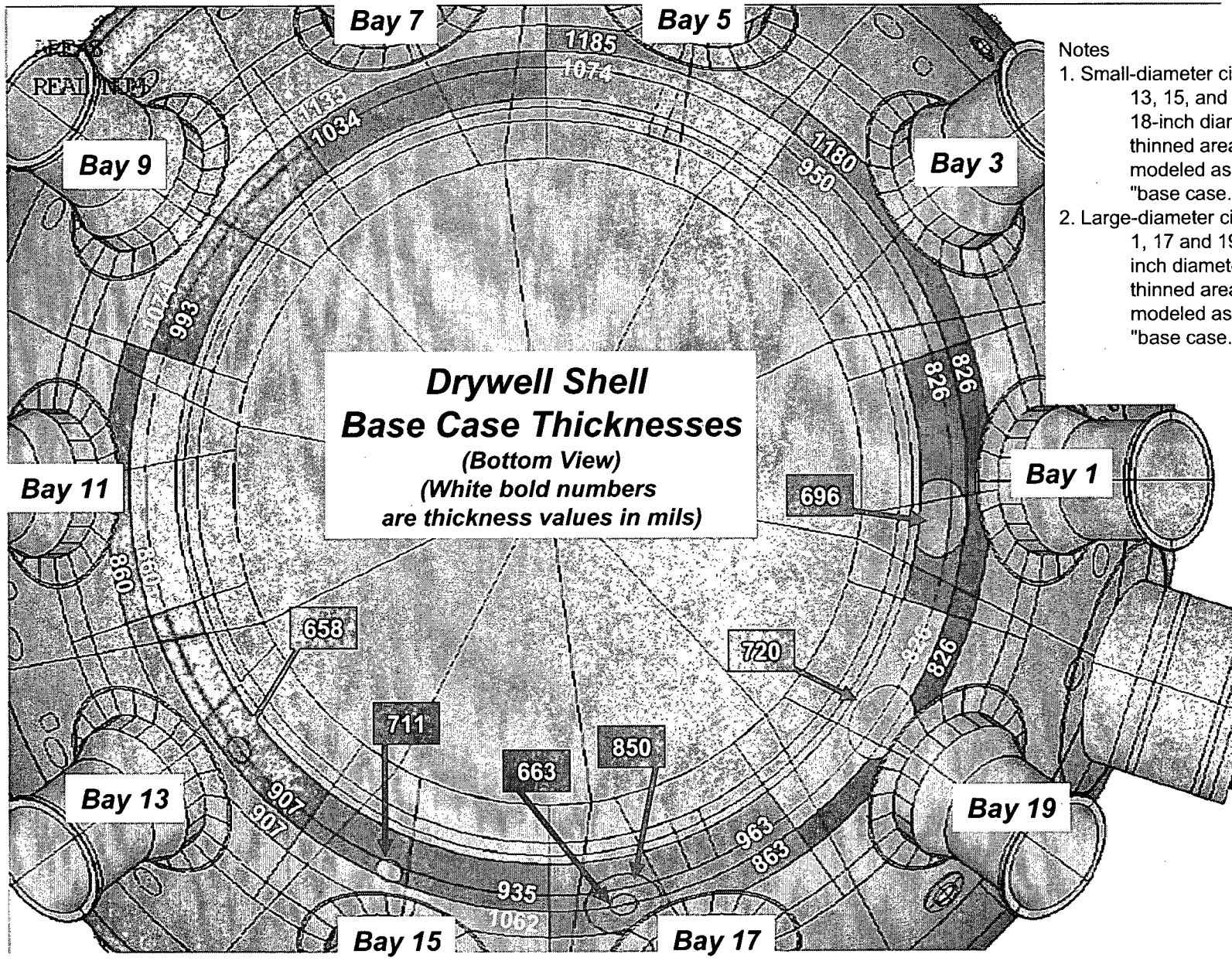
/RA/
E. Roy Hawkens, Chairman
ADMINISTRATIVE JUDGE

/RA/
Dr. Anthony J. Baratta
ADMINISTRATIVE JUDGE

* Judge Abramson has filed a "Separate Advisory Opinion" that immediately follows this Memorandum.

Rockville, Maryland
October 29, 2008[11]

[11] Copies of this Memorandum were sent this date by Internet e-mail to counsel for: (1) AmerGen; (2) Citizens; (3) the NRC Staff; and (4) New Jersey.



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."

Separate Advisory Opinion of Judge Abramson

I write this separate advisory opinion to express to the Commission my specific concerns and views regarding the request they have effectively made of this Board through their "referral" of this particular matter to us for "resolution" as promptly as practicable. I am personally hamstrung by needing to approach this matter both from my perspective as an attorney and from my perspective as a scientist/engineer.

I begin with observing that this Board has been concerned since receipt of this "referral" about defining the precise nature of the Commission's charge to us. Given that the Commission has not reversed our decision in LBP-07-17, there are only two possibilities: (a) the Commission has remanded this matter to us for a determination on its merits; and (b) the Commission has asked for our advisory opinion regarding the specific question it has referred to us.[1] Since the Commission is quite capable of expressing itself and using the word "remand," it is my opinion as a legal judge, that this matter has not been remanded to us for a merits determination, but rather it has been referred to us to provide an advisory opinion.

The particular inquiry which the Commission made of us is: "whether the structural analysis that AmerGen has committed to perform [on the Oyster Creek drywell shell], and that is reflected in the Staff's proposed license condition, matches or bounds the sensitivity analyses that Judge Baratta would impose. In any event, [determine] whether additional analysis is necessary" (CLI-08-10, 67 NRC __, __ (slip op. at 3) (May 28, 2008)). Judge Baratta's

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[1] As is noted in the majority's Memorandum, the Board had the parties brief this issue. The Staff and Applicant took the view that the Commission's action was neither a remand nor a reversal, and while Citizens did not provide legal authority that disputes that conclusion, they took the view that the Board has broad latitude in dealing with the referral, including reopening the record to conduct additional evidentiary hearings on the referred matter. See Tr. at 918-28. In addition to these briefs, however, we are also faced with the Commission's characterization, in dicta in its opinion rendered in CLI-08-23, of its referral action here as a remand. See CLI-08-23, 68 NRC __, __ (slip op. at 12) (Oct. 6, 2008). I take that dicta to be just that, and therefore not an accurate reflection of the Commission's view of the legal ramifications of its referral.

concerns were discussed in his "Additional Statement" that accompanied our decision in LBP-07-17.

Thus, we have been requested to advise the Commission by "resolving" the referred matter, and while I agree with Citizens, see supra note 1, that we have wide latitude in fulfilling this mandate, I do not agree that the Commission has indicated its approval for us to reopen the record to accomplish this goal. Moreover, from a legal standpoint, I see no need to reopen the record in the present circumstance, because I perceive no material relationship between the referred question and the appeal of LBP-07-17 awaiting decision by the Commission.

The simple answer to the Commission's inquiry, which could have been rendered within days of the referral, is that no additional analysis is required with respect to, and there is nothing raised by the referred question that impacts, in any way, the license renewal proceeding before this Board or this Board's determination that the challenge should be resolved in favor of the Applicant.[2]

Moreover, I do not believe that even the holding of an evidentiary adjudication would result in the sort of definitive answer requested by the Commission (i.e., will AmerGen's planned analyses bound or match the sensitivity analyses which Judge Baratta would impose, or will it not); rather, it would produce a ruling to the effect that the preponderance of the evidence either supports or fails to support AmerGen's position that the yet-to-be performed computations will bound the concerns expressed by Judge Baratta. Thus, at the end of the day, I do not believe it can reasonably be expected that adjudication can provide the answer to the Commission's inquiry.

Furthermore, such an inquiry at this stage is an illogical effort to adjudicate something not ripe for adjudication (because the analyses and computations have not been performed), as

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[2] The matters raised in the referred question were not at issue, nor necessary to our decision, in LBP-07-17.

well as an unnecessary expenditure of adjudicative and litigative resources (and, as discussed below, the proper and well vetted mechanism already exists for the Agency to assure the proper analytical understanding of this matter at the appropriate time). While the discussion provided in the majority's Memorandum may inform the Commission on the majority's understanding of AmerGen's computations, it cannot and does not provide any definitive answer to the explicit inquiry posed to us. Nor could I reach the sort of definitive answer which was requested because to do so would require, at the very least, the gathering of a great deal of specific information regarding the details of the computations and the computer code to be used as well as the underlying data.

Because I disagree with the apparent perception of the majority that the Commission is interested in a partially informed and relatively inconclusive opinion from the Board, I cannot join in that discussion, nor do I have the technical information to reach even the limited conclusions reached in the majority's Memorandum. In sum, we are simply not presently in a position to reach the requested definitive conclusion regarding what AmerGen's computations will show, nor do I believe we could do so upon the basis of an evidentiary hearing.

More constructive advice, however, and more important to the Commission's ultimate approach to this matter, can be obtained through recognition that the Commission has a perfectly rational and effective mechanism for assuring that AmerGen's commitment to perform these analyses is met and produces results acceptable to the Agency – and that mechanism is that the commitment is a License Condition which the Staff will enforce. The Staff has available, both in-house and through its extensive base of expert outside consultants, ample resources to examine the analyses once they have been completed, confirm their accuracy and boundaries, and make confirmatory computations.[3] In my view, and it is my advice to the Commission in

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[3] In sharp contrast, the members of this Board have neither the expertise nor the (continued...)

response to the referral, the Commission should apply its customary license condition review practices to the issue it wishes to have addressed, and the Agency can, and should, enforce AmerGen's commitment in the customary manner. I do recommend, as does the majority, that the Commission direct its technical staff to engage appropriate expertise to conduct a thorough examination of the analyses when submitted.

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[3](...continued)
resources to perform those functions, and the customary practice within the Agency would seem to me to be that the job of determining the adequacy of those computations resides with the Commission's technical staff, not with this Board.