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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

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

In the Matter of:	)	July 27, 2007
AmerGen Energy Company, LLC	)	
(License Renewal for Oyster Creek Nuclear Generating Station)	)	Docket No. 50-219

AMERGEN'S MOTION IN LIMINE TO EXCLUDE PORTIONS OF CITIZENS' INITIAL WRITTEN SUBMISSION

I. INTRODUCTION

In accordance with 10 C.F.R. §§ 2.1204, 2.323 and 2.337, and the Atomic Safety and Licensing Board's ("Board") Orders of April 19, 2006,[1] and April 17, 2007,[2] AmerGen Energy Company, LLC ("AmerGen") hereby moves to exclude portions of (1) "Citizens'[3] Initial Statement Regarding Relicensing of Oyster Creek Nuclear Generating Station," dated July 20, 2007 ("Citizens' Statement"); (2) the "Pre-Filed Direct Testimony of Dr. Rudolf H. Hausler," ("Testimony"); (3) Citizens' Exhibits 12 and 13; and (4) the entirety of Citizens' Exhibits 26, 27,

1 Memorandum and Order (Prehearing Conference Call Summary, Initial Scheduling Order, and Administrative Directives) (unpublished).

2 Memorandum and Order (Prehearing Conference Call Summary, Case Management Directives, and Final Scheduling Order) (unpublished).

3 "Citizens" are: 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.

TEMPLATE = SECY-041

SECY-02

and 36. Specifically, the Board should exclude such information[4] because: (1) Dr. Hausler is not an expert in statistical analyses or in epoxy coating systems; (2) Citizens have yet again defied the Board by improperly litigating numerous issues that are outside the scope of the admitted contention; (3) Citizens' Statement, Testimony and Exhibits include unreliable speculation and unsupported statements of fact; and (4) Dr. Hausler's Testimony contains impermissible "attachments." Such information is inadmissible in this proceeding and must be excluded pursuant to 10 CFR § 2.337(a).[5]

II. ARGUMENT

The very narrow question at issue in this proceeding is the frequency of AmerGen's ultrasonic testing ("UT") during the period of extended operation for the sand bed region of the drywell shell located at the Oyster Creek Nuclear Generating Station ("OCNGS").[6]

A. Legal Standards

10 C.F.R. Part 2, Subpart L, incorporates by reference the general provisions in Subpart C.[7] Section 2.337(a), located within Subpart C, and governing the admissibility of evidence states that, "[o]nly relevant, material, and reliable evidence . . . will be admitted . . . . [i]mmaterial and irrelevant parts of an admissible document will be segregated and excluded so far as is practicable."

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[4] Attachments 1 through 4 to this Motion identify specific statements to be stricken in Citizens' Statement, Testimony, and Exhibits 12 and 13, respectively, with numbers and letters corresponding to the specific subsections of Section II.B of this Motion where the exclusions are discussed. Attachment 5 to this Motion is a chart summarizing the reasons for the proposed exclusions and the corresponding subsections, to assist the Board and the parties in their review of the proposed exclusions.

[5] Counsel for AmerGen has consulted with Citizens' and NRC Staff counsel in accordance with 10 C.F.R. § 2.323(a). As a result of those conversations, this Motion has been modified to eliminate certain planned objections to Citizens' Initial Written Submission. Citizens' counsel does not concur with this Motion. NRC Staff counsel indicated that the Staff would respond as appropriate after review of the Motion.

[6] Memorandum and Order (Denying AmerGen's Motion for Summary Disposition) at 2 (June 19, 2007) (unpublished) ("June 19 Order"); *see also AmerGen Energy Company, LLC* (Oyster Creek Nuclear Generating Station), LBP-06-22, 64 N.R.C. 229, 240 (2006) ("LBP-06-22").

[7] *See* 10 C.F.R. § 2.1200.

Based on this standard, Boards have excluded testimony and exhibits on issues that are outside the scope of the admitted contention, that are wholly unrelated to the issues in the proceeding, or that seek to raise issues that should have been raised in earlier pleadings.[8]

Parties also may move to exclude unreliable expert witness testimony as recognized by the Commission:

> [NRC] precedents . . . place the burden of demonstrating that a witness is qualified to serve as an expert on the party who offers the witness. A witness may qualify as an expert by "knowledge, skill, experience, training, or education" to testify "[i]f scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue."[9]

Fully consistent with this standard, an expert's opinion is admissible only if it is based on the "methods and procedures of science," rather than on "subjective belief or unsupported speculation."[10]

B. Inadmissible Portions of Citizens' Submission

1. Citizens Have Identified the Wrong Expert for Their Arguments

A very large portion of Citizens' Statement and Testimony relates to statistical treatment of the UT data collected from the external surface of the drywell shell in the sand bed region.

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8 *See, e.g.*, *Louisiana Energy Services, L.P.* (National Enrichment Facility), Memorandum and Order (Ruling on In Limine Motions and Providing Administrative Directives) (Jan. 21, 2005) (unpublished) ("LES"); *LES*, Memorandum and Order (Ruling on In Limine Motions Regarding Prefiled Direct Testimony and Providing Administrative Directives) (Feb. 5, 2005) (unpublished); *LES*, Memorandum and Order (Ruling on In Limine Motions and Motion to Dismiss) (Oct. 4, 2005) (unpublished); *LES*, Memorandum and Order (Ruling on In Limine Motions Regarding Prefiled Exhibits and Rebuttal Testimony) (Oct. 20, 2005) (unpublished); *LES*, Memorandum and Order (Ruling on In Limine Motion) (Jan. 11, 2006) (unpublished).

9 *Duke Energy Corp.* (Catawba Nuclear Station, Units 1 and 2), CLI-04-21, 60 N.R.C. 21, 27-28 (2004) (internal citations omitted) (upholding expert witness qualifications on interlocutory review); *see also Duke Power Co.* (William B. McGuire Nuclear Station, Units 1 and 2), ALAB-669, 15 N.R.C. 453, 475 (1982) (upholding Licensing Board conclusion that witness lacked sufficient expertise to testify) (internal quotations omitted); *Entergy Nuclear Vermont Yankee, L.L.C.* (Vermont Yankee Nuclear Power Station) Memorandum and Order (Ruling on Motions in Limine) (July 28, 2006) (denying Intervenor's Motion to disqualify applicant's expert).

10 *Duke Cogema Stone & Webster* (Savannah River Mixed Oxide Fuel Fabrication Facility), LBP-05-04, 61 N.R.C. 71, 98-99 (2005) (quoting *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 589-90 (1993)) (disqualifying expert for certain purposes).

Dr. Hausler is not qualified to provide such expert opinions.[11] Although the Board may have accepted Dr. Hausler as an expert relating to *corrosion of the drywell shell*, it has not accepted him as an expert in statistical analyses.[12] Nor have Citizens introduced information on the record to demonstrate that Dr. Hausler is currently qualified to present such expert opinion. His expertise relates to the "selection, testing and application of Oil Field Chemicals, primarily corrosion inhibitors," and the development of "corrosion testing facilities" and "corrosion inhibitors."[13] There is no evidence on the record that he has any experience in the use of statistics to analyze the potential for failure of a metal structure, and he has little if any educational background in statistics.[14] Accordingly, Citizens' arguments on this topic supported by Dr. Hausler's Testimony should be excluded as indicated in Attachments 1, 2, 3 and 4.

Dr. Hausler is similarly unqualified to provide expert opinions regarding the application, performance, and expected life span of the epoxy coating system that covers the exterior surface of the drywell shell in the sand bed region. Citizens have introduced no information in their submission to demonstrate that Dr. Hausler holds the requisite expertise to present an expert opinion on these topics. Instead, his experience, education, and expertise appear to be confined to chemical corrosion inhibitors—not coatings.[15] Accordingly, Citizens' arguments on this topic that are supported by Dr. Hausler should be excluded as indicated in Attachments 2 and 3.

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11 *Duke Energy Corp.*, CLI-04-21, 60 N.R.C. at 27 (establishing standard for expert witness qualification).

12 *See* LBP-06-22, 64 N.R.C. at 242 n.14).

13 Testimony Attach. 1 at 1-2.

14 Testimony at A.5; Testimony Attach. 1 at 3. There is no syllabus for the course that Dr. Hausler allegedly developed, and he cites no statistical papers that he has authored. The use of statistical computer programs does not imply understanding of the discipline. He apparently has only limited—and dated—statistical experience in the use of "Compositional Statistics to optimize complex mixtures with a minimum of tests."

15 Testimony, Attach. 1.

2. Citizens Continue to Litigate Numerous Issues That Are Beyond the Scope of This Proceeding

a. Citizens' Challenge to AmerGen's Statistical Analyses

The Board has repeatedly ruled that the statistical analyses used to calculate the existing drywell shell thickness margins are outside the scope of the admitted contention.[16] Most recently, the Board "admonished" Citizens not to raise yet another challenge to the "methods of calculation or uncertainties contained in AmerGen's Statistical Analysis" or to argue "that AmerGen must consider additional uncertainties in performing its analysis."[17]

Citizens have done exactly that. Most of their Statement and Testimony is devoted to resurrecting their challenge to AmerGen's statistical analyses by proposing an "*alternative approach* for estimating the mean thickness of the sand bed region" using "the latest thickness measurements taken from the outside of the vessel."[18] For example, in direct contravention to the Board, Citizens apply additional uncertainties to AmerGen's external data to derive reduced margin calculations, despite the fact that AmerGen does not use the external data to determine margin to the buckling criteria for the purposes of license renewal.[19] Instead, AmerGen uses only the UT data from the *internal* grids to determine margin for buckling.[20] The "contour plots" in Citizens' Testimony Attachment 4 and Exhibit 13 also represent an impermissible "alternative approach." Accordingly, the statements identified in Attachments 1, 2, 3 and 4 must be excluded.

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16 LBP-06-22, 64 N.R.C. at 254-55; June 19 Order at 2 n.4; Memorandum and Order (Clarifying Memorandum and Order Denying AmerGen's Motion for Summary Disposition) at 4 (July 11, 2007) (unpublished) ("July 11 Order").

17 July 11 Order at 4.

18 Citizens' Statement at 2 (emphasis added).

19 AmerGen Dir. Part 3 at A.27, A.29. Moreover, as explained in Section II.B.3, below, Dr. Hausler acknowledges that his "alternative approach" is nothing but unfounded speculation.

20 AmerGen Dir. Part 3 at A.24, A.28, A.31; *see also* Staff Testimony at 27; Final SER at 4-60.

b. Citizens' Testimony About Corrosive Conditions on the Embedded Interior of the Drywell Shell

Citizens also attempt to resurrect issues, related to the embedded interior surface of the drywell shell, that the Board has long ago ruled are outside the scope of the proceeding. On February 9, 2007, this Board rejected a late-filed contention that AmerGen's UT monitoring program was inadequate because it did not "provide systematic monitoring of potential corrosion occurring from the *inside* of the drywell shell in the sand bed region."[21] In rejecting that proposed contention on *substantive* grounds, the Board stated that "significant corrosion has *not* occurred, and will *not* occur, on any portion of the interior side of the embedded shell in the lower and bed region."[22]

Although Citizens failed to provide "any credible facts or arguments that place AmerGen's conclusion [about corrosion of the interior surface of the drywell shell] in genuine dispute" at the pleadings stage, they recycle those arguments now.[23] Citizens are simply prohibited from doing so.[24] Accordingly, the statements identified in Attachments 1 and 2, and all of Citizens' Exhibits 26, 27 and 36 must be excluded.[25]

c. Citizens' Testimony Challenging the Local Buckling Criterion

Citizens also impermissibly recycle challenges to the established acceptance criteria. Citizens allege that AmerGen may not use the local buckling criterion (*i.e.*, 0.536" in the "tray"

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21 Memorandum and Order (Denying Citizens' Motion for Leave to Add Contentions and Motion to Add Contention) at 2, 5 (Feb. 9, 2007) (unpublished) (quoting Citizens' contention, emphasis added).

22 *Id.* at 11 (emphasis in original) (citations omitted).

23 *Id.* at 12; *see, e.g.*, Citizens' Statement at 25-27.

24 *See LES*, Memorandum and Order at 4 (Jan. 21, 2005) ("Having been rejected at the pleadings stage, [a] matter cannot now be resurrected by virtue of the prefiled direct testimony of a witness who, for whatever reason, did not provide support [for an] issue when it was previously proffered").

25 In its June 19, 2007 Order, the Board expressed the expectation that "the parties will scrupulously endeavor to remain within [the narrow] scope [of the contention] as they prepare testimony for the evidentiary hearing." June 19 Order at 9. Relying on this warning from the Board, AmerGen specifically did not address in its Initial Written Statement the potential for corrosion on the interior embedded portion of the drywell shell.

configuration shown in Applicant's Exhibit 11) because the criterion does not satisfy ASME Code requirements.[26] This is an impermissible challenge to the derivation of the acceptance criteria, and to the OCNGS CLB.[27] Citizens, therefore, are barred from raising it again, and the statements identified in Attachments 1, 2 and 4 should be excluded.

d. Citizens' Testimony About the Scope of UT

Citizens' Statement and Testimony are peppered with impermissible references to alleged inadequacies in the scope of AmerGen's UT monitoring program. For example, Citizens offer unsupported assertions that, "UT monitoring locations . . . are not representative of the corrosion,"[28] and "no measurements are available to verify whether AmerGen did . . . capture all of the most corroded areas . . . ."[29] Dr. Hausler extensively discusses "contour plots" in an attempt to demonstrate that additional UT measurement locations are needed.[30] Such arguments are not litigable in this proceeding.[31] Thus, these arguments must be excluded, as indicated in Attachments 1, 3 and 4.

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[26] *E.g.*, Citizens' Statement at 5-9 (including the allegation that the GE analyses, upon which that criterion is based, result in a reduction in the ASME Code safety factor of two). Citizens also wrongly suggest that "the Board must determine . . . the most appropriate local area acceptance criterion." Citizens' Statement at 5. Contrary to Citizens' request, the Board has no authority to "determine" the local buckling acceptance criteria. This criterion is part of the CLB, and that is not within the scope of the Board's jurisdiction in this license renewal proceeding. *See Florida Power & Light Co.* (Turkey Point Nuclear Generating Plant, Units 3 & 4), CLI-01-17, 54 N.R.C. 3, 8-9 (2001) ("the Commission did not believe it necessary or appropriate to throw open the full gamut of provisions in a plant's [CLB] to re-analysis during the license renewal review"); *see also* LBP-06-22, 64 N.R.C. at 253.

[27] LBP-06-22, 64 N.R.C. at 240; June 19 Order at 2 n.4; *see also* Memorandum and Order (Denying Citiznes' Motion for Leave to Add a Contention and Motion to Add a Contention) at 6 (Apr. 10, 2007) (unpublished) (denying Citizens' late-filed acceptance criteria contention as untimely).

[28] Testimony Attach. 3, at 1.

[29] Testimony Attach. 4 at 10

[30] *Id.* at 9-11, 17-23. The discussion of the "contour plots" is punctuated by statements such as, "AmerGen did [not] in fact manage to capture all of the most corroded areas as claimed," and "[w]e are therefore left with a great uncertainty as to the true extension [sic] of the damage . . . ." *Id.* at 10.

[31] LBP-06-22, 64 N.R.C. at 249-51; *see also* June 19 Order at 2 n.4.

e. Citizens' Argument About Real-Time Corrosion Monitoring

Citizens argue that "Dr. Hausler knows of applications where real-time corrosion monitoring has been installed. There appears to be no reason why this approach could not be taken to monitor both interior and exterior corrosion of the drywell shell."[32] This appears to be a direct challenge to the *use*, as opposed to the *frequency* of UT, and as such is clearly outside the scope of the proceeding.[33] Attachments 1 and 2 to this Motion identify the statements that must be excluded.

3. Citizens Have Submitted Speculative Statements, Unsupported Assertions, and Unreliable Exhibits

Only reliable evidence will be admitted.[34] Citizens' Statement and Testimony offer a variety of statements of fact that are unsupported by citations to any document or other basis, or that are simple speculation. For example, Dr. Hausler's Testimony includes "guess[es]"[35] and "suggestion[s]"[36] about undiscovered corrosion that "could"[37] exist, and other speculative statements. Dr. Hausler even acknowledges that his "alternative approach" to analyzing UT data is based on speculation: "calculating averages between [external UT data points] cannot possibly lead to results with a high degree of confidence."[38] "The paucity of data . . . makes definite conclusions very difficult and assessment of the extent of the corroded areas somewhat

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[32] Citizens' Statement at 4 n.1.

[33] *C.f.* LBP-06-22, 64 N.R.C. at 245, 247-48 (rejecting Citizens' argument that AmerGen adopt a "continuous monitoring" plan for moisture in the sand bed region).

[34] 10 C.F.R. § 2.337(a).

[35] Testimony Attach. 4, at 10.

[36] *Id.*

[37] *Id.*

[38] *Id.* at 5.

intuitive."[39] This material should be excluded as unreliable and is identified in Attachments 1, 2, 3 and 4.

4. The "Attachments" to Dr. Hausler's Testimony Should Be Stricken

Finally, Citizens submitted Dr. Hausler's pre-filed Testimony as a ten-page written testimony document, followed by five attachments, including a list of documents reviewed, Dr. Hausler's resume, and three other substantive written documents. In NRC proceedings, "the general practice relative to prefiled testimony is that, other than resumes or curriculum vitae regarding the witness, attachments are not to be used with the testimony in lieu of exhibits."[40] Thus, Attachments 3, 4, and 5 to Dr. Hausler's Testimony should be excluded in their entirety.[41] Citizens' Exhibits 12 and 13, however, appear to duplicate Attachments 3 and 4 to Dr. Hausler's Testimony. Attachments 3 and 4 to this Motion identify the statements in Citizens' Exhibits 12 and 13 that cannot be admitted into evidence for reasons described in other sections of this Motion. In the event that Citizens resubmit Attachment 5 to Dr. Hausler's Testimony as an exhibit, pages 5-27 of Attachment 1 to this Motion also identify the statements in this document that cannot be admitted into evidence for reasons described in other sections of this Motion.

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39 *Id.* at 2 (emphasis added)

40 *LES*, Memorandum and Order at 4 n.2 (Jan. 21, 2005).

41 Pages 5 to 27 of Citizens' Statement appear to duplicate Attachment 5 to Dr. Hausler's Testimony. Thus, exclusion of Attachment 5 will also essentially remove the evidentiary support for the statements on pages 5 to 27 of Citizens' Statement, requiring these portions of Citizens' Statement to be stricken for this reason, independent of any other reasons in this Motion. Also, Attachment 3 to Dr. Hausler's Testimony is a redacted version of a memorandum previously prepared in response to AmerGen's Motion for Summary Disposition. Citizens' Exhibit 12 appears to be another copy of this redacted memorandum. The redactions remove "certain testimony that [Dr. Hausler] understand[s] is beyond the scope of the proceeding" or is "outdated," but the redacted portions appear in the margins of the Attachment and *again* at the end of Attachment 3. Citizens' motive in submitting this "deleted" material is unclear, but it is clear that this admittedly irrelevant material must be excluded from evidence. Attachment 3 to this Motion also identifies portions of Dr. Hausler's redacted Memorandum that must be excluded for reasons described in other sections of this Motion.

III. CONCLUSION

Because Citizens' Statement and Testimony rely upon an unqualified expert, attempt to litigate issues that are beyond the scope of the contention, include unreliable and unsupported speculation, and include impermissible "attachments" to testimony, the Board should exclude the statements identified in Attachments 1, 2, 3 and 4 to this Motion and should exclude Citizens' Exhibits 26, 27 and 36 in their entirety.

Respectfully submitted,

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COUNSEL FOR AMERGEN ENERGY COMPANY, LLC

Dated in Washington, D.C.
this 27th day of July 2007.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	July 27, 2007
AmerGen Energy Company, LLC	Docket No. 50-219
(License Renewal for Oyster Creek Nuclear Generating Station)	

CERTIFICATE OF SERVICE

I hereby certify that copies of the "AmerGen's Motion In Limine to Exclude Portions of Citizens' Initial Written Submission" were served this day upon the persons listed below, by e-mail and first class mail, unless otherwise noted.

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ATTACHMENT 1

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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

CITIZENS' INITIAL STATEMENT REGARDING RELICENSING OF OYSTER CREEK NUCLEAR GENERATING STATION

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July 20, 2007

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NUCLEAR REGULATORY COMMISSION
OFFICE OF THE SECRETARY

ATOMIC SAFETY AND LICENSING BOARD

Before Administrative Judges:
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	)	July 20, 2007
AMERGEN ENERGY COMPANY, LLC	)	
	)	Docket No. 50-0219-LR
(License Renewal for the Oyster Creek Nuclear Generating Station)	)	
	)	

CITIZENS' INITIAL STATEMENT OF POSITION

PRELIMINARY STATEMENT

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") show in this filing that, based on the current record, the license for the Oyster Creek Nuclear Generating Station ("Oyster Creek") cannot be renewed because the most corroded area of the primary containment system is already thinner than required due to past corrosion. This containment consists of a largely freestanding thin-walled iron vessel, termed the "drywell shell." The most corroded area is in the lower part of the vessel, termed the sandbed region. That region is divided into ten odd numbered Bays located around the circumference of the vessel.

Furthermore, even analyses by AmerGen Energy Co. LLC ("AmerGen"), despite many inconsistencies, have shown that the margins above the required wall-thickness are at best approximately 0.034 inches at the lower ninety five percent confidence interval and potential corrosion rates are greater than 0.017 inches per year. If these assessments are correct, the proposed monitoring frequency of every 4 years is too long, because corrosion in excess of the margin could occur in less than 4 years. To date, AmerGen has failed to justify the selection of once every 4 years as the UT monitoring frequency. 1; 2.a

More specifically, the established acceptance criterion for the average thickness of the drywell shell in the sand bed area is 0.736 inches. Using AmerGen's past approach to determine margin above this criterion, the margin in Bay 19 is 0.064 inches with a lower 95% confidence limit of 0.034 inches. However, the interior grid measurements, from which this margin is derived, may overestimate the average thickness of the vessel. Thus, it is important to analyze the other available data to find the actual margin available. 1; 2.a

An alternative approach for estimating the mean thickness of the sand bed region in each bay is the use the latest thickness measurements taken from the outside of the vessel. These measurements have the advantage that they are more widely spaced over the vessel. These measurements generally indicate that margins may be lower than indicated by the interior grid measurements. For example, using the external data in Bay 15, Citizens currently estimate the minimum margin compared to the average thickness acceptance criterion to be 0.032 inches with a lower 95% confidence limit of less than zero.

AmerGen has been very inconsistent and non-systematic in its approach to deciding whether local square areas that are thinner than 0.736 inches and greater than around two inches in diameter are acceptable. However, comparing the UT data with the established criterion, 2.c which restricts contiguous areas thinner than 0.736 inches to less than 12 inches by 12 inches, 2.c AmerGen's own assessment is that this criterion is exceeded ninefold in Bay 1. Citizens have also shown that mid-range estimates of such corroded areas in Bays 1 and 13 probably exceed this criterion by factors of around three or more. Furthermore, it is not possible for AmerGen to 1; 2.a show that Bays 1, 13, and 19 meet even the most permissive local area acceptance criteria ever used for local area with 95% confidence. Finally, for very localized areas that are approximately two inches in diameter or less, the known margin at 95% confidence may also be less than zero, depending the statistical approach taken to estimate the thinnest point on the drywell shell. Without repair, the drywell shell cannot get thicker before the end of the current license. Because the shell probably fails to meet appropriate acceptance criteria, or at least is not meeting 1; 2.a the acceptance criteria with 95% confidence, it will therefore fail to meet the criteria with the required level of confidence at the start of any extended period of operation. Obviously, no amount of monitoring can maintain a non-existent safety margin. Thus, based on the current record, the severe corrosion of the drywell shell precludes the relicensing of Oyster Creek.

Even if the Atomic Safety and Licensing Board (the "Board") finds that there is some margin at the required degree of confidence, it would still be essential to increase the frequency at which AmerGen is required to perform thickness measurements, because corrosive conditions could occur between inspections during any extended licensed period of operation. Corrosion could occur from the exterior or the interior. Exterior corrosion of the drywell shell could occur 2.b because the protective coating is at or close to the end of its life and water could be present. The potential future corrosion rate from the exterior in case of corrosive conditions occurring is poorly defined, but AmerGen's expert has assumed it could be as high as 0.039 inches per year. On the interior, water is present at the interface between the interior concrete floor and the steel 2.b shell. Measured corrosion rates have been around 0.02 inches per year so far, but they could accelerate. Indeed, an expert retained by the State of New Jersey to review the possibility of interior corrosion suggested ongoing real time corrosion monitoring could be possible.[1] 2.b 2.b; 2.e

The required monitoring frequency is a function of the available margin and the potential corrosion rate. According to established practice, if the Board finds that AmerGen has some margin available it should take the lower 95 percent confidence interval of the lowest existing margin and divide that by the higher 95 percent confidence interval of the potential corrosion rate. For example, if the Board decided to apply AmerGen's pre-2007 approaches to determining margin, it would find that the margin above the mean thickness requirement is 0.034 inches inches at the lower 95% confidence interval. Using AmerGen's assumed combined corrosion rate of 0.040 inches per year, ultrasonic ("UT") monitoring would be required more than once per year. The current proposed monitoring frequency is once every four years. Thus, the contention alleging that proposed monitoring frequency is inadequate to maintain required safety margins is fully supported. 1; 2.a

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. Ex. 1 at 47.[2] It is free standing from an elevation of 8 feet 11.75 inches from the bottom. *Id.* at

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1 In fact, Dr. Hausler knows of applications where real-time corrosion monitoring has been installed. There appears to be no reason why this approach could not be taken to monitor both interior and exterior corrosion of the drywell shell. 2.b; 2.e

2 Citizens' trial exhibits are referred to throughout as "Ex. __," where the blank is the exhibit number. Similarly, AmerGen trial exhibits are referred to as "AmerGen Ex. __." Citizens understand that NRC Staff will attach relevant sections of the Safety Evaluation Report

40. For around 3 feet 4 inches above that level to elevation 12 feet 3 inches, the exterior of the steel shell used to be supported by sand, but the sand was removed 1992 in an effort to prevent further corrosion. *Id.* at 47-48. This portion of the drywell shell is termed the sand bed region. 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* Ex. 2. In the sand bed region, the thickness of the shell wall was 1.154 inches in its uncorroded state. Ex. 1 at 40.

STATEMENT OF FACTS

I. Current Margins

A. 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 so that the Board must determine which is the most appropriate local area acceptance criterion. 2.c

B. 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 2.c

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for Oyster Creek ("SER") as an exhibit. These sections are merely referred to as "SER" in this statement.

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." Ex. 3 at 2 (emphasis added). 2.c

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.

SER at 4-56 (emphasis added). After 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). 2.c

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. 2.c

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. 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 2.c 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. 2.c

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. Ex. 4 (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. 2.c

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, Ex. 5 (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, 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% 2.c reduction in bucking capacity would be acceptable, contrary to his March 2006 recommendations.

2.c (Entire page)

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. 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. C-1302-187-5320-024 rev. 2, Ex. 33 (AmerGen Ex. 16) 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, Ex. 5 (AmerGen Ex. 20), 2.c

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 squares. The NRC Staff did not consider this issue in the SER because they erroneously believed AmerGen's representation that the total area thinner than 0.736 inches was around 0.68 inches. SER at 3-128, 4-58. As shown below, in some Bays, the areas thinner than 0.736 inches are long, thin grooves running almost horizontally along the drywell shell. These grooves could undermine the stability of the drywell more than square areas of corrosion of the same size. Therefore, great care must be exercised in applying acceptance criteria based on modeling of square areas to such grooves. As such, Dr. Hausler believes that at minimum, local areas thinner than 0.736 inches should be smaller than one square foot and thicker than 0.636 inches on average, as AmerGen required in September 2006.

C. Methods Employed For Measuring Drywell Thickness

The available UT data fall into three categories, 6 inch by 6 inch grids of data taken above the interior concrete floor of the drywell, additional grids of data taken in two trenches that were created on the inside of the drywell before the sand in the sandbed region was removed, and data taken from the exterior of the sandbed region. The grid and trench data consists 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 odd numbered bays numbered from 1 to 19. 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." SER 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. Ex. 7 at 16. At 7 other locations a single horizontal line of 7 points was taken in Bays 1, 3, 5, 7, 9, 13, and 15. *Id.* at 16. 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; Ex. 5 (AmerGen Ex. 20) at 6.

AmerGen only measured the thicknesses in two trenches below the drywell interior floor thrice, in 1986, 1992, and in 2006. Ex. 8 (AmerGen Ex. 19) at 4. 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. Finally, measurements have been taken from the exterior in 1992 and 2006 at various locations that were visually identified as the thinnest points before the 1992 measurements. Calculation C-1302-187-E310-041, Rev. 0, Ex. 5 (AmerGen Ex. 20) at 48. However, in 2006 it emerged that these results were not actually measured at the thinnest points. Because the locations of the points measured in 1992 were not marked on the coating, the exact locations could not be repeated. *Id.*; *see also* Ex. 8 (AmerGen Ex. 19) Attachment 4 at 14 (some locations not found). However, the results for 2006, show that at some points in Bays 7, 15, 17 and 19 AmerGen scanned a 0.25 inch area around the nominal location of the point. *Id.* at 8, 16, 18, 20. Strikingly, in Bay 15, the reported results were actually the *maximum* readings obtained. In this Bay, the *minimum* readings were as much as 0.068 inches less than the recorded value. *Id.* at 16. Similarly, in Bay 19 the recorded results were up to 0.07 inches more than the minimum measured value. *Id.* at 20.

D. Margins Based On Mean Thickness

1. Interior Data Taken Above The Curb

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 in Bay 19 to 1.122 inches in Bay 17. Ex. 5

(AmerGen Ex. 20) at 6. Where corrosion was occurring, AmerGen compared the current and projected lower 95% confidence limit of the means to the acceptance criteria for the uniform thickness. SER at 4-60. 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." Ex. 10 at 2; SER at 3-121. Confirming that AmerGen really was referring to the standard deviation, the standard deviation of the data set from the interior grid at location 19A is around 0.06 inches, Ex. 5 (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 appears to have mistakenly only applied one standard deviation to derive the uncertainty. Using normal statistics one should use 1.96 standard deviations as the 95% confidence interval. Thus, using AmerGen's own approach, the uncertainty in the means of the interior grids at 95% confidence is around 0.02 inches of random error plus a possible 0.01 inches of systematic error, giving an uncertainty of plus or minus 0.03 inches. 1; 2.a

Moreover, 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. SER at 4-55. Indeed, in 2006, AmerGen mistakenly stated that it had used the 95 percentile of the measured means to calculate the margin. Ex. 35 at 13. In fact, to date AmerGen has largely failed to take account of the variance of the means or the uncertainty regarding systematic error when comparing them to the acceptance criteria, except prior to 1992, when corrosion was clearly ongoing.

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." SER 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, Staff concluded that the 1994 and 1996 readings were "anomalous." SER 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. Ex. 11 at 1. Thus, an allowance of at least 0.01 1; 2.a
inches to control for systematic error is justified.

2. Interior Data Taken In The Trenches

Unfortunately, the trenches were dug in Bays 5 and 17, which are the least corroded bays. 2.d; 3
The trench data are therefore of little assistance in deriving margins. However the data are helpful to examine how representative the grid data are and to see how the external measurements compare. Dr. Hausler's analysis shows that the interior grids may overestimate 1; 2.a
the overall thickness of the drywell shell and that the external results may more accurately represent the thickness of certain areas of the drywell shell.

Figure 2, attached to Ex. 12, plots all individual 2006 measurements from the trench in 1; 2.a; 2.d
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 show the nature of the "golf ball type" surface described in AmerGen literature. 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. 1; 2.a; 2.d

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. To shed light on these issues, Figure 4, also attached to Ex. 12, compares the average remaining wall thickness from trench measurements (averaged over the horizontal direction) with the average of the 6 by 6 grid measurement from the inside and the direct UT measurements from the outside. Also graphed in this figure are the averages of the external measurements for the three zones for which data are reported.[3] The averages for the grid and the trench data overlap quite well at the same elevation, but the floor and above curb zones are significantly thinner than the curb zone in which the grids are located. Figure 4 actually shows that the external data better represent the floor and above curb zones. 1; 2.a; 2.d

Finally, confirming that the uncertainty in the trench data is similar to the interior grids, in taking account of the variability of the mean of the measured data in the trenches, AmerGen subtracted 0.02 inches before it compared the mean to the acceptance criterion. *See e.g.* Ex. 8 (AmerGen Ex. 19) at 8.

3. Data Taken From The Exterior

Turning to the measurements taken from the exterior, the results taken in Bay 11 show that the measured average thickness was 0.783 inches. Calculation C-1302-187-5320-024 Rev. 2, Ex. 33 (AmerGen Ex. 16) at 52. For Bay 1, the mean of the points is 0.801 inches. *Id.* at 21, and the mean of the minimum data measured at each point in Bay 15 is 0.768 inches. *See* Ex. 12 at Table 1. 1; 2.a

3 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. Ex. 9 at Figure 4-6

AmerGen has argued that applying uncertainty to these results is unnecessary because they are already biased toward the thin side. However, this qualitative reasoning is undercut by Ex. 4, Figure 4, which compares all the data available for Bay 17. It shows that while the external data are indeed biased low for the middle elevations, they overestimate the mean thickness compared to the trench data for the most extreme upper and lower elevations. Thus, it is necessary to take account of the uncertainty in the external data to derive statistical estimates of parameters of interest, such as the mean thickness of the shell in the sandbed region. 1; 2.a

For example, looking first at the random errors, 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. Therefore, the lower 95% confidence limit for the mean thickness is 0.750 inches. Similarly, in Bay 15, the lower 95^{th} percentile of the mean of the corrected data is 0.731 inches, and in Bay 1, it is 0.747 inches. Ex. 12 at Table 1. 1; 2.a

In addition to the random error, it is also important to take account of the possibility of systematic error. Indeed, AmerGen has claimed that the 1992 measurements were biased high by 12 to 20 mils. Ex. 9 at 5-2. Although AmerGen has reasonably claimed that the 2006 technique was an improvement over the previous method, *id*, it is prudent to allow for the possibility of systematic bias. Citizens believe that the best approach to this problem is to regard the external readings as representative, even though they might actually be biased to the thin side by their method of selection. This approach ensures that the required degree of conservatism is maintained.

4. Margins Derived From Mean Values

The acceptance criterion for the mean values is 0.736 inches. The lowest estimated mean from the 2006 interior grids is 0.807 in Bay 19 plus or minus 0.03 inches at 95% confidence. Thus, the estimated lowest mean margin derived from the interior grids is 0.071 inches and the lower 95% confidence limit is 0.041 inches. However, the trench data suggest that the means of the external data more accurately represent the true state of the drywell, at least at the extreme upper elevations and below the level of the interior floor. The means of the exterior measurements are 0.783 inches in Bay 11 and 0.768 inches in Bay 15 (using the corrected data). Thus, the mean margins in these Bays are 0.047 inches and 0.032 inches respectively. At the lower 95% confidence limit the means derived from the external data in Bays 11 and 15 are 0.750 inches and 0.731 inches. Thus, these data indicate that there is currently no reasonable assurance that AmerGen can meet its acceptance criterion for the means in Bay 15 and the margin in Bay 11 is a miniscule 0.014 inches at the lower 95% confidence limit. 1; 2.a; 3

E. Margins For Very Small Areas

The lowest single point measurement is 0.602 inches taken from the exterior in Bay 13. The 95% confidence limits on single point measurements are around plus or minus 0.09 inches. Ex. 13 at 8. Adding in a possible 0.01 inches of systematic error means that this measurement could represent a thickness of 0.502 inches at the lower 95% confidence limit. Based on an acceptance criterion of 0.49 inches, this means the lower 95% confidence limit of the margin is 0.012 inches.

2.d

The lack of certainty on single point values comes in part from the inconsistent search for the thinnest points at each location and the failure to take account of the repeat values where such a search was conducted. In addition, high uncertainty may well be inherent in the measurement methodology. The lack of certainty is illustrated by the scans around the nominal points in Bay 15, where the minimum readings were as much as 0.068 inches less than the recorded value, Ex. 8 (AmerGen Ex. 19), Attachment 4 at 16, even though the nominal point was visually chosen as the thinnest point. 2.d

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. In zone 3 of Bay 1, above the interior floor, but below the curb, the lower 95% confidence limit is around 0.456 inches. Ex. 12 at Figure 6. The uncertainty in estimating the minimum thickness of this area stems from large measured differences in a few data points. Because the lower 95% confidence limit is below the acceptance criterion of 0.49 inches, AmerGen has failed to establish that it has any margin above the very small area criterion.

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

1. Existing Local Areas Thinner Than 0.736 Inches

AmerGen evaluated the 2006 external results in revision 2 of Calculation C-1302-187-5320-024. 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. Calculation C-1302-187-5320-024, Rev. 2, Ex. 33 (Amergen Ex. 16) 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, Ex. 4 (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 shows a 9 square foot area in Bay 1 that is 0.696 inches thick. Calculation C-1302-187-5320-024, Rev. 2, Ex. 33 (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. Furthermore, the "bathtub ring" shown on Figure 1-2 appears to be even more extensive than estimated by AmerGen. Thus, based on AmerGen's own estimates, it is possible that an area exists in Bay 1 that is thinner than 0.736 inches but thicker than 0.636 inches and is larger than nine square feet in extent. 3

To take a more systematic approach than merely drawing shapes around data points, Citizens applied a contouring program to produce unbiased interpolations of the data. This approach estimated that Bay 1 has two areas thinner than 0.736 inches. Ex. 13 at Figure 3. The first is a long thin groove that is around 3 square feet in extent and the second is a smaller area that is around 0.4 square feet in extent. The actual extent of the first area could be considerably larger because it is not bounded by the data on the left hand side. 1; 2.a 1; 2.a; 3

Similarly, on the top left of Bay 13, there could be a rectangular area which is 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, Ex. 33 (AmerGen Ex. 16) at 64. The contouring program confirmed these findings. The best fit for the data show an area thinner than 0.736 inches that is around 5 square feet in extent, but is not bounded by the data. Ex. 13 at Figures 4 and 5 (the thin area on the upper right of Bay 13 is not shown on the 2006 plot because AmerGen failed to repeat the measurement at point 2, which was 0.615 thick in 1992). Indeed, the thinnest point is at the edge of the predicted area. 1; 2.a; 2.d

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; Ex. 13 at Figure 1. The extent of this area could range from around 3 square feet to more than 9 square feet. 1; 2.a; 3

Turning to the thickness of areas that are greater than 2 inches in diameter, but less than one square foot in extent, in 1992 the thinnest local area measured was 0.618 inches thick at point 7 in Bay 13, which AmerGen stated could extend over a 6 inch by 6 inch area. Calculation C-1302-187-5320-024, Rev. 1, Ex. 4 (AmerGen Ex. 17) at 36. In 2006, the thickness at the same location was measured at 0.602 inches. Ex. 8 (AmerGen Ex. 19), Attachment 4 at 14. The data show that this point is adjacent to point 15, which has measured thickness of 0.666 inches. Calculation C-1302-187-5320-024 Rev 2, Ex. 33 (AmerGen Ex. 16) at 58, 63-64. Thus, that data show that an area of over one square feet at thickness 0.636 inches could exist in Bay 13. AmerGen appears to have omitted consideration of the reading at point 15 from its calculations, but based on readings at points 7, 8, and 11, it has concluded that the thinnest one square foot area in Bay 13 is 0.658 inches. *Id.* at 59. Notwithstanding the omission of point 15, because the 95% uncertainty limits of a mean based on three points are at around plus or minus 0.05 inches, AmerGen's own calculation shows an area of one square foot in extent could be less than 0.608 inches thick, at the lower 95% confidence limit. 1; 2.a; 2.c

The area estimates are highly uncertain because large areas of the sandbed have not been measured at all. 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. The estimates of area given by the contouring program should therefore be regarded as a floor rather than a ceiling. 1; 2.a; 2.d

2. Margins Based on Local Area Criteria

The various formulations of the local area acceptance criteria restrict the area of the 2.c drywell that can be below certain thicknesses. Citizens have shown that the mid-range estimate of the largest contiguous area thinner than 0.736 inches in Bay 1 is probably larger than 3 square feet and the area thinner than 0.736 inches in Bay 13 is probably larger than 5 square feet. Upper 3 bound estimates put the largest contiguous areas in Bays 1 and 13 thinner than 0.736 inches at over nine square feet. Most versions of the acceptance criteria for local areas requires 2.c contiguous areas thinner than 0.736 inches to be smaller than one square foot. It is therefore highly likely that Bays 1 and 13 violate these criteria. Even the most expansive version of the local area acceptance criterion only allows a contiguous area of 9 square feet to be thinner than 0.736 inches. Because the thin areas in Bays 1, 13, and 19 are not bounded, it is not possible to 1; 2.a demonstrate that these areas meet even that minimum requirement with 95% certainty.

Figure 1-5 of Calculation C-1302-187-5320-024, Rev. 2 (Ex. 33 or 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 1; 2.a; 3 either of these readings could be 0.09 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. This means that there is no reasonable assurance that Bay 1 meets AmerGen's current required acceptance criteria for local areas thinner than 0.736 inches. 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.

1; 2.a; 2.c; 3

Turning to areas of around one square feet in extent, it is likely that an area of thickness 0.636 inches that is larger than one square foot exists in Bay 13. Most versions of the local area acceptance criteria require thin areas of one square feet in extent to be thicker than 0.636 inches. It is likely that Bay 13 violates these versions of the local area acceptance criterion for areas of around one square feet in extent. 1; 2.a; 2.c; 3

II. Potential For A Corrosive Environment To Exist

A. Exterior Corrosion

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* Photograph of "Bay 5 before shell coating" provided by AmerGen as reference material to the ACRS, Ex. 14. 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, 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, Ex. 16 at 61:12-22. 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. Ex. 19 at 1. The latest inspections showed separated seams and voids in Bays 1, 7, 9, 15. *Id.* These defects meant that water could have penetrated the epoxy coating on the floor prior to its repair. *Id.* at 2. This means that any water in the sand pocket would not necessarily have been directed to the drains.

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. Ex. 20, Letter from Conte to Webster, dated November 9, 2006 *available at* ML063130465. The source of this water was not determined. *Id.* Furthermore, it has not been established that the only source of water is the reactor fueling cavity. Indeed, documents indicate that the equipment pool has also leaked. Ex. 21 at OCLR 29277. Other documents indicate that fuel pool water that did not originate from the reactor cavity has been found in the sandbed region. Ex. 22 at OCLR 28915. In addition, some water 3
will result from condensation during outages. *See* Ex. 23 (water found in bottles capturing

drainage from the sandbed region in April 2006 had no activity). Moreover, AmerGen has 3 admitted that it has not yet devised a means of preventing the reactor fueling cavity from leaking. Transcript from ACRS Meeting on Feb. 1, 2007, Ex. 24 at 217-222. Thus, it is entirely reasonable for all parties to assume that water may enter the exterior of the sandbed region during any extended period of licensed operation.

B. Interior Corrosion

2.b (Entire Subsection)

In the October 2006 inspection, AmerGen unexpectedly found water in the trenches. 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 as* 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* 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, 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:

2.b (Entire Subsection)

> 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.

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, 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 BWRs have experienced corrosion *inside* their drywells. SER 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.'" Ex. 26 at OCLR 14454. Furthermore, Oyster Creek has experienced corrosion inside the drywell in the reactor building closed cooling water system. 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.* 2.b

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.

III. Future Corrosion Rate

A. Exterior Corrosion

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. SER 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 large. 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. 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. Ex. 5 (AmerGen Ex. 20 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.[4] *Id.*

To illustrate the potential for corrosion from the outside, using a set of assumptions that included a corrosion rate of 0.039 inches per year, Mr. Gordon estimated that if the coating failed and moisture got to the metal surface, metal loss could be up to 0.042 inches in the 56 weeks following an outage. Ex. 29, Affidavit of Barry Gordon, dated March 26 2007 at ¶ 18. Thus, Mr. Gordon appears to believe that additional corrosion at an appreciable rate could occur if the coating fails and wet conditions are present. This supports Citizens' position. The difference is that because Citizens believe that that the margins are, at best, less than 0.04 inches, Citizens conclude that a monitoring frequency of every 4 years is too long. Indeed, even if Mr. Tamburro were correct that the minimum margin is 0.064 inches, the possibility that 0.042 inches could be lost each outage if coating decay commences would still indicate that monitoring should be undertaken every outage.

B. Interior Corrosion

2.b (Entire Subsection)

Although AmerGen believes the rate of interior corrosion will generally be small, New Jersey has recently written to NRC providing cautionary expert comments. 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

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4 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.

1; 2.a

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.*

2.b (Entire Subsection)

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.

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

2.b (Entire Subsection)

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. Ex. 36, E-mail from Schlaseman to Ray, dated November 2, 2006. Indeed, 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. Another potential source of water to the interior of the drywell shell is the containment spray. Recently, on July 17, 2007, Citizens understand that the containment spray was used during an unplanned outage. It is currently unclear what quantities of water were released or whether that water contained impurities that could accelerate interior corrosion. 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 core spray to add significant amounts of water. Thus, there is inadequate assurance that the past low rate will be maintained in the future.

2.b; 3

ARGUMENT

I. AmerGen Must Prove Its UT Monitoring Frequency Is Adequate

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. Here, a renewed license may only be issued if 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 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. 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). SER at 1-18, A-32-33.

In its ruling on July 11, 2007, the Board clarified that AmerGen bears the burden of showing that the drywell shell will not violate the minimum required thickness at 95% confidence. Board Memorandum dated July 11, 2007 at 3-4. Thus, to prevail AmerGen must now show first that it currently has margin with 95% confidence and second that it can maintain that margin with the proposed UT testing frequency of once every four years. As a corollary, Citizens may prevail either by showing that at 5% confidence the drywell thickness is already below the established acceptance criteria, or that the thickness could go beyond any established margin within four years.

II. There Is No Reasonable Assurance That The Drywell Shell Would Meet The Current Licensing Basis On Renewal

The evidence shows that there is no reasonable assurance that the CLB will be maintained. In fact, it is highly probable that the shell does not currently meet the established 1; 2.a; 2.c acceptance criterion for local deterioration of square areas bigger than 2 inches in diameter. In 1; 2.a; 2.c addition, there is a greater than a 5% chance that the shell fails acceptance criteria for mean 1; 2.a thickness and thickness of local areas smaller than 2 inches in diameter. Furthermore, because of the high uncertainties, AmerGen cannot demonstrate the drywell shell meets even the most 1; 2.a; 2.c lenient acceptance criteria ever applied for deteriorated local areas larger than 2 inches in diameter at 95% confidence.

Because AmerGen has made no proposal to repair the deteriorated areas, the current state of the drywell shell is the best state the drywell shell could be in during any period of extended operation. Thus, because the shell probably already fails some established criteria and there is a reasonable possibility that it could be failing others, AmerGen cannot provide reasonable assurance that it can maintain the CLB during license renewal.

A. Established Acceptance Criteria

The Board has ruled that established, valid practices are generally those accepted by the NRC Staff in approving AmerGen's application. Board Memorandum dated July 11, 2007 at Note 4. Citizens generally may not challenge such practices, but may point out deviations from such practices. Board Memorandum dated June 17, 2007 at 8. The acceptance criteria for mean and local area less than two inches in diameter are not in dispute, but considerable uncertainty remains about the local area acceptance criterion. 2.c In the SER, NRC Staff accepted the explanation that square contiguous local areas thinner than 0.736 had to be both thicker than 0.536 inches and smaller than one square foot in extent. SER at 4-56, 4-58. However, 2.c subsequently AmerGen questioned the validity of this approach and revised the acceptance criterion to be more stringent, requiring one foot by one foot areas to be thicker than 0.636

inches. Most recently, AmerGen used an approach to acceptance that was less stringent than that described in the SER, without explaining why it had done so.

2. c (Entire page)

Citizens assert that the Board should find that the best statement of the local area acceptance criterion applying to square areas of local corrosion is contained in Revision 1 of Calculation C-1302-187-5320-024, because that version was rewritten to address the deficiencies pointed out by AmerGen. Although the Board has generally found that the SER will provide the established valid criteria, it appears that AmerGen did not share its concerns about the validity of calculation C-1302-187-5320-024 revision 0 with NRC Staff. AmerGen should not be permitted to gain any advantage from its lack of candor to the Staff. Having decided that the approach that Staff endorsed was invalid, AmerGen can hardly now claim that the endorsed approach was valid and therefore not litigable in this proceeding. Therefore, this Board should find that the established acceptance criterion for square local areas thinner than 0.736 inches on average is that they must be smaller than one contiguous square foot and thicker than 0.636 inches on average.

Finally, Staff and AmerGen appear to have given little consideration to acceptance of corroded areas that are not square. Citizens assert that the groove shaped thin areas found on Bays 1 and 19 reduce the buckling capacity more than squares of similar area. Therefore, a more stringent local area acceptance criterion must be applied to such areas. There is no established acceptance criterion for such areas and in the absence of any modeling it is impossible to quantify how much more stringent the criteria should be. However, given the sizes of the local areas assessed, this issue should not be important unless the Board decides that the established local area criterion allows square areas thinner than 0.736 inches to be up to nine square feet in extent.

B. AmerGen Probably Violates The Appropriate Local Area Acceptance Criterion 1; 2.a; 2.c

AmerGen's latest assessment is that in Bay 1 there is an area 9 square feet in extent that has average thickness of 0.695 inches. This area is nine times larger than is permitted by the established acceptance criterion for square areas. Dr. Hausler estimates that the areas below 0.736 inches in Bays 1, 13 and 19 are larger than 3 square feet, 5 square feet, and 3 square feet respectively. Leaving aside the issue that these areas are not square and therefore should have a more stringent criterion applied, they easily violate the established acceptance criterion for square local areas. In addition, in Bay 13, it is likely that there is an area that is larger than one square foot of thickness 0.636 inches. This violates the version of the local area acceptance criterion that Citizens assert the Board should apply.

C. AmerGen Cannot Meet The Established Acceptance Criteria With 95% Confidence

The established acceptance criterion for the mean thickness of the drywell shell is 0.736 inches. The external measurements show that Bay 15 has a mean thickness of greater than 0.731 inches with 95% confidence. Thus, there is a greater than 5% chance that the mean thickness of Bay 15 violates the established acceptance criterion. The very small area acceptance criterion is 0.49 inches. The external data in zone 3 of Bay 1 shows that the mean thickness there is greater than 0.45 inches with 95% confidence. Thus, there is a greater than 5% chance that the thinnest small area in zone 3 of Bay 1 is thinner than 0.49 inches.

1; 2.a

1; 2.a; 3

With regard to the local area acceptance criterion, the uncertainties are hard to quantify because there are very few points and each point itself has some uncertainty attached. However, Dr. Hausler has estimated that the areas thinner than 0.736 inches in Bays 1, 13, and 19 could reasonably be larger than nine square feet. Thus, Citizens assert that at there is more than a 5% chance that these Bays fail even the most expansive version of the local area acceptance 1; 2.a; 3

criterion, which in any event Citizens assert is not applicable to the groove-shaped areas found in Bays 1 and 19.

1; 2.a; 2.c; 3

Moreover, reference to Figure 1-5 of Calculation C-1302-187-5320-024 Rev. 2 shows that if points 1 and 6 in Bay 1 were around 0.01 inches thinner, the Bay would violate even the latest less stringent criterion applied by AmerGen. Because the uncertainty in the thickness of each point is around 0.09 inches, this shows that there is a much greater than 5% chance that Bay 1 fails the latest version of local area acceptance criterion. Moreover, upper range estimates for the contiguous areas thinner than 0.736 inches in Bays 1, 13, 15 and 19 are greater than nine square feet. Thus, AmerGen cannot show that these Bays meet even the least stringent the local area acceptance criterion with 95% confidence.

3

1; 2.a

III. Minimum Monitoring Frequency Is Less Than Once Per Year

AmerGen's own assumptions show that the proposed monitoring frequency of once every four years is inadequate. AmerGen has established that to determine the UT monitoring interval based on the mean thickness acceptance criterion, the lower 95% confidence limit of the mean thickness of the thinnest Bay should be projected forwards until it reaches the acceptance criterion. However, because no statistically significant slope has been observed since 1992, Amergen found that the regression method used to achieve this goal before 1992 ceased to be applicable. Since 1992, AmerGen has used various other approaches to estimate future corrosion, none of which are mentioned in the SER. For example, AmerGen's expert, Mr. Gordon, estimated that a total of 0.042 inches of metal could be lost every refueling outage, at a rate of 0.39 inches per year, even if no water penetrated into the sandbed region during operation. Gordon Aff. at ¶ 18.

The goals of the established method can be met by combining the various approaches used by AmerGen. For example, the estimate for the minimum margin derived from the mean of the 49 point grids is 0.064 inches, without applying any uncertainty. Using an uncertainty of 1; 2.a plus or minus 0.03 inches, as suggested by AmerGen, shows that the margin is 0.034 inches at 95% confidence. Then, using Mr. Gordon's technique to project forwards, AmerGen would have to monitor slightly less than one year after a refueling outage. If it found minimal corrosion, the plant could then operate to the next refueling cycle. Citizens assert that even this approach is not sufficiently conservative because it does not take account of the possibility of water leaking into the sandbed region during operation, interior corrosion accelerating, or the 3 much narrower margins shown by the external measurements. However, even if this Board finds that AmerGen has established 0.034 inches of margin at 95% confidence, has eliminated all water sources except those that could occur during refueling, and has shown that internal corrosion will remain insignificant, the minimum monitoring frequency would be effectively once per year in order to maintain reasonable assurance that the drywell is meeting the CLB.

CONCLUSION

For the foregoing reasons, Citizens' position is that the record shows that Oyster Creek cannot be relicensed because the drywell shell has suffered from age-related degradation to the point that there is no reasonable assurance that the drywell shell can meet the current licensing basis at the start of any period of extended operation. Furthermore, even if the Board accepts AmerGen's past arguments about the available margin, the uncertainty, the potential water sources, and the limits on the future corrosion rate, it should decide that the required UT monitoring frequency is effectively once per year.

Respectfully submitted

Richard Webster, Esq
RUTGERS ENVIRONMENTAL LAW CLINIC
Attorneys for Citizens

Dated: July 20, 2007

ATTACHMENT 2

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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

PRE-FILED DIRECT TESTIMONY OF DR. RUDOLF H. HAUSLER

Richard Webster
Rutgers Environmental Law Clinic
123 Washington Street
Newark, NJ 07102-3094
Counsel for Citizens

July 20, 2007

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
OFFICE OF THE SECRETARY

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 (License Renewal for the Oyster Creek Nuclear Generating Station)	)))))))	Docket No. 50-0219-LR

AFFIDAVIT OF DR. RUDOLF H. HAUSLER
REGARDING HIS PREFILED TESTIMONY
IN SUPPORT OF
CITIZENS' DRYWELL CONTENTION

I, Dr. Rudolf H. Hausler of full age, do solemnly swear, as follows:

1. Through Corro-Consulta, Inc., I am employed as a consultant to the Citizens groups in this proceeding.

2. The attached pre-filed testimony represents my current opinion on the topics it covers.

3. I believe that the currently proposed UT monitoring frequency of every four years is inadequate for the reasons stated in my pre-filed testimony.

4. As stated in my pre-filed testimony I further believe that the UT data show that it is likely that the drywell shell in the sand bed region does not currently meet the applicable acceptance criteria. At minimum, I believe AmerGen cannot show to that the drywell shell in the sand bed region currently meets the applicable acceptance criteria with 95% certainty.

5. I declare under penalty of perjury that this affidavit and the attached pre-filed testimony and attachments thereto are factually accurate to the best of my knowledge, information and belief.

Rudolf H. Hausler

Dr. Rudolf H. Hausler

Sworn to me this 19th day of July, 2007

LORRAINE A SHELTON
Notary Public, State of Texas
My Commission Expires
May 20, 2009

Notary Public

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
OFFICE OF THE SECRETARY

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. 50-0219-LR
(License Renewal for the Oyster Creek Nuclear Generating Station)	)	
	)	

INITIAL PREFILED WRITTEN TESTIMONY OF
DR. RUDOLF H. HAUSLER
REGARDING
CITIZENS' DRYWELL CONTENTION

On behalf of Citizens, Dr. Rudolph H. Hausler hereby submits the following testimony regarding Citizens' contention.

Q1. Please state your name and address.

A1. My name is Dr. Rudolf H. Hausler and my business address is 8081 Diane Drive, Kaufman, Texas, 75142.

Q2. What is your educational and professional background?

A2. I have received the following degrees at the Swiss Federal Institute of Technology in Zurich, Switzerland: BS and MS in Chemical Process Technology and Ph.D. in Chemical Engineering. I am an expert in corrosion prevention, chemical inhibition, material selection, failure analysis, and trouble shooting. My resume is attached to this testimony as Attachment 1.

During a professional career spanning over more than 25 years, I have:

- Consulted for various organizations worldwide regarding nuclear safety, including the safety of spent fuel storage casks.
- Consulted for major oil companies and engineering companies throughout the world on selection, testing, and application of oil field chemicals, with a primary focus on corrosion inhibitors
- Developed corrosion testing facilities to meet industry-specific needs for Mobil Oil and developed custom corrosion inhibitors for Petrolite Corporation.

Q3. Can you cite specific examples of recognition by the scientific community?

A3. I received the 2003 Fellow Award, as well as the 1990 Technical Achievement Award, from the National Association of Corrosion Engineers (NACE). I am a NACE-certified Corrosion Specialist. I currently hold 17 patents, have published 58 papers, and have given more than 100 technical presentations about a variety of topics, including corrosion management, over the course of my career. I am a registered Professional Corrosion Engineer with the California Board of Professional Engineers and Land Surveyors.

Q4. Please discuss your experience as it relates to corrosion prevention.

A4. In the past 11 years as an independent corrosion consultant, I have advised several major oil companies worldwide, as well as various small US producers, on the testing of oil field chemicals, primarily corrosion inhibitors. In particular, while consulting for Teikoku Oil, Japan's National Oil Company, I advised the company on a range of corrosion subjects such as drill string corrosion, amine unit corrosion of 304 stainless steel, and the chemical prevention of corrosion of 13%-Cr in sweet production. Prior to becoming an independent consultant, I developed a $1.5M custom continuous flow-through corrosion test facility for Mobil Oil to meet industry-specific requirements. While employed at Petrolite Corp., I directed and conducted the development of novel corrosion inhibitors for extreme operating conditions. In addition, I developed the only qualified corrosion inhibitor for nuclear steam generator cleaning. The results were published in the EPRI publication, NP-2020 in June 1983. I have several years of hands-on experience with the failure analysis of coated tubulars (production tubing, pipelines), the development of unique corrosion models, and with statistical methodologies, such as Extreme Value Statistics.

Q5. What are your qualifications in the area of statistics

A5. While working in Chicago I was given the opportunity to study Statistical Design and Evaluation of Experiments under Steward Hunter and Norman Draper. I subsequently developed a 40 hour in-house course in statistics for the scientists at UOP and coached them in the use of the methodologies. At Petrolite I used Compositional Statistics to optimize complex mixtures with a minimum of tests. While at Mobil Oil Company in Dallas we always used the SAS software, specifically JMP (JUMP).

Q6. What materials have you reviewed in preparation for your testimony?

A6. Among the materials I have reviewed are various AmerGen/Exelon and NRC documents and technical data, and GPU Nuclear safety evaluation data. A list of the most pertinent references is provided in Attachment 2 to this testimony.

Q7. Have you reviewed all of the documents listed in Attachment 2?

A7. Yes, I have used the documents in Attachment 2 to inform me of relevant facts and derive my conclusions.

Q8. What is your understanding of the issues presented by this proceeding?

A8. This proceeding is about the extent to which structural integrity of the steel containment system, called the drywell shell, at Oyster Creek Nuclear Generating Station has been and will be affected by corrosion. There is no doubt that the shell is severely corroded in an area called the sandbed region, an area toward the bottom of the spherical part of the shell where sand was present until around 1992. The issues in dispute are whether we can be confident that the shell will meet safety requirements when any extended period of operation begins, and, if so, whether conducting ultrasonic (UT) measurements of the shell every four years is sufficient to maintain the required safety margins.

Q9. What are Attachments 3, 4 and 5 to this testimony?

A9. Attachment 3 is an edited version of a memorandum originally prepared for the purpose of opposing summary disposition giving my analysis of the situation as I understood it in April

2007. Among other things, it contains detailed analysis of the trench results and compares the data measured externally to the data measured internally. Upon the advice of Citizens attorney, the document has been excerpted to remove certain testimony that I understand is beyond the scope of the proceeding and other testimony that is now outdated. Attachment 4 is an update to Attachment 3 and provides further detailed analysis of the areas that are currently below 0.736 inches in thickness. Attachment 5 is an overview of the relevant facts on which I have worked with Citizens' attorney in an effort to produce a factual summary that follows the logic suggested by the Board.

Q10. To your knowledge, are Attachments 3, 4, and 5, coupled with this testimony, true and accurate statements of the issues most relevant to this proceeding?

A10. Yes, Attachments 3, 4 and 5 and this testimony provide, to the best of my knowledge, true and accurate statements of the facts and my conclusions regarding the issues most relevant to this proceeding. The facts include an in-depth analysis of the 2006 data, a review of the methods used to derive the margins and project corrosion into the future, a review of past exterior corrosion including rates and sources of water to the exterior of the drywell shell, and a review of interior corrosion.

Q11. What broad conclusions have you reached concerning the current state of the drywell shell?

1; 2.a; 2.c; 3

A11. I believe that the thickness of the drywell is very likely insufficient to meet the acceptance criterion established by AmerGen concerning the extent of contiguous areas of severe corrosion. At minimum, there is less than 95% confidence that the drywell shell currently meets the area acceptance criteria and other acceptance criteria concerning the mean thickness and the thickness of small areas that are less than two inches in diameter that were established by AmerGen and accepted by NRC.

Q12. Is 95% confidence a reasonable degree of certainty to require?

1

A12. I believe 95% confidence is the minimum one should require when dealing with the structural integrity of a safety-related component like the primary containment system. To put it into context, 95% confidence means that we could be wrong approximately one in forty times (on the downside) about whether the drywell shell meets safety requirements. The 95% confidence limits correspond to a spread of two (2) sigma (standard deviation) from either side of the mean to embrace all data thought to belong to the same population. Uunder Jack Welsh's leadership, General Electric instituted operating initiative whereby all parts and products manufactured by GE or its suppliers had to be within 5 sigma of the specified mean. This guaranteed a failure rate of many orders of magnitude less than one in forty. Requiring AmerGen to show that the drywell meets safety requirements with 95% confidence also accords with established past practice, when 95% confidence intervals were calculated and projected forward to derive the required monitoring frequency. 1

Q13. How do you reach the conclusion that the drywell shell is probably insufficient to meet safety requirements?

A13. Significant areas that are thinner than 0.736 inches exist in Bays 1, 13, and 19 of the drywell shell. A computer based interpolation package has shown that these areas in Bays 1 and 13 are probably larger than 3 square feet and 5 square feet respectively. The acceptance criterion applied to such areas has varied from requiring them to be smaller than one square foot to allowing them to be as large as nine square feet. However, the acceptance criterion established after an AmerGen employee expressed concern about the earlier approach to acceptance was tightened and requires areas that are thinner than 0.736 inches to be less than one square foot in extent and thicker than 0.636 inches. Because there are at least two areas that are probably at least three to five times larger than allowed by this criterion, I believe the drywell shell is currently deficient. 1; 2.a; 2.c; 3

Q14. If the acceptance criterion for the areas thinner than 0.736 inches allowed them to be as large as nine square feet, would you still believe the drywell shell was deficient?

A14. Yes, because AmerGen is required to show that it has 95% confidence that it is meeting the acceptance criteria. AmerGen's own assessment places an area thinner than 0.736 inches that is nine square feet in extent in Bay 1, without taking any account of uncertainty in the measurements. This area is not well defined and could easily be larger. 3 Similarly, in Bay 13, the five square feet area thinner than 0.736 inches shown by the contouring program is arbitrarily cut off because there is a large area on the upper left of the Bay for which there are no 1; 2.a

1; 2.a measurements. This area could easily be larger than nine square feet, given the uncertainty attached to each point and the lack of measurements to bound the area. 3 Even in Bay 19, I do not believe AmerGen can show that the area thinner than 0.736 inches in smaller than nine square feet with the required degree of certainty, because a line of points that measured thinner than 0.736 inches runs along the upper part of the Bay. 1; 2.a

Q15. Are there other reasons to believe that AmerGen lacks 95% confidence that the drywell shell is currently meeting safety requirements?

A15. Yes, there are many reasons that contribute to this lack of confidence, including the following:

1. The lower 95% confidence limit of the mean of the corrected external measurements in Bay 15 is smaller than 0.736 inches, the acceptance criterion for mean thickness. 1; 2.a
2. The lower 95% confidence limit of the mean of the measurements in zone 3 of Bay 1 is less than 0.49 inches, the acceptance criterion for areas less than 2 inches in diameter.
3. There is at least a one square foot area whose thickness is less than 0.636 inches at the lower 95% confidence limit. The appropriate version of the acceptance criterion for areas that are larger than 2 inches in diameter but less than one square foot requires such areas to be thicker than 0.636 inches on average. 1; 2.a; 2.c
4. AmerGen's own assessment shows that in the transitions between the thinnest areas and 0.736 inches, margins are as small as 0.01 inches on individual points. Because each point is uncertain to approximately plus or minus 0.09 inches, these areas could be considerably below even the latest less stringent version of the acceptance criteria at the lower 95% confidence limit. 1; 2.a
5. The areas thinner than 0.736 inches in Bays 1 and 13 are grooves, not squares. It is unclear how to apply acceptance criteria that assume the corroded areas are squares to such grooves, which could have more effect on buckling capacity for the same area. 1, 2.c; 3

Q16. If AmerGen can establish margin at the required level of confidence, is the proposed UT monitoring regime adequate to maintain safety margins?

A16. No. AmerGen is proposing to monitor once every four years. The margin AmerGen has claimed to have is 0.064 inches, but this was based on the mean of 49 point grid of measurements, not on the lower 95% confidence limit of that mean. Using AmerGen's estimate of uncertainty of the mean, this margin would be 0.034 inches at the lower 95% confidence limit and allowing for a possible 0.01 inches of systematic error. Mr. Gordon, AmerGen's expert on corrosion issues, has assumed that the corrosion rate could be around 0.039 inches per year if the exterior coating failed and water entered the sandbed region. I see no reason to disagree with this assumption. In addition, corrosion from the interior could add 0.002 inches per year onto the corrosion rate. The industry standard is to measure at half the interval in which it is possible to have lost margin. Given a total corrosion rate of 0.041 inches per year, a margin of 0.034 inches could be lost in less than a year. Thus, the monitoring interval would have to be more than once every six months. 1; 2.a 3 2.b 2.b; 3

Q17. Why do you assume that water could be present in the exterior drywell?

A17. There are a number of potential sources of water that have been identified by the reactor operator, including the refueling cavity, the equipment pool, and condensation. In addition, AmerGen has not managed to devise a method to ensure that the refueling cavity will not leak in the future, nor has AmerGen been able to definitively trace the source of the water found most recently in the drains from the drywell. Thus, it appears likely that some water will be present on the surface of the drywell shell during refueling outages, and it is not possible to rule out the potential for water from other sources to enter during operation.

Q18. Would the proposed approach to water monitoring alert AmerGen to the presence of water in the exterior sandbed?

A18. Not necessarily. AmerGen is proposing to monitor for water in the sandbed pocket by looking at the sand bed drains. However, if, for example, small droplets of condensation formed on the shell, these would likely not cause observable flow into the sandbed drains. In addition, if the defects in the floor coating recur, water could run down into those defects, rather than running to the drains. Although the cause of the deterioration of the floor coating has not been identified, it is reasonable to expect that the deterioration will continue or get worse. Furthermore, in the past the drains have clogged and it is reasonable to assume that this situation could recur. All of these effects could lead to a failure to detect corrosive conditions in the exterior sandbed using the currently proposed method. 3

Q19. Could AmerGen realistically achieve a monitoring interval of six months?

A19. Shutting down the plant every six months to allow measurements to be taken in the sand bed region would be possible, but expensive. A possible alternative would be to adapt real-time 2.e
corrosion monitoring technology to measure corrosion of the drywell in real time. While I do not know of any nuclear power plant where this has been done, I do know of other successful applications of real-time corrosion measurement. There appears to be no technical reason why it could not be done.

Q20. Is it important to use the external measurements as well as the interior grids to check the progress of the corrosion in the sandbed region?

A20. Yes. The external measurements provide information about corrosion occurring at the lower elevations of the sandbed region below the interior floor, which cannot be gathered from the inside except in the two least corroded Bays, where the trenches are present. In addition, the 1; 2.a
exterior measurements are the only measurements that allow us to estimate the areas that are corroded beyond acceptance thresholds.

Q21. Does the epoxy coating on the exterior of the drywell shell protect the shell from further exterior corrosion?

A21. No, it is not reasonable to assume that the coating will not fail during any period of extended operation. It is also not reasonable to assume that visual inspection could detect the early stages of coating failure. The lifetime of the coating has been estimated at anything from ten to twenty years. Its exact lifespan in this application is actually unknown. We do know that the epoxy coating placed upon the concrete floor of the sandbed region deteriorated quickly after it was installed in 1992 and was eventually repaired in the 2006 outage. In addition, it is likely that there were defects in the coating when it was applied, because no electrical testing of the applied coating was performed. Over time, any water in the sandbed can penetrate the coating through defects that were present at installation or develop over time. This water would then reach steel interface beneath the coating and cause further corrosion. It is important to remember 3
that the corrosion rate (rate of deterioration) in pitting situations as well as on coated materials,

increases exponentially with time. Hence, past performance is no indication of what may happen in the future. 3

Q22. Do you believe that AmerGen has established valid methods to analyze the current margins and project how they may change into the future?

A22. No. In the past AmerGen used a statistical method based on regression to find the current lower 95% confidence in the margin and project that limit into the future. After the sand was removed in 1992, AmerGen has not found any statistically significant slope and so has been unable to apply the regression method. Unfortunately, AmerGen's practice since then has been inconsistent. With regard to current margins, AmerGen has asserted that it is taking account of the variance of the data and in other cases AmerGen has asserted it is comparing the lower 95% confidence limit of the data to the acceptance criteria. Unfortunately, in practice AmerGen has failed to do this. With regard to future changes in margin, AmerGen has admitted that a high corrosion rate could be experienced if water was present in the exterior drywell and the coating failed, but has not taken this into account in its latest acceptance calculations. In addition, because the interior corrosion issue was only raised in December 2006, AmerGen has not established a method to take account of future corrosion from the inside of the drywell in the sandbed region. 2.b

Q23. How has AmerGen calculated the extent of areas that were corroded below the thickness thresholds set by the local area acceptance criteria?

A23. In the first version of the calculation C-1302-187-5320-024, AmerGen made some assessments of how big these areas were based on visual observations. Unfortunately, the second version of the same calculation took an inconsistent approach to estimating the extent of the severely corroded areas and assumed, contrary to the visual observation, that all the severely areas measured were less than 2" in diameter. Most recently, in the third version of calculation C-1302-187-5320-024, AmerGen has taken the approach of drawing squares by eye on plots of the external data points. As far as I can tell there is no established valid method for estimating the extent of the severely corroded areas. Indeed, I have been unable to devise a means of doing the required estimates with the required degree of confidence.

Q24. Do you have concerns with regard to the applying the local area acceptance criteria to the identified severely corroded areas?

A.24. Yes. The local area acceptance criteria were derived for square areas. The data show that the severely corroded areas in Bays 1 and 19 are more like long grooves, and the thinnest area is Bay 13 is an irregular shape. I believe that in late 2006 AmerGen correctly took a more conservative approach to the selection of the local area acceptance criteria and required local areas thinner than 0.636 inches on average to be less than one square foot in area. However, without explanation, it has subsequently taken a less conservative approach that I believe cannot be justified. 2.c

Q25. In summary, what do you currently believe the Board should do?

A25. I believe the Board should not allow the proposed relicensing because AmerGen cannot demonstrate with any certainty that the drywell shell in the sandbed region can meet the acceptance criteria at the start of any period of extended operation. Even if the Board decides that the relicensing can proceed, the monitoring interval for UT measurements should be less than every six months.

Q26. Have you now completed your initial testimony regarding the contention?

A26. Yes.

Attachment 1

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SUMMARY

Over 30^+ years planned, conducted, and directed advanced chemical research focused on oil production and processing additives. Acquired expertise in corrosion prevention, chemical inhibition, and materials selection, failure analysis, trouble shooting and economic analysis. Proficient in German, French, and Italian.

EXPERIENCE:

1996 - Present **CORRO-CONSULTA** (Dallas TX, and Kaufman TX)

President private Consulting Company

Consulted with major Oil Companies on selection, testing and application of Oil Field Chemicals, primarily corrosion inhibitors.

- Worked on Global Sourcing Team for Mobil Oil Company (major fulltime 6^+ months study)
- Consulted for Mobil Oil Company on production chemical usage at Mobile Bay sour gas production field and prepared for changeover to alternate chemical supplier (two year project).
- Consulted for Arco Oil company
    - on sour production in Middle East
    - reviewed North Slope corrosion data (statistical evaluation)
- Consulted for Mobil Oil Company at major CO_2 flood in Oklahoma (extensive laboratory and field testing - two major publications)
- Consulted with Teikoku Oil Company (Japanese National Oil Company) on various subjects of
    - drill string corrosion
    - amine unit corrosion of 304 stainless steel
    - corrosion of 13%-Cr in sweet production and the chemical inhibition thereof
    - identifying qualified corrosion testing laboratories in the US and the world
    - application limits for 3% Cr-steels in oil and gas production
- Consulted for Exxon Mobil on new sourcing study for combined Mobile Bay operations. (Developed novel approach for bid procedure and evaluation of bids on purely technical basis. Developed long-range approach to streamlining operations with potentially large savings.)
- Consulting for Oxy Permian Ltd. on major gas gathering system (changing from dry gas gathering to wet gas gathering)
- Prepared several major publications (see list of publications)
- Major consulting contract for ExxonMobil in Indonesia
- Consulting with various smaller Producers in the US (incl. Anadarko Petroleum Corp and Swift Energy Company)

- Consulting with various engineering companies (e.g. Stress Engineering Services Inc.)
- Consultant on call for Blade Energy Partners
- Consulted with various organization concerned with nuclear safety, including the safety of spent fuel storage casks.

1991 - 1995 **MOBIL Oil Company** (Dallas Research Center), Dallas, Texas

Senior Engineering Advisor

Developed corrosion testing facilities for basic research and to meet specific oil field requirements.

- Planned and developed H_2S corrosion test facility
- Planned safety and wrote safety manual
- Developed unique continuous flow-through corrosion test facility ($$ 1.5MM)
- Developed test protocols and supervised operations of the FTTF
- Extensive consultation with Affiliates on problem solving and chemical usage
- Established supplier relationships and consulted with Affiliates on establishing Enhanced Supplier Relationships
- Developed theory and practice of novel approach to autoclave testing

1979 - 1991 **PETROLITE CORPORATION** St. Louis, Missouri

Research Associate 1986 - 1991

Directed and conducted the development of novel corrosion inhibitors for extreme operating conditions

- New corrosion inhibitor to combat erosion corrosion of carbon steel in gas condensate wells
- Extensive studies on CO_2 corrosion aimed at establishing predictive corrosion model
- Developed the only qualified corrosion inhibitor for nuclear steam generator cleaning (EPRI publication NP-3030 June 1983)

Special Assistant to Executive Vice President 1985 - 1987

Special Assignments focused at support of International Sales

- Extensive travel to secure major accounts in Europe, Russia and East Asia
- Monitored out-sourced R&D in Germany and England

Senior Research Scientist 1979 - 1985

- Developed novel chemical composition under contract with EPRI for corrosion inhibition of cleaning fluids used in nuclear steam generators and methodology of application (only effective formulation still used today)
- Developed unique corrosion model for CO_2 corrosion in oil and gas wells
- Conducted numerous detailed field studies to establish case histories of chemical performance and applications technology

1976 - 1979 **Gordon Lab, Inc.,** Great Bend, Kansas

Technical Director

Responsible for all technical issues involving formulation, application and sales of sucker well production chemicals (corrosion, emulsion, scale, bacteria)

- Conducted failure analysis for customers and developed pertinent reports
- Supervised service laboratory
- Established technical training of sales and support personnel
- Developed technical sales literature and company brochure

1963 - 1976 **UOP (a division of SIGNAL COMPANIES)** Des Plaines, Illinois

Research Associate	1972 - 1976
Associate Research Coordinator	1967 - 1972
Research Chemist	1963 - 1967

To conduct research in electrochemistry, analytical methods development, heat exchanger fouling processes and refinery process additives

- Developed novel organic electrochemical synthesis procedure
- Developed unique (patented) test apparatus for measuring anti-foulant activity
- Introduced statistical design and evaluation of experiments to R&D department and Developed 20 hr course on statistics.
- Developed full 3 credit hour corrosion course to be taught at IIT and DeSoto Chemical Company

EDUCATION

- Ph.D. Chemical Engineering; Swiss Federal Institute of Technology, Zurich Switzerland
- BS, MS Chemical Process Technology, same as above

PROFESSIONAL ASSOCIATION

- American Chemical Society
- The Electrochemical Society
- Society of Petroleum Engineers
- NACE International (Corrosion Engineers)
- American Society fro Metals (ASM)

- Active in NACE on local, regional and national level

RECOGNITION
- NACE Technical Achievement Award (1990)
- NACE Fellow Award 2003

ACHIEVEMENTS
- 17 patents, 58 publications and more than 100 technical presentations
- Registered Professional Engineer (Corrosion Branch, California)
- NACE certified Corrosion Specialist

Attachment 2

ATTACHMENT 2 – LIST OF MOST RELEVANT DOCUMENTS REVIEWED

No.	Document Identification	Other Reference
1	GPU Nuclear, Drywell Steel Shell Plate Thickness Reduction (July 21, 1995).	Citizen's Exhibit NC 8
2	Partial Cross Section of Drywell and Torus.	Citizen's Exhibit NC 10
3	Memorandum from Peter Tamburro on the Unclear Documentation of Calculation C-1302-187-5320-024 (AR 00461639 Report) (Mar. 30, 2006).	Exhibit ANC 8
4	Exelon Nuclear, Calculation C-1302-187-5320-024 Revision 1: O.C. Drywell Ext. UT Evaluation in Sandbed (Jan. 12, 1993).	AmerGen's Exhibit 3
5	Exelon Nuclear, Calculation C-1302-187-E310-041 Revision 0: Statistical Analysis of Drywell Vessel Sandbed Thickness Data 1992, 1994, 1996, and 2006 (Dec. 12, 2006).	Exhibit SJA 1
6	Affidavit of Peter Tamburro, Mar. 26, 2007.	
7	AmerGen, NRC Information Request: Audit Question Numbers AMP-141, 210, 356 (Apr. 5, 2006).	Citizen's Exhibit NC 1
8	AmerGen, Passport 00546049 07 (AR A2152754 E09): Water Found in Drywell Trench 5 - UT Data Evaluation (Nov. 7, 2006).	Exhibit SJA 2
9	Structural Integrity Associates, Inc., Statistical Analysis of Oyster Creek Drywell Thickness Data (Jan. 4, 2007).	AmerGen's Exhibit 4

10	AmerGen, NRC Information Request: Audit Question Numbers AMP-357, 356, 210 (Jan. 24, 2006 and Feb. 16, 2006).	Citizen's Exhibit NC 2
11	Email from Peter Tamburro to Ahmed Ouaou (June 6, 2006, 14:03 EST).	OCLR00013624-13625
12	Memorandum from Dr. Rudolph Hausler, Apr. 25, 2007 (Redacted).	
13	Memorandum from Dr. Rudolph Hausler, July 19, 2007.	
14	AmerGen, Reference Material to the ACRS: Photograph of the Sand Bed Region (1992).	Exhibit SJA 3
15	Transcript of Nuclear Regulatory Commission Proceedings, Advisory Committee on Reactor Safeguards Subcommittee on Plant License Renewal Oyster Creek Generating Station (Jan. 18, 2007).	ML070240433
16	Transcript of Nuclear Regulatory Commission Proceedings, Advisory Committee on Reactor Safeguards Meeting of Plant License Renewal Subcommittee (Oct. 3, 2006).	
17	Email from Steven Hutchins to John Hufnagel Jr., with Drywell White Papers attachment (Sept. 18, 2006, 16:51 EST).	OCLR00013714 - 13734
18	Affidavit of Jon R. Cavallo, Mar. 26, 2007.	
19	AmerGen, Action Request: Determine the Proper Sealant for Drywell Sandbed Floor Voids (Oct. 23, 2006).	Exhibit ANC 5
20	Letter from Richard J. Conte, Chief Engineering Branch 1, Nuclear Regulatory Commission, to Richard Webster, Esq., Rutgers Environmental Law Clinic (Nov. 9, 2006).	Exhibit ANC 6

21	Letter from J.C. Devine, Jr., Vice President of Technical Functions, GPU Nuclear, to the Nuclear Regulatory Commission (Dec. 5, 1990) (Attachment 3; GPUN Detailed Summary Addressing Water Intrusion and Leakage Effects Related to the Oyster Creek Drywell).	OCLR00029270-29283
22	GPU Nuclear, Clearing of the Oyster Creek Drywell Sand Bed Drains (Feb. 15, 1989).	OCLR00028912-28918
23	AmerGen, Disclosed Document Relating to Drywell Leakage.	OCLR00013354
24	Transcript of Nuclear Regulatory Commission Proceedings, Advisory Committee on Reactor Safeguards 539th Meeting (Feb. 1, 2007)	
25	Letter from the Nuclear Regulatory Commission to C. Crane (Jan. 17, 2007)	ML070170396
26	Email from Steven Dunsmuir, FIN/Operations RO, Exelon Corp., to Howie Ray, et al. (Oct. 22, 2006, 04:52 EST).	OCLR00014454-14455
27	Email from Tom Quintenz to Kevin Muggleston, et al. (Feb. 1, 2006, 17:02 EST).	OCLR00013629
28	GPU Nuclear, Evaluation of February 1990 Drywell UT Examination Data (Mar. 8, 1990).	Citizen's Exhibit NC 9
29	Affidavit of Gordon, Mar. 26, 2007.	
30	Letter from Jill Lipoti, Director Division of Environmental Safety and Health, New Jersey Dept. of Environmental Protection, to Dr. Pao-Tsin Kuo, Director Division of License Renewal, U.S. Nuclear Regulatory Commission (Apr. 26, 2007).	

31	AmerGen, Calculation Sheet C-1302-187-5300-01	
32	GPU Nuclear, Calculation Sheet C-1302-187-5320-024 Revision 0: Oyster Creek Drywell Exterior Evaluation in Sandbed (1993).	Citizen's Exhibit NC 3
33	Exelon Nuclear, Calculation C-1302-187-5320-024 Revision 2: O.C. Drywell Ext. UT Evaluation in Sandbed (Mar. 18, 2007).	
34	ACRS Information Packet (Dec. 2006).	Exhibit ANC 2
35	Letter from AmerGen to the NRC (2103-06-20426) (Dec. 3, 2006)	Exhibit ANC 1
36	Email from Caroline Schlaseman, MPR Associates, Inc., to Howie Ray (Nov. 2, 2006, 12:09 EST).	OCLR00015433-15434

Attachment 3

4 (Entire Attachment)

Attachment 4

4 (Entire Attachment)

Attachment 5

4 (Entire Attachment)