RAS 13185



**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: | ) | March 5, 2007 |
| AmerGen Energy Company, LLC | ) | |
| | ) | Docket No. 50-219 |
| (License Renewal for Oyster Creek Nuclear Generating Station) | ) | |

# AMERGEN'S ANSWER OPPOSING CITIZENS' FEBRUARY 6, 2007 MOTION FOR LEAVE TO ADD A CONTENTION AND MOTION TO ADD A CONTENTION

Pursuant to 10 C.F.R. § 2.309(h)(1), AmerGen Energy Company, LLC ("AmerGen") hereby files its Answer opposing Citizens'[1] Motion for Leave to Add a Contention and Motion to Add a Contention, dated February 6, 2007 ("Motion").[2] As discussed below, the Motion should be denied in its entirety because the proposed contention fails to meet the timeliness requirements set forth in 10 C.F.R. §§ 2.309(f)(2)

1 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.

2 The Board previously held that if Citizens elected to file a new contention, then AmerGen and the NRC Staff could file an answer in accordance with the requirements of 10 C.F.R. § 2.309(h)(1). *See* Memorandum and Order, LBP-06-16, 63 N.R.C. 737, 745 (2006). Accordingly, this response is due within 25 days of Citizens' submission, or by Monday, March 5, 2007, as required by Sections 2.309(h)(1) and 2.306 ("Computation of Time").

and (c)(1), and fails to meet the applicable substantive standards for admissibility set forth in 10 C.F.R. § 2.309(f)(1).

## I. INTRODUCTION

This is Citizens' fourth untimely challenge to the acceptance criteria for the drywell shell. In this latest iteration, the proposed contention alleges deficiencies in the acceptance criteria for required thickness of the sand bed region of the Oyster Creek Nuclear Generating Station's ("OCNGS") drywell shell. General Electric Nuclear Energy ("GE") developed these criteria in the early 1990s. Citizens now claim that a recent analysis performed by Sandia National Laboratories ("Sandia") and two AmerGen documents provide new and material information that call into question the acceptance criteria identified in GE's analyses. Motion at 2-3, 9. Citizens allege that:

> The computer modeling undertaken by General Electric, upon which the disputed acceptance criteria are based, used unjustified factors leading to underestimation of the uniform required thickness by over 0.108 inches and of the small area required thickness by over 0.082 inches. For this reason, the acceptance criterion for the average thickness of each bay of the drywell shell should be increased to around 0.844 inches to ensure the ASME Code safety requirements are met or should be replaced with a set of criteria based on accurate and realistic three dimensional modeling of further degradation in the sandbed. For similar reasons, the acceptance criterion for small area thickness should be increased to at least 0.618 inches or integrated into the acceptance criteria derived from further three dimensional modeling.

Motion at 6.

This latest Motion should be recognized for what it is: yet another attempt by Citizens to expand the scope of the proceeding and introduce delay by means of a pleading laden with repetitive, unfounded, and non-meritorious speculation, and error – not to mention incomplete information. Substance aside, Citizens are now also using documents obtained in the mandatory disclosure process to recycle old arguments and resurrect a contention that was *already incurably late eight months ago*, when they identified alleged deficiencies in the drywell shell acceptance criteria in their "Petition to Add a New Contention" (June 23, 2006) ("June 23 Petition"). *See* Memorandum and Order, LBP-06-22, 64 N.R.C. __, slip op. at 10-14 (Oct. 10, 2006).

As explained below, each item of allegedly "new" information cited by Citizens in the instant Motion represents a preliminary or incomplete analysis of the purported technical issues. In some cases, Citizens are, or should have been, aware of the resolution of these issues. In the remaining cases, the information Citizens cite is irrelevant to the acceptance criteria. Absent any valid substantive basis for admissibility, in combination with the absence of any valid justification for late filing, the Board must reject Citizens' newest proposed contention as a matter of law.

### A. **Procedural Posture**

The procedural history of Citizens' previous attempts to raise allegations regarding the drywell shell acceptance criteria highlights the repetitive, erroneous, and non-meritorious aspects of Citizens' Motion. Citizens' "Request for Hearing and Petition to Intervene" (Nov. 14, 2005) ("Original Petition") did not challenge the acceptance criteria. Quite the contrary – Citizens' initial drywell contention relied on comparisons of UT thickness data to the now-disputed general area thickness criterion. Original Petition at 9. Three months later, however, in a "Motion for Leave to Add Contentions or Supplement the Basis of the Current Contention" (Feb. 7, 2006) ("Feb. 7 Motion"), Citizens questioned the acceptance criteria for the first time:

> the original acceptance criterion for the thickness measurements was 0.736 inches, but some measurements taken in 1992 were less than . . . that. Thus, *new acceptance criteria must be developed* to ensure that the currently unacceptable areas do not grow to levels where they threaten the structural integrity of the drywell liner.

Feb. 7 Motion at 12. The Board rejected Citizens' Motion because it was not based on new, materially different information. *See* Memorandum and Order, LBP-06-11, 63 N.R.C. 391, 298 (2006).

Over four months later, Citizens recycled this erroneous[3] allegation into two similarly unfounded contentions when they filed their June 23 Petition, this time relying on AmerGen correspondence with the NRC Staff. *See* LBP-06-22, slip op. at 10. Citizens included this argument in the text of the following proposed contention:

> AmerGen must provide an aging management plan for the sand bed region of the drywell shell that ensures that safety margins are maintained throughout the term of any extended license, but the proposed plan fails to do so because the acceptance criteria are inadequate . . . .

June 23 Petition at 4.

Prior to any Board ruling, Citizens reiterated their challenge to the acceptance criteria in a July 25, 2006 "Supplement to Petition to Add a New Contention" ("Supplement"). This time, they relied on a report from a new consultant, Stress Engineering Services, Inc. ("SESI"), which essentially claimed that the GE reports that developed the acceptance criteria were outdated, and that newer "state-of-the-art" structural analysis methods are available. Letter, from R. Biel, SESI, to R. Webster, Rutgers Environmental Law Clinic, at 2 (July 15, 2006) (attached to Supplement as "Cursory Check of Structural Analyses, Oyster Creek Drywell Vessel"), at 2; *see also* Supplement at 17-22.

[3] As Citizens now apparently understand, the 1992 UT thickness measurements below 0.736" still met ASME Code requirements. *See* Motion at 9.

The Board rejected these second and third challenges to the acceptance criteria because it found that Citizens were well aware of these criteria at the time of their Original Petition. LBP-06-22, slip op. at 12-14 ("Thus, any challenge to the adequacy of AmerGen's acceptance criteria should have been made at the time Citizens filed their initial Petition to Intervene.").

Also germane to the disposition of the instant Motion is the fact that the OCNGS license renewal application has been the subject of three meetings with the Advisory Committee on Reactor Safeguards ("ACRS") and its License Renewal Subcommittee: Subcommittee meetings on October 3, 2006 and January 18, 2007; and a full Committee meeting on February 1, 2007. *See* Letter from W. Shack, ACRS Chairman, to D. Klein, NRC Chairman, "Report on the Safety Aspects of the License Renewal Application for the Oyster Creek Generating Station," at 1 (Feb. 8, 2007) ("Exhibit 1"). Citizens' representatives participated in all three of these meetings, listening to the dialogue between the ACRS, applicant, and NRC Staff. Their legal counsel even provided lengthy oral presentations, sometimes accompanied by slides, at *each* of the three meetings.

This level of participation by Citizens is particularly important because Citizens' Motion relies on the events of the January 18 Subcommittee meeting, but fails to even mention that a subsequent meeting occurred on February 1. The Motion ignores the dispositive information that AmerGen and the NRC Staff presented to the ACRS at the February 1 full Committee meeting – a meeting that counsel for Citizens attended and even presented at, but did not mention in a Motion filed five days later. Thus, Citizens' counsel filed a Motion that he arguably should have known was, either all or in part, without merit.[4]

### B. Legal Standards Governing the Admissibility of Citizens' New Contentions

The standards governing admissibility of Citizens' new contention are set forth in the Board's March 22, 2006 Order denying Citizens' Motion to Add or Supplement. *See* LBP-06-11, 63 N.R.C. at 395-396; Memorandum and Order (Denying Citizens' Motion for Leave to Add Contentions and Motion to Add Contention) at 5-6 (Feb. 9, 2007) (unpublished) ("Feb. 9 Order"). Where, as here, the regulatory time limit has long since expired for filing a petition to intervene, a petitioner may submit a new contention only with leave of the presiding officer upon a showing that:

(i) The information upon which the amended or new contention is based was not previously available;

(ii) The information upon which the amended or new contention is based is materially different than information previously available; and

(iii) The amended or new contention has been submitted in a timely fashion based on the availability of the subsequent information.

*See* 10 C.F.R. § 2.309(f)(2)(i)-(iii).

If a new contention meets the above three criteria, then it is considered "timely" and the petitioner is not required to satisfy the requirements of 10 C.F.R. § 2.309(c)(1) for non-timely filings. LBP-06-11, 63 N.R.C. at 396 n.3; Feb. 9 Order at 5-6. If, however, the information underlying the proposed contention is not new or materially

---

[4] In this regard, Citizens appear to have "failed to disclose critical information," the same accusation they leveled against AmerGen and Exelon in their "Motion to Apply Subpart G Procedures," at 1 (May 5, 2006). This failure raises serious questions regarding compliance with counsel's "manifest and iron-clad obligation of candor." *Public Serv. Co. of Okla.* (Black Fox Station, Units 1 & 2), ALAB-505, 8 N.R.C. 527, 532 (1978) (admonishing counsel for failure to bring relevant *(footnote continued)*

different from previously-available information, then to be admitted, the new contention must satisfy the eight factor balancing test in Section 2.309(c)(1) as well. LBP-06-11, 63 N.R.C. at 396 n.3; Feb. 9 Order at 6 n.7.[5]

Commission precedent makes clear that the eight factors in Section 2.309(c)(1) are not of equal importance: absence of good cause (factor 1) and the likelihood of substantial broadening of the issues and delay of the proceeding (factor 7) are the most telling. *See, e.g.*, *Project Mgmt. Corp.* (Clinch River Breeder Reactor Plant), ALAB-354, 4 N.R.C. 383, 395 (1976). Factors 5 (availability of other means) and 6 (interests represented by other parties) are entitled to the least weight. *See Private Fuel Storage, L.L.C.*, LBP-00-08, 51 N.R.C. 146, 154 (2000) (citing *Commonwealth Edison Co.* (Braidwood Nuclear Power Station, Units 1 and 2), CLI-86-8, 23 N.R.C. 241, 244-45 (1986)).

Even if the temporal criteria established by Section 2.309(f)(2) and (c)(1) are satisfied, a petitioner also must satisfy the following substantive admissibility requirements in 10 C.F.R. § 2.309(f)(1): (1) specify the issue to be raised; (2) briefly explain the basis for the contention; (3) demonstrate that the issue is within the scope of the proceeding; (4) demonstrate that the issue is material to the proceeding; (5) provide a

---

evidence to the attention of the Appeal Board); *see also Nuclear Mgmt. Co., LLC* (Palisades Nuclear Plant), LBP-06-10, 63 N.R.C. 314, 382-84 (2006) (J. Young, Additional Statement).

[5] Section 2.309(c)(1) sets forth the following factors to be considered in the admission of non-timely contentions: (1) good cause, if any, for failure to file on time; (2) the nature of the petitioner's right under the [Atomic Energy] Act to be made a party to the proceeding; (3) the nature and extent of the petitioner's property, financial, or other interest in the proceeding; (4) the possible effect of any order that may be entered in the proceeding on the petitioner's interest; (5) the availability of other means whereby the petitioner's interest will be protected; (6) the extent to which the petitioner's interests will be represented by existing parties; (7) the extent to which the petitioner's participation will broaden the issues or delay the proceeding; and (8) the extent to which the petitioner's participation may reasonably be expected to assist in developing a sound record.

concise statement of the alleged facts or expert opinion that support the petitioner's opinion; and (6) demonstrate that a genuine dispute exists on a material issue of law or fact, and include specific references to allegedly deficient portions of the application.

As discussed below, Citizens' new contention fails to meet the requirements of 10 C.F.R §§ 2.309(f)(2), (c), and (f)(1).

## II. CITIZENS' CONTENTION IS INADMISSIBLE AND MUST BE REJECTED AS A MATTER OF LAW AND FACT

### A. Background Information

Before the sand was removed from the sand bed region in 1992, GE performed an engineering analysis of the Oyster Creek drywell shell to determine whether historical corrosion prevented the drywell from performing its intended functions. GE conducted this analysis in 1991, based on ASME Code requirements, to establish the minimum required general thickness, with the sand removed, for both pressure and buckling stresses.[6]

The results of GE's analysis show that the minimum required thickness in the sand bed region is controlled by buckling. Moreover, a general thickness acceptance criterion of 0.736" will satisfy ASME Code requirements with a safety factor of 2.0 against buckling for the controlling refueling load combination, and 1.67 safety factor for the post-accident load combination (*i.e.*, flooding of the containment). *See* ACRS Info.

---

6 Citizens' Dec. 20, 2006 Motion to Add Contentions, Exh. ANC-2 at 6-7 ("ACRS Info. Package"). The analysis uses a finite-element model (36 degree slice) of the drywell. *Id.* The 36 degree slice derives from the configuration of ten "bays" in the sand bed region created by the torus vent headers. These vent headers stiffen the shell in these areas. *Id.* at 6-9.

Package at 6-8. Locally-thinned areas are evaluated against a minimum local average thickness acceptance criterion of 0.536".[7]

GE performed its buckling analysis in conformance with the methodology set forth in ASME Code Case N-284, "Metal Containment Shell Buckling Design Methods, Section III, Class MC." The capacity reduction factors in that Code Case, however, do not account for orthogonal stresses in which one of the stresses is in tension (*i.e.*, the type of loading considered in the GE analysis). Thus, with involvement and input from the author of Code Case N-284, Dr. Clarence Miller, GE used a modified capacity reduction factor of 0.340 to account for the presence of tensile stress. ACRS Tr. at 96-97 (Jan. 18, 2007) ("ACRS Jan. 18 Tr.") *available in ADAMS at* ML070240433. This factor was based upon the effects of hoop tension, which would be present in the refueling load combination. *Id.* at 96.

The NRC Staff approved GE's initial analysis in a Safety Evaluation Report ("SER") dated April 24, 1992 ("Exhibit 2"). The Staff concurred with the conclusion that the Oyster Creek drywell shell meets ASME Code requirements. The NRC explicitly accepted use of Code Case N-284 for purposes of the Oyster Creek analysis and accepted use of the modified capacity reduction factor. *See* Exhibit 2, at 4. Accordingly, the GE analysis is the analysis of record for purposes of license renewal, and is part of the plant's current licensing basis.

On January 18, the ACRS Subcommittee asked AmerGen to discuss GE's use of this modified capacity reduction factor during the February 1 meeting. AmerGen and the Staff discussed the issue to the ACRS' satisfaction at the February 1 meeting. *See* ACRS

---

[7] ACRS Info. Package at 6-8, 6-18. If any local UT measurements reveal thicknesses below 0.736", a separate evaluation is done to confirm that the locally-thin areas, in the as-found condition, meet ASME Code criteria.

Tr. at 215 (Feb. 1, 2007) *available in ADAMS at* ML070430485 ("ACRS Feb. 1 Tr."); Exhibit 1, at 2 ("The staff reaffirmed its position that the use of the increased capacity reduction factor is appropriate for the analysis of the OCGS drywell shell. We concur with this position.").

In support of its review of the Oyster Creek license renewal application, the NRC Staff sponsored Sandia to perform an independent, confirmatory analysis of the Oyster Creek drywell.[8] Sandia finalized its report before the February 1 meeting, so the final report uses a capacity reduction factor of 0.207 because the Sandia analysts could not find a justification for the increased value of 0.340 used by GE. Sandia Report at 67; ACRS Jan. 18 Tr. at 242-43. Using a 0.207 capacity reduction factor, Sandia generated a general average thickness criterion of 0.844". Sandia Report at 79. It was not until the February 1 ACRS meeting that Dr. Miller explained why the use of the 0.340 capacity reduction factor was appropriate. ACRS Feb 1 Tr. at 205-208, 212-215. The NRC Staff explained during the February 1 meeting that, had Sandia used 0.340 instead of 0.207, Sandia's 0.844" general thickness criterion would have been "less than" GE's 0.736" general thickness criterion. *See* NRC Staff Presentation to ACRS at 11 (Feb. 1, 2007), *available in ADAMS at* ML070440100. The ACRS accepted this conclusion during its February 1 meeting and documented its acceptability in its subsequent letter to the Commission. *See* Exhibit 1, at 2.

8 Jason P. Petti, "Sandia Report: Structural Integrity Analysis of the Degraded Drywell Containment at the Oyster Creek Nuclear Generating Station" (January 2007), *available in ADAMS at* ML070120395 ("Sandia Report").

## A. Bases for the Proposed Contention

The late-filed contention relies on four items Citizens mistakenly claim contain "significant and material new information." Motion at 2; *see also id.* at 3, 9. First, they point to the final Sandia Report, which Citizens claim, "reaches a very different result" from the GE analysis because its authors "rejected" the use of an increased capacity reduction factor used in the GE analysis. Motion at 7. Accordingly, Citizens argue that the existing general and local area thickness criteria need to be modified.

Second, Citizens next put on blinders and cite "comments on the Sandia Study made at the January 18, 2007 meeting of the ACRS." *Id.* In doing so, they completely ignore the subsequent February 1 meeting of the full ACRS. Based on the results of the Sandia Report, and the NRC Staff and ACRS comments at the January 18 meeting, Citizens argue that the minimum wall thickness acceptance criteria should be increased. *Id.* at 9.

Third, looking back to the fall 2006 refueling outage, Citizens cite a preliminary report AmerGen recently produced to them via the mandatory disclosure process to challenge "the latest UT results" taken by AmerGen during October 2006. *Id.* at 3, 7. According to Citizens, the new "full information" shows that "worst point" thickness measurements have decreased by 0.118" since 1992. *Id.* at 3. Therefore, Citizens argue that, "it has become even more critical to accurately estimate how much any existing margin has been reduced." *Id.*

Finally, Citizens cite Assignment Report ("AR") 00461639, a document they also recently obtained through the mandatory disclosure process, which allegedly "acknowledges AmerGen's failure to show that the local wall thickness acceptance criteria would maintain ASME Code requirements." *Id.* at 9. Citizens claim that this document supports the Sandia Report's "suggestion" that the local area minimum wall thickness should be amended to 0.618". *Id.*

**B. The Proposed Contention Does Not Meet the Timeliness Requirements of 10 C.F. R. §§ 2.309(f)(2) and (c)(1)**

1. The Proposed Contention Does Not Meet the Requirements of 10 C.F.R § 2.309(f)(2)

As explained in detail below, Citizens' proposed new contention is untimely because its first two bases do not constitute information that is materially different from what was previously available, contrary to 10 C.F.R. § 2.309(f)(2). Moreover, Citizens' first two bases mislead the Board. As we have seen, Citizens cite to the Sandia Report and comments on that report at the January 18, 2007 ACRS Subcommittee meeting to allege fundamental flaws in the GE analysis, without even mentioning that these alleged flaws were entirely and unambiguously resolved during the subsequent presentations made by AmerGen and the NRC Staff at the February 1 ACRS meeting.

With respect to Citizens' remaining two bases, the preliminary statistical analysis of the 2006 UT results and AR 00461639, the first is irrelevant to the acceptance criteria, and the second is not new information. Thus, Citizens have failed to proffer new, materially different information to support their new late-filed contention as required under Section 2.309(f)(2). Rather, Citizens cite these documents in a misguided attempt to suggest that AmerGen does not understand the condition of the drywell, as part of their rhetorical campaign to prevent issuance of a renewed license. Such tactics have no place before the Board.

(a) The Sandia Report: Citizens argue that, although they have previously challenged the GE analysis, "they have not previously contended that the GE modeling, upon which the disputed acceptance criteria are based, used unjustified factors leading to systemic underestimation of the required [thicknesses]." Motion at 2. Nothing in this statement even suggests that the new contention is based on new information not previously available, nor does it excuse Citizens' earlier failure to mount an adequate challenge.

It is quite apparent that the GE analyses that developed the acceptance criteria are not new. Citizens did not challenge them in their Original Petition. The Board already has excluded Citizens' previous challenges to the GE report for lack of timeliness: "Had Citizens wished to challenge the methodology used to determine this acceptance criteria for the sand bed region, it had an obligation – once it became aware of that criteria – to obtain the information necessary to advance such a challenge." LBP-06-22, slip op. at 12. In LBP-06-22, the Board rejected Citizen's attempt to use its own expert – SESI – to challenge decade-old acceptance criteria. It is unclear why Citizens believe that using the NRC's contractor – Sandia – to challenge those same acceptance criteria would be timely eight months later. Citizens simply recycle their previously-rejected claim under the cover of the Sandia Report and the partial discussion of that report at the ACRS Subcommittee meeting.

Citizens allege that the report "reaches a very different result from the GE modeling upon which AmerGen is relying to justify its acceptance criteria." Motion at 7. This is incorrect. As Citizens point out, "the Sandia Study predicted no *definitive* violations of ASME code requirements," *id.* at 4 (emphasis in original), and that was by using a 0.207 capacity reduction factor. The NRC Staff views the results of the Sandia Report as confirming the GE analysis. ACRS Feb. 1 Tr. at 244 ("We are satisfied that that analysis confirms the 1992 licensing basis.").

Moreover, as discussed above, the factors used in the GE modeling analysis have been available for over a decade, and when the disputed 0.340 capacity reduction factor is applied to the Sandia analysis, the minimum thickness is *less than* GE's 0.736" general area thickness criterion. NRC Staff Presentations to the ACRS at 11 (Feb. 1, 2007), *available in ADAMS at* ML070440100.

Thus, the Sandia Report does not provide new, materially different information that justifies revising this Board's previous conclusion that, "any challenge to the adequacy of AmerGen's acceptance criteria should have been made at the time Citizens filed their initial Petition to Intervene. It cannot be submitted at this late juncture." LBP-06-22, slip op. at 14.

(b) <u>January 18 ACRS Subcommittee Meeting</u>: Citizens also allege that "comments on the Sandia Study made at the January 18, 2007 meeting of the ACRS" also justify their new contention. Specifically, Citizens note that ACRS Member Dr. Said Abdel-Khalik "pointed out that the thickness of 0.736 inches would yield a factor of safety of 1.27 if the GE model were used without the increased capacity reduction factor." Motion at 8.

The information from the January 18 meeting is not materially different than previously-available information, because the ACRS' concerns were resolved at the February 1 meeting, *with information that has been available for years*, as documented in the NRC's 1992 SER. The Sandia Report itself concluded that there were no violations of ASME Code requirements as a result of its analysis. Motion at 4 (citing Sandia Report at 13). During the February 1 meeting of the full ACRS, Dr. Clarence Miller, the author of the applicable ASME Code Case N-284, explained that it was acceptable to use the

0.340 capacity reduction factor under the ASME Code. This capacity reduction factor was derived from tests conducted on metal cylinders. Dr. Miller, however, demonstrated that the increased capacity factor also could be used for spheres, such as the drywell shell. ACRS Feb. 1 Tr. at 205-208, 212-215. The NRC Staff concurred with this conclusion, as it had done 15 years earlier, in its April 24, 1992 SER, which is and has been publicly available. *See id.* at 242 ("*We had made that same determination in 1992.* We made the same determination again in 2006.") (emphasis added); Exhibit 2, at 4. In its final report to the Commission, the ACRS also concurred with Dr. Miller's opinion that the increased capacity reduction factor was permissible. Exhibit 1, at 2 ("We concur with this position.").

Further, the fact that ACRS members sought clarification regarding the GE analysis hardly provides sufficiently new and material information to support a contention. This basis can therefore be rejected for the same reason this Board rejected Citizens' previous attempts to litigate the acceptance criteria:

> To the extent Citizens seek to create the impression that, because the NRC Staff sought clarification of AmerGen's methods for deriving the acceptance criteria, these methods were previously unknown to the Staff or were otherwise altered, such an impression is demonstrably incorrect. . . . [T]he analyses currently in effect for Oyster Creek are the same as those documented in the early 1990s.

LBP-06-22, slip op. at 13-14.

Thus, the January 18 ACRS Subcommittee meeting did not reveal new and materially different information as required by 10 C.F.R § 2.309(f)(2).

(c) <u>The Latest UT Results</u>: Citizens argue that the October 2006 UT results show "that the sandbed is now 0.02 inches thinner than it was in 1992 on average and over 0.1 inches thinner in certain spots, indicating that ongoing corrosion may be occurring."

Motion at 3. For support, they cite to a preliminary analysis, dated November 9, 2006, prepared by an AmerGen consultant analyzing the October 2006 UT data. AmerGen produced this initial analysis to Citizens as part of the mandatory disclosure process on January 26, 2007, and the document is Citizens' Exhibit ANC-7.

Citizens do not even attempt to connect this information to their proposed new contention. Instead, they simply castigate, "[b]ecause the wall thickness is now less than measured in 1992, it has become even more critical to accurately estimate how much any existing margin has been reduced." Motion at 3. This statement is completely irrelevant to the proposed contention: whether "[t]he computed modeling undertaken by General Electric . . . used unjustified factors leading to underestimation" of the required thickness of the drywell shell. *See* Motion at 6.

Absent any connection between the latest UT results and the acceptance criteria, these data are simply irrelevant (as opposed to new and material) to the proposed new contention and do not meet the requirements of 10 C.F.R. § 2.309(f)(2).

(d) Assignment Report (AR) 00461639: AmerGen also produced this document on January 26, 2007, identified by Citizens as ANC-8, under the mandatory disclosure process. The document is an internal critique of a now-superseded 1993 calculation that analyzed UT data collected during the 1992 refueling outage. The calculation was used to demonstrate that the 1992 drywell thickness data met design specifications. ANC-8 at 1. Pointing to the statement in Item 4 of this document, Citizens claim that under the GE calculation, the "ultimate theoretical buckling capacity" is reduced by 9.5% and may not meet Code requirements. Motion at 5 (citing ANC-8 at 2).

Some background on ARs is useful to understand why this document does not constitute new, materially different information. ARs are part of OCNGS' corrective action program. An employee who identifies a concern with any part of the plant, its operations, or its processes, programs, or procedures, can author an AR. The first part of the AR identifies the observed or alleged deficiencies. The second part of the AR verifies the validity and documents the resolution of the observed deficiencies. ARs are electronic records and can be printed at any time before, during, or after this resolution.

Citizens' Motion emphasizes the initial observation at issue, but omits any discussion of its ultimate resolution. The resolution, however, is identified on the last page of the AR as "Assign # 02" with the following description: "Revise calculation C-1302-187-5320-024 to address issues . . . ." Citizens' Exhibit ANC-8 at 5. AmerGen produced a copy of the revised calculation referenced in the AR to Citizens on December 12, 2006, and it is appended to this Answer as Exhibit 3. Thus, Citizens had the resolution of this AR in their possession for nearly 60 days before they filed their Motion.[9]

Thus, AR 00461639 is not new, nor is it materially different information as required by 10 C.F.R. § 2.309(f)(2). Citizens' contention is therefore untimely, and must meet the requirements of Section 2.309(c).

[9] AmerGen submitted the same document to the ACRS on December 8, 2006, as Reference 42 to the ACRS Information Package. It is worth reiterating that Citizens submitted this package to the Board, listing the revised calculation as a reference, as Exhibit ANC-2 in their December 20 Motion to Add Contentions.

## 2. The Proposed Contention Does Not Meet the Requirements of 10 C.F.R § 2.309(c)

Citizens have not met the requirements of the eight-factor test for non-timely filings under 10 C.F.R § 2.309(c)(1) because they have not shown good cause for failure to file on time (factor 1). Furthermore, the contention would unreasonably broaden the issues and delay the proceeding (factor 7), and litigation of the contention would be unlikely to assist in developing a sound record on this issue (factor 8). Factors 2, 3, and 4, listed in note 5 above, speak to standing issues that are irrelevant to Citizens' Motion. Because the two most important factors, 1 and 7, weigh strongly against Citizens, as does factor 8, the balance under Section 2.309(c)(1) strongly favors denial of their Motion.

Citizens have not demonstrated good cause under Section 2.309(c)(1)(i) for failure to adequately challenge the acceptance criteria in a timely manner. In their Motion, they claim good cause "because they could not have filed the contention before the Sandia Study was published." Motion at 13. This statement is simply incorrect. The text of the proposed new contention does not even reference the Sandia Report. Motion at 6. The alleged deficiencies discussed in the text of the contention – underestimation of the uniform and small area required thicknesses – could have been identified with the information available at the time Citizens filed their Original Petition. *See* LBP-06-22, slip op. at 12. Citizens chose not to pursue such a challenge in a timely fashion, and they should not be permitted to do so now.

Further, the Motion introduces allegations based on issues raised and resolved before the ACRS, thereby unreasonably broadening the issues and delaying the proceeding, contrary to the Section 2.309(c)(1)(vii). As we have seen in Section B.1, above, AmerGen and the NRC Staff addressed _all_ of the relevant issues from the January

18 Subcommittee meeting in detail before the full ACRS and counsel for Citizens on February 1, 2007.

Finally, as discussed throughout this Answer, the Motion demonstrates a lack of understanding of the technical issues, presents unsupported allegations, and omits dispositive information known to Citizens. As a result, Citizens' litigation of this late-filed contention would be unlikely to assist in developing a sound record, as described in Section 2.309(c)(1)(viii).[10]

For these reasons, even if the Board finds that Citizens have met the requirements of 10 C.F.R § 2.309(f)(2), the balance of the relevant factors under Section 2.309(c)(1) weigh heavily against admission of Citizens' new late-filed contention.

### C. The Proposed Contention Does Not Meet the Requirements of 10 C.F.R. § 2.309(f)(1)

In addition to its lack of timeliness, Citizens proposed new contention lacks any substantive merit, because none of the bases cited by Citizens raises a genuine dispute on a material issue of law or fact.[11] As discussed in Section A, above, Citizens' first two bases mislead the Board and omit dispositive information. The remaining alleged bases are not relevant to the proposed new contention. Also, both of the remaining bases rely

---

10 Further, the Motion once again highlights broader "concerns . . . regarding the degree to which it seems Citizens are able to contribute to the formation of a record in this proceeding." Feb. 9 Order at 21 (J. Abramson, concurring).

11 The late-filed contention also is arguably outside the scope of a license renewal proceeding because it challenges the current licensing basis. As discussed above, the GE analysis uses methods permitted by the ASME code and approved by the NRC's SER in 1992. Thus the acceptance criteria form part of the current licensing basis, and are not subject to challenge in a 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); *see also* LBP-06-22, slip op. at 32. AmerGen's continued use of the acceptance criteria derived from that analysis was not open to challenge at any point during license renewal, much less at this late stage. Thus, Citizens' late-filed contention also could be dismissed under 10 C.F.R § 2.309(f)(1)(iii).

on preliminary documents obtained by Citizens under the mandatory disclosure process for the admitted contention, and AmerGen has resolved the concerns identified in both documents through its internal processes.

(a) The Sandia Report: Citizens allege that, although the Sandia Report predicted no violations of ASME code requirements, it "showed that the GE modeling relied upon by AmerGen had some critical flaws." Motion at 4. Sandia allegedly "reaches a very different result . . . primarily because the GE study assumed that [the capacity reduction factor] should be 0.34, whereas Sandia used a value of around 0.2." *Id.* at 7. Therefore, Citizens contend, AmerGen should adopt the Sandia criteria or "replace [the GE analysis] with a set of criteria based on an accurate and realistic three dimensional modeling . . . ." *Id.* at 6.

As discussed above, however, the Sandia Report was intended to, and did, confirm the earlier GE analyses.[12] While the Sandia analysts did not obtain sufficient evidence to use a 0.340 capacity reduction factor prior to issuing their final report, Sandia Report at 67, this evidence is now in the record and the Staff has testified that if Sandia had used the 0.340 capacity reduction factor then it would have resulted in a minimum general area thickness of less than 0.736." ACRS Feb. 1 Tr. at 242-43. Moreover, the ACRS has accepted and concurred with the use of the 0.340 value. Exhibit 1, at 2.

Although the Sandia analysis used a different methodology, this study does not invalidate the GE results, nor does it challenge whether AmerGen's techniques are code-

[12] As ACRS Subcommittee Chairman Dr. Maynard observed at the January 18 meeting, "Personally, I'm not bothered by some of the differences between the GE and the Sandia analysis. I think it's good to approach things from different ways. I think they both show that there's [sic] additional conservatisms that are still in both of the analyses. They're still very conservative analyses." ACRS Jan. 18 Tr. at 369.

compliant or satisfy NRC requirements. *See* ACRS Feb. 1 Tr. at 243. The fact that other allegedly improved or state-of-the-art methods may exist to meet those requirements does not raise a genuine dispute of material fact or law under 10 C.F.R § 2.309(f)(1)(vi) – instead, this argument is an impermissible challenge to the applicable NRC regulations. *See, e.g.*, *Metropolitan Edison Co.* (Three Mile Island Nuclear Station, Unit No. 1), LBP-83-76, 18 N.R.C. 1266, 1273 (1983) (holding that the Intervenor's assertion that a different analytical technique should be used other than that called for by the NRC regulations and incorporated ASME Code provisions "does attack the Commission's regulations and is rejected").[13]

For the above reasons, the Citizens have failed to articulate a genuine dispute of material fact arising from the Sandia Report.

(b) January 18 ACRS Subcommittee Meeting: As discussed in Section B.1, above, Citizens allege that the comments of Dr. Abdel-Khalik and others at this meeting justify their new contention. AmerGen, however, fully addressed the ACRS members' questions posed at the January 18 ACRS Subcommittee meeting at the February 1, 2007 meeting. AmerGen Exhibit 1, at 2.

The meeting transcript, moreover, shows that Dr. Abdel-Khalik's question was hypothetical and speculative. ACRS Jan. 18 Tr. at 292-93 ("Let[']s say you backtrack . . . and you ask your experts and they say, no, the ASME code does not allow this . . . . What would have been your response . . . ?"). AmerGen then addressed these concerns

13 Additionally, as was discussed at the February 1 ACRS meeting, and as recommended by the ACRS, AmerGen recently docketed a commitment to perform a three-dimensional finite-element analysis of the drywell shell prior to entering the period of extended operation. Letter from M. Gallagher, AmerGen, to NRC Document Control Desk, "Additional Commitments Related to the Aging Management Program for the Drywell Shell, Associated with AmerGen's License Renewal Application (TAC No. MC7624)" (Feb. 16, 2007).

directly at the February 1, 2007 full Committee meeting by showing that the ASME code *allows* the use of the 0.340 capacity reduction factor. ACRS Feb. 1 Tr. at 205-208.

Citizens also point to "acknowledgments" from Sandia and the NRC Staff that AmerGen's safety margin calculations would be "considerably lower" if Sandia's 0.844" minimum thickness value were used instead of 0.736" used in the GE analysis. Motion at 8. This also is irrelevant. Sandia developed the 0.844" value without using the increased capacity reduction factor. As we have seen, if Sandia had used the increased capacity reduction factor, then they would have reached results very similar to the GE analyses.

Having failed to challenge the resolution AmerGen and the NRC Staff presented at the February 1 meeting, Citizens also have failed to identify a material dispute of fact arising from the January 18 ACRS Subcommittee meeting.

(c) <u>The Latest UT Results</u>: As discussed in Section B above, the October 2006 UT results simply are not relevant to the proposed new contention because Citizens fail to make a connection between the UT results discussed in Citizens' Exhibit ANC-7 and any deficiency in the acceptance criteria. Instead, they offer the observation that, "[b]ecause the wall thickness is now less than measured in 1992, it has become even more critical to accurately estimate how much any existing margin has been reduced," Motion at 3, and the even more irrelevant allegation that "the . . . 2006 exterior UT results undercut AmerGen's belief that the proposed aging management program for the sand bed region will provide reasonable assurance that the loss of intended function would be detected before safety requirements are violated . . . ." Motion at 10.

Even if there were any connection between this information and any alleged deficiency in the acceptance criteria, the preliminary analysis Citizens cite has been superseded by a final analysis, and the technical issues raised in the preliminary analysis have been resolved. Namely, Citizens' Exhibit ANC-7 is a November 2006 preliminary report by an AmerGen consultant, George Licina. AmerGen produced this document through the mandatory disclosure process on January 26, 2007. Mr. Licina completed his analysis and produced a final report, dated January 4, 2007, that supersedes Exhibit ANC-7 (the preliminary report cited by Citizens). The final report is appended to this Answer as AmerGen Exhibit 4; AmerGen collected this document during its January 2007 mandatory disclosure searches, and disclosed it to Citizens in its February 15, 2007 mandatory disclosure update.

Mr. Licina's final report explains that differences in the measurement techniques implemented in 1992 and 2006 introduced a bias in the 2006 thickness measurements that would account for the uniform differences between the two sets of data. AmerGen Exhibit 4, at 5-1 to -2. The report concludes that "the actual mean value of the difference between 2006 and 1992 thickness measurements is zero or a value very near zero . . . ." *Id.* at 5-2.[14] Also, because the 2006 visual inspections of the epoxy coating on the exterior of the drywell shell identified the coating to be in good condition, certain measurements that appeared to show large thickness losses, such as 0.070" or more, could only be statistical outliers that must be ignored. *Id.* at 6-1.

Thus, Citizens' reliance on Mr. Licina's November 2006 preliminary analysis is inappropriate to meet the requirements of 10 C.F.R § 2.309(f)(1)(vi), as they have once

---

14 ACRS Member Dr. J. Sam Armijo concurred with this conclusion in comments addressed to counsel for Citizens at the February 1 meeting. "Independently, I did something very similar to what Mr. Licina did, and . . . I saw the same phenomena . . . . [T]here are systematic changes, systematic bias and there was no way I could conclude that there was continuing corrosion, that the most reasonable interpretation of the data is that the corrosion had been arrested since 1992." ACRS Feb. 1 Tr. at 262.

again failed to identify a dispute of material fact related to the latest UT results.

(d) AR 00461639: As discussed in Section B, above, AmerGen has resolved the issues identified in this AR, and produced this resolution to Citizens on December 12, 2006. Accordingly, this document cannot provide an adequate basis for the proposed new contention under 10 C.F.R § 2.309(f)(1) because it tells only half the story.

The revised calculation required by this AR has been completed, and it demonstrates that the 1992 UT data met ASME Code requirements in 1992. *See* Exhibit 3, at 4. Furthermore, the UT data collected during the 2006 outage demonstrate that the monitored areas of the drywell shell have experienced no observable corrosion since 1992. *See* Exhibit 4, at 6-2 ("Corrosion rate, as defined by physical observation of coating condition and a thorough analysis of the 106 thickness measurements done in both 1992 and 2006 confirms that the apparent corrosion over that 14 year period is essentially nil.").

Therefore, Citizens also have failed to identify a dispute of material fact related to this AR.

## III. CONCLUSION

Citizens' new late-filed contention fails to meet the procedural requirements for admission and has no substantive merit. Yet again, Citizens have filed a new contention based on "unsupported arguments and failures to address facts obviously necessary to provide a foundation for a proposed contention." Feb. 9 Order at 22 (J. Abramson, concurring). Because it lacks an adequate basis and fails to meet the requirements of 10 C.F.R. §§ 2.309(c), (f)(1), and (f)(2), it should be dismissed by the Board in its entirety.

Respectfully submitted,


Donald J. Silverman, Esq.
Kathryn M. Sutton, Esq.
Alex S. Polonsky, Esq.
MORGAN, LEWIS & BOCKIUS, LLP
1111 Pennsylvania Avenue, N.W.
Washington, DC 20004
Phone: (202) 739-5502
E-mail: dsilverman@morganlewis.com
E-mail: ksutton@morganlewis.com
E-mail: apolonsky@morganlewis.com

J. Bradley Fewell
Associate General Counsel
Exelon Corporation
4300 Warrenville Road
Warrenville, IL 60555
Phone: (630) 657-3769
E-mail: Bradley.Fewell@exeloncorp.com

COUNSEL FOR
AMERGEN ENERGY COMPANY, LLC


Dated in Washington, D.C.
this 5th day of March 2007

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

| | | |
|---|---|---|
| In the Matter of: | ) | March 5, 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 "AmerGen's Answer Opposing Citizens' February 6, 2007 Motion for Leave to Add a Contention and Motion to Add a Contention" were served this day upon the persons listed below, by E-mail and first class mail, unless otherwise noted.

Secretary of the Commission*
U.S. Nuclear Regulatory Commission
Attn: Rulemakings and Adjudications Staff
One White Flint North
11555 Rockville Pike
Rockville, Maryland 20852-2738
(E-mail: HEARINGDOCKET@nrc.gov)

Administrative Judge
E. Roy Hawkens, Chair
Atomic Safety and Licensing Board Panel
Mail Stop – T-3 F23
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
(E-mail: erh@nrc.gov)

Administrative Judge
Paul B. Abramson
Atomic Safety and Licensing Board Panel
Mail Stop – T-3 F23
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
(E-mail: pba@nrc.gov )

Administrative Judge
Anthony J. Baratta
Atomic Safety and Licensing Board Panel
Mail Stop – T-3 F23
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001
(E-mail: ajb5@nrc.gov)

John A. Covino
Ellen Barney Balint
Valerie Anne Gray
Caroline Stahl
Division of Law
Environmental Permitting and Counseling Section
P.O. Box 093
Hughes Justice Complex
Trenton, NJ 08625
(E-mail: john.covino@dol.lps.state.nj.us)
(E-mail: Ellen.Balint@lps.state.nj.us)
(E-mail: Valerie.Gray@dol.lps.state.nj.us)
(E-mail: Caroline.Stahl@lps.state.nj.us)

Office of Commission Appellate Adjudication**
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Richard Webster
Rutgers Environmental Law Clinic
123 Washington Street
Newark, NJ 07102-5695
(E-mail: rwebster@kinoy.rutgers.edu)

Suzanne Leta
NJPIRG
11 N. Willow Street
Trenton, NJ 08608
(E-mail: sleta@njpirg.org)

Paul Gunter
Nuclear Information and Resource Service
1424 16th Street, NW
Suite 404
Washington, DC 20036
(E-mail: pgunter@nirs.org)

Mitzi A. Young
Steven C. Hamrick
Jody C. Martin
Office of the General Counsel, 0-15D21
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
(E-mail: may@nrc.gov)
(E-mail: schl@nrc.gov)
(E-mail: jcm5@nrc.gov)

Debra Wolf
Law Clerk
Atomic Safety and Licensing Board
Mail Stop: T-3F23
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
(E-mail: dawl@nrc.gov)

* Original and 2 copies
** First Class Mail only

Raphael P. Kuyler

Exhibit 1

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, DC 20555 - 0001

February 8, 2007

The Honorable Dale E. Klein
Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: REPORT ON THE SAFETY ASPECTS OF THE LICENSE RENEWAL APPLICATION FOR THE OYSTER CREEK GENERATING STATION

Dear Chairman Klein:

During the 539th meeting of the Advisory Committee on Reactor Safeguards, February 1-3, 2007, we completed our review of the license renewal application for the Oyster Creek Generating Station (OCGS) and the updated Safety Evaluation Report (SER) prepared by the NRC staff. Our Plant License Renewal Subcommittee also reviewed this matter during meetings on October 3, 2006 and January 18, 2007. During these reviews, we had the benefit of discussions with representatives of the NRC staff and its contractor Sandia National Laboratories (SNL), members of the public, and AmerGen Energy Company, LLC (AmerGen) and its contractors. We also had the benefit of the documents referenced. This report fulfills the requirements of 10 CFR 54.25 that the ACRS review and report on all license renewal applications.

RECOMMENDATIONS

1. With the incorporation of the conditions described in Recommendations 2, 3, and 4, the application for license renewal for OCGS should be approved.

2. We concur with the staff's proposal to impose license conditions to increase the frequency of the drywell inspections and to monitor the two drywell trenches to ensure that the sources of water are identified and eliminated.

3. The staff should add a license condition to ensure that the applicant fulfills its commitment to perform an engineering study prior to the period of extended operation to identify options to eliminate or reduce the leakage in the OCGS refueling cavity liner.

4. The staff should add a license condition to ensure that the applicant fulfills its commitment to perform a 3-D (dimensional) finite-element analysis of the drywell shell prior to entering the period of extended operation.

DISCUSSION

The Oyster Creek Generating Station is located in Lacey Township, Ocean County, New Jersey, approximately 2 miles south of the community of Forked River, 2 miles inland from the shore of Barnegat Bay, and 9 miles south of Toms River, New Jersey. The NRC issued the provisional operating license for OCGS on April 9, 1969 and the operating license on July 2,

1991. OCGS is a single unit facility with a single cycle, forced circulation boiling water reactor (BWR)-2 with a Mark 1 containment. The nuclear steam supply system was furnished by General Electric and the balance of the plant was originally designed and constructed by Burns & Roe. The licensed power output is 1930 MWt with a design electrical output of approximately 650 MWe. The applicant, AmerGen requested renewal of the OCGS operating license for 20 years beyond the current license term, which expires on April 9, 2009.

During the 1980s, the licensee discovered corrosion on the outside wall of the OCGS drywell shell. Although some corrosion had occurred in the upper shell region, the majority had occurred in a region near the base of the shell where the shell was partially supported by a sand bed. The licensee determined that water had been leaking through flaws in the refueling cavity liner during refueling operations. This water had migrated down the outside of the drywell shell and into the sand bed. As part of the corrective actions, the licensee removed the sand and applied an epoxy coating to the outside of the shell in the sand bed region. In addition, repairs were made to the refueling pool liner and the concrete drain trough under the refueling seal. These repairs reduced the leakage and routed any leakage to a drain line rather than down the outside of the drywell shell. To further reduce leakage, the licensee applied strippable coatings to the liner during all but one of the subsequent refueling outages. The licensee performed ultrasonic testing (UT) to determine the as-found condition of the drywell shell and performed a structural analysis in 1992 to demonstrate acceptability of the containment in the degraded condition.

The 1992 structural analysis was reviewed and approved by the NRC staff. This analysis included a determination of the stresses in the thinned region under the design pressure loads and an evaluation of the potential for buckling during normal operations and postulated accident conditions. The buckling analysis utilized American Society of Mechanical Engineers (ASME) Code Case N-284, Revision 1. The staff accepted the use of this Code Case in the 1992 analysis. In support of the review of the OCGS license renewal application, the staff had SNL perform a confirmatory structural analysis. Both analyses demonstrated that the drywell shell met the minimum ASME Code requirements for buckling. However, the amount of margin above the Code minimum depended on the applicability of the increase in the buckling capacity due to tensile stresses orthogonal to the applied compressive stresses computed according to the Code Case. During the January 18, 2007 meeting, the Subcommittee requested additional justification for using the increased capacity factor. At our February meeting, Dr. C. Miller, the author of the ASME Code Case, described the technical basis for the Code Case and presented test results to demonstrate that the increased capacity factor was applicable to OCGS. The increased capacity factor used in the 1992 analysis provided by the applicant was based on results for metal cylinders. Dr. Miller showed results of tests conducted on metal spheres which demonstrated that the results for cylinders were conservative for spherical shells. The staff reaffirmed its position that the use of the increased capacity factor is appropriate for the analysis of the OCGS drywell shell. We concur with this position.

The 1992 structural analysis was based on the assumption that the shell is uniformly thinned in the sand bed region. The applicant has committed to perform a 3-D finite-element analysis of the OGCS drywell to determine the margin of the shell in the as-found condition using modern methods. This analysis will provide a more accurate quantification of the margin above the Code required minimum for buckling. The applicant has committed to complete the analysis prior to the period of extended operation. We commend the applicant for this action and would like to be briefed by the staff on the results when they become available. Although it is anticipated that the analysis will demonstrate additional margin above the Code required minimum, the applicant should complete this analysis in a timely manner prior to entering the period of extended operation in order to identify and resolve any unexpected results. The analysis should include sensitivity studies to determine the degree to which uncertainties in the size of thinned areas affect the Code margins. The staff should impose a license condition to ensure that the applicant completes the analysis prior to entering the period of extended operation.

In 2006, the applicant performed additional UT and visual inspections of the drywell shell. When compared to the previous UT, the 2006 results confirmed that the corrective actions taken in the sand bed region had been effective and that the corrosion had been arrested or at least that the corrosion rates were very low (i.e., within the data scatter). The epoxy coating appeared in very good condition with no evidence of degradation which is also consistent with the conclusion that the corrosion has been effectively arrested. These examinations also demonstrated that the corrosion rate in the upper shell region and the embedded floor regions remained sufficiently low to demonstrate structural integrity during the period of extended operation. The applicant has committed to perform UT and visual inspections of the drywell shell during the period of extended operation. Because of the relatively small margin above the Code minimum against buckling in the sand bed region shown by current analyses, the staff is proposing a license condition to increase the frequency of drywell inspections and UT in the sand bed region to all 10 bays every other refueling outage for the extended period of operation. Increased inspections will result in additional radiation exposure to personnel involved in the inspections. Therefore, the applicant should be allowed to increase the period between inspections if it demonstrates increased margin through analysis or if the ongoing inspections continue to demonstrate that the corrosion has been sufficiently arrested. With this provision, we agree with this license condition.

The 2006 examinations revealed that when the cavity was flooded for refueling, water leakage was still occurring. This leakage of approximately 1 gallon per minute is well within the capacity of the drain as long as the drain system is working properly. The purpose of the drain system is to catch water that may leak past a failed refueling seal or liner and divert the water to sumps, and prevent it from coming into contact with the outside of the drywell shell. Leakage is not expected to occur as part of normal operation with properly maintained equipment and structures. The applicant has committed to continue monitoring for leakage of the refueling cavity liner and other water sources associated with the drywell. The applicant has also committed to complete an engineering study to identify cost-effective repair or replacement options to eliminate the refueling cavity liner leakage. The engineering study will be completed prior to entering the period of extended operation. We agree that efforts should be made to eliminate routine leakage in order to provide increased protection against further degradation. The staff should impose a license condition to ensure the study is completed by the applicant prior to the period of extended operation.

During the 2006 refueling outage, the applicant discovered water in two trenches that had been previously excavated to allow access to and inspection of the inside of the shell in the embedded region. The applicant determined that the water had come from normal operation and maintenance activities. The water had migrated to the trenches due to a blocked drain tube in the sub-pile area and the lack of a seal between the shell and concrete curb. The applicant repaired the drain tube and installed a seal in the gap between the shell and concrete curb. The applicant intends to fill these trenches after two consecutive outages in which no water is observed. Having the trenches open is beneficial for identifying drainage issues, but it increases the risk of additional corrosion because it provides an open area in which water can be trapped against the shell. The staff is proposing a license condition that would require the applicant to leave the trenches open and monitor them during each refueling outage until such time that the applicant can demonstrate that the water sources have been identified and eliminated. We agree with the monitoring of the trenches to ensure the elimination of the sources of water. However, leaving the trenches open longer than necessary increases the risk of future corrosion. Therefore, the applicant should not be unnecessarily delayed in repairing the trenches. With this provision, we agree with the license condition proposed by the staff.

In the updated SER, the staff documents its review of the license renewal application and other information submitted by AmerGen and obtained during an audit and inspections conducted at the plant site. The staff reviewed the completeness of the applicant's identification of structures, systems, and components (SSCs) that are within the scope of license renewal; the integrated plant assessment process; the applicant's identification of the plausible aging mechanisms associated with passive, long-lived components; the adequacy of the applicant's aging management programs (AMPs); and the identification and assessment of time-limited aging analyses (TLAAs) requiring review.

The OCGS application either demonstrates consistency with the Generic Aging Lessons Learned (GALL) Report or documents deviations from the approaches specified in the GALL Report. The staff reviewed this application in accordance with NUREG-1800, the "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants."

The applicant identified those SSCs that fall within the scope of license renewal. For these SSCs, the applicant performed a comprehensive aging management review. Based on the results of this review, the applicant will implement 57 AMPs for license renewal including existing, enhanced, and new programs. In the SER, the staff concludes that the applicant has appropriately identified SSCs within the scope of license renewal and that the AMPs described by the applicant are appropriate and sufficient to manage aging of long-lived passive components that are within the scope of license renewal. With the incorporation of the license conditions described in Recommendations 2, 3 and 4, we agree with this conclusion.

The staff conducted inspections and an audit of the license renewal application. The purpose of the inspections was to verify that the scoping and screening methodologies are consistent with the regulations and are adequately reflected in the application. In addition, the inspectors personally examined selected areas of the sand bed region to verify the condition of the epoxy coating. The audit confirmed the appropriateness of the AMPs and the aging management reviews. Based on the inspections and audit, the staff concluded that these programs are consistent with the descriptions contained in the OCGS license renewal application. The staff also concluded that the existing programs, to be credited as AMPs for license renewal, are generally functioning well and that the applicant has established an implementation plan in its commitment tracking system to ensure timely completion of the license renewal commitments.

The applicant identified those systems and components requiring TLAAs and reevaluated them for 20 more years of operation. Affected TLAAs include those associated with neutron embrittlement, metal fatigue, irradiation-assisted stress corrosion cracking, environmental qualification of electrical equipment, and stress relaxation of hold-down bolts. The staff concluded that the applicant has provided an adequate list of TLAAs. Further, the staff concluded that in all cases the applicant has met the requirements of the license renewal rule by demonstrating that the TLAAs will remain valid for the period of extended operation, or that the TLAAs have been projected to the end of the period of extended operation, or that the aging effects will be adequately managed for the period of extended operation. With the incorporation of the license conditions described in Recommendations 2, 3 and 4, we concur with the staff that OCGS TLAAs have been properly identified and that criteria supporting 20 more years of operation have been met.

With the incorporation of the license conditions described in Recommendations 2, 3, and 4, no issues related to the matters described in 10 CFR 54.29(a)(1) and (a)(2) preclude renewal of the operating license for OCGS. The programs established and committed to by AmerGen provide reasonable assurance that OCGS can be operated in accordance with its current licensing basis for the period of extended operation without undue risk to the health and safety of the public and the NRC should approve the AmerGen application for renewal of the operating license for OCGS.

Sincerely,

William J. Shack

References:

1. Updated Safety Evaluation Report Related to the License Renewal of Oyster Creek Generating Station, December 29, 2006.

2. Safety Evaluation Report with Open Items Related to the License Renewal of the Oyster Creek Generating Station, August 18, 2006.

3. Oyster Creek Generating Station- Application for Renewed Operating Licenses, July 22, 2005.

4. Supplemental Information Related to the Aging Management Program for the Oyster Creek Drywell Shell, Associated with AmerGen's License Renewal Application, June 20, 2006.

5. Audit and Review Report for Plant Aging Management Reviews and Programs- Oyster Creek Generating Station August 18, 2006.

6. Supplemental Response to NRC Request for Additional Information (RAI 2.5.1.19-1), dated September 28, 2005, Related to Oyster Creek Generating Station License Renewal Application, November 11, 2005.

7. Oyster Creek Generating Station - NRC License Renewal Inspection Report 05000219/2006007, September 21, 2006

8. Memorandum dated December 14, 2006 from Louise Lund to John Larkins, Subject: Review Background Materials for the Meeting of the License Renewal Subcommittee Scheduled on January 18, 2007, Related to the Interim Review of the License Renewal of the Oyster Creek Generating Station. ML063470557

9. Memorandum date December 8, 2006 from Michael P. Gallagher to the U.S. Nuclear Regulatory Commission, Subject: Submittal of Information to ACRS Plant License Renewal Subcommittee Related to AmerGen's Application for Renewed Operating License for Oyster Creek Generating Station. ML063470532

10. Sandia National Laboratories Report "Structural Integrity Analysis of the Degraded Drywell Containment at the Oyster Creek Nuclear Generating Station," January 2007

11. ASME Code Case N-284-1, "Metal Containment Shell Buckling Design Methods, Class MC, Section III, Division one, March 14, 1995."

12. Letter dated January 31, 2007, from Senator Frank Lautenberg, Senator Robert Menendez, Representative Christopher H. Smith, and Representative Jim Saxton to The ACRS.

13. Letter dated January 31, 2007 from Richard Webster, Rutgers Environmental Law Clinic to the ACRS, regarding the Safety Evaluation Report for Oyster Creek Nuclear Power Plant.

14. Oyster Creek Generating Station-NRC In-Service Inspection and License Renewal Commitment Followup Inspection Report 0500021/2006013, January 17, 2007.

**EXHIBIT 2**

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

April 24, 1992

Docket No. 50-219

Mr. John J. Barton
Vice President and Director
GPU Nuclear Corporation
Oyster Creek Nuclear Generating Station
Post Office Box 388
Forked River, New Jersey 08731

Dear Mr. Barton:

SUBJECT: EVALUATION REPORT ON STRUCTURAL INTEGRITY OF THE OYSTER CREEK DRYWELL (TAC NO. M79166)

The staff has completed the review and evaluation of the stress analyses and stability analyses reports of the corroded drywell with and without the sand bed. Our evaluation report is contained in the enclosure. GPUN used the analyses to justify the removal of the sand from the sand bed region. Even though the staff, with the assistance of consultants from Brookhaven National Laboratory (BNL), concurred with GPUN's conclusion that the drywell meets the ASME Section III Subsection NE requirements, it is essential that GPUN continue UT thickness measurements at refueling outages and at outages of opportunity for the life of the plant. The measurements should cover not only areas previously inspected but also accessible areas which have never been inspected so as to confirm that the thickness of the corroded areas are as projected and the corroded areas are localized.

We request that you respond within 30 days of receipt of this letter indicating your intent to comply with the above requirements as discussed in the Safety Evaluation.

The requirements of this letter affect fewer than 10 respondents, and therefore, are not subject to Office of Management and Budget review under P.L. 96-511.

Sincerely,

Alexander W. Dromerick

Alexander W. Dromerick, Sr. Project Manager
Project Directorate I-4
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosure:
As stated

cc w/enclosure:
See next page

Mr. John J. Barton
GPU Nuclear Corporation

Oyster Creek Nuclear
- Generating Station

cc:

Ernest L. Blake, Jr., Esquire
Shaw, Pittman, Potts & Trowbridge
2300 N Street, NW.
Washington, DC 20037

Regional Administrator, Region I
U.S. Nuclear Regulatory Commission
475 Allendale Road
King of Prussia, Pennsylvania 19406

BWR Licensing Manager
GPU Nuclear Corporation
1 Upper Pond Road
Parsippany, New Jersey 07054

Mayor
Lacey Township
818 West Lacey Road
Forked River, New Jersey 08731

Licensing Manager
Oyster Creek Nuclear Generating Station
Mail Stop: Site Emergency Bldg.
Post Office Box 388
Forked River, New Jersey 08731

Resident Inspector
c/o U.S. Nuclear Regulatory Commission
Post Office Box 445
Forked River, New Jersey 08731

Kent Tosch, Chief
New Jersey Department of
Environmental Protection
Bureau of Nuclear Engineering
CN 415
Trenton, New Jersey 08625

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

# SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

## DRYWELL STRUCTURAL INTEGRITY

## OYSTER CREEK NUCLEAR GENERATING STATION

## GPU NUCLEAR CORPORATION

## DOCKET NO. 50-219

## I. INTRODUCTION

In 1986 the steel drywell at Oyster Creek Nuclear Generating Station (OCNGS) was found to be extensively corroded in the area of the shell which is in contact with the sand cushion around the bottom of the drywell. Since then GPU Nuclear Corporation, (GPUN, the licensee of OCNGS), has instituted a program of periodic inspection of the drywell shell sand cushion area through ultrasonic testing (UT) thickness measurements. The inspection has been extended to other areas of the drywell and some areas above the sand cushion have been found to be corroded also. From the UT thickness measurements, one can conclude that corrosion of the drywell shell in the sand cushion area is continuing. In an attempt to eliminate corrosion or reduce the corrosion rate, the licensee tried cathodic protection and found it to be of no avail. An examination of the results of consecutive UT measurements, confirmed that the corrosion is continuing. There is concern that the structural integrity of the drywell cannot be assured. Since the root cause of the corrosion in the sand cushion area is the presence of water in the sand, the licensee has considered sand removal to be an important element in its program to eliminate the corrosion threat to the drywell integrity.

In the program, the licensee first established the analysis criteria and then performed the analyses of the drywell for its structural adequacy with and without the presence of the sand. The licensee performed stress analyses and stability analyses for both with and without the sand cases and concluded the drywell with or without the sand to be in compliance with the criteria established for the reevaluation. It is to be noted that the original purpose of the sand cushion is to provide a smooth transition of stresses from the fixed portion to the free-standing portion of the steel drywell.

## II. EVALUATION

The staff with the assistance of consultants from Brookhaven National Laboratory (BNL) has reviewed and evaluated the information (Refs. 1,2,3,4,5) provided by the licensee.

1. Re-Analysis Criteria

The drywell was originally designed and constructed to the requirements of ASME Section VIII code and applicable code cases, with a contract date of July 1, 1964. The Section VIII Code requirements for nuclear containment vessels at that time were less detailed than at any subsequent date. The evolution of the ASME Section III Code for metal containments and its relation with ASME Section VIII Code were reviewed and evaluated by Teledyne Engineering Services (TES). The evaluation criteria used are based on ASME Section III Subsection NE Code through the 1977 summer addenda. The reason for the use of the Code of this vintage is that it was used in the Mark I containment program to evaluate the steel torus for hydrodynamic loads and that the current ASME Section III Subsection NE Code is closely related to that version. The following are TES's findings relevant to Oyster Creek application:

a) The steel material for the drywell is A-212, grade B, Firebox Quality (Section VIII), but it is redesignated as SA-516 grade in Section III.

b) The relation between the allowable stress (S) in Section VIII and the stress intensity (Smc) in Section III for metal containment is 1.1S = Smc.

c) Categorization of stresses into general primary membrane, general bending and local primary membrane stresses and membrane plus bending stresses is adopted as in Subsection NE.

d) The effect of a locally stressed region on the containment shell is considered in accordance with NE-3213.10.

In addition to ASME Section III Subsection NE Code, the licensee has also invoked ASME Section XI IWE Code to demonstrate the adequacy of the Oyster Creek drywell. IWE-3519.3 and IWE-3122.4 state that it is acceptable if either the thickness of the base metal is reduced by no more than 10% of the normal plate thickness or the reduced thickness can be shown by analysis to satisfy the requirements of the design specification.

The staff has reviewed the licensee's adoption of ASME Section III Subsection NE and Section XI Subsection IWE in its evaluation of the structural adequacy of the corroded Oyster Creek drywell, and has found it to be generally reasonable and acceptable.

By adopting the Subsection NE criteria, the licensee has treated the corroded areas as discontinuities per NE-3213.10, which was originally meant for change in thicknesses, supports, and penetrations. These discontinuities are highly localized and should be designed so that their presence will have no effect on the overall behavior of the containment shell. NE-3213.10 defines clearly the level of stress intensity and the extent of the discontinuity to be considered localized. A stress intensity limit of 1.1 Smc is specified at the boundary of the region within which the membrane stress can be higher than 1.1 Smc. The region where the stress intensity varies from 1.1 Smc to 1.0 Smc is not defined in the Code because of the fact that it varies with the loading. In view of this, the licensee rationalized that the 1.1 Smc can be applied beyond the region defined by NE-3213.10 for localized discontinuity without any restriction throughout the drywell. The staff disagreed with the licensee's interpretation of the Code. The staff pointed out that for Oyster Creek drywell, stresses due to internal pressure should be used as the criterion to establish such a region. The interpretation of Section XI Subsections IWE-3519.3 and IWE-3122.4 can be made only in the same context. It is staff's position that the primary membrane stress limit of 1.1 Smc not be used indiscriminately throughout the drywell.

In order to use NE-3213.10 to consider the corroded area as a localized discontinuity, the extent of the reduction in thickness due to corrosion should be reasonably known. UT thickness measurements are highly localized; however, from the numerous measurements so far made on the Oyster Creek drywell, one can have a general idea of the overall corroded condition of the drywell shell and it is possible to judiciously apply the established re-analysis criteria.

2. <u>Re-analyses</u>

The re-analyses were made by General Electric Company for the licensee, one reanalysis considered the sand present and the other considered the drywell without the sand. Each re-analysis comprises a stress analysis and stability analysis. Two finite element models, one axisymmetric and another a 36° pie slice model were used for the stress analysis. The ANSYS computer program was used to perform the analyses. The axisymmetric model was used to determine the stresses for the seismic and the thermal gradient loads. The pie slice model was used for dead weight and pressure loads. The pie slice model includes the vent pipe and the reinforcing ring, and was also used for buckling analysis. The same models were used for the cases with and without sand, except that in the former, the stiffness of sand in contact with the steel shell was considered. The shell thickness in the sand region was assumed to be 0.700" for the with-sand case and to be 0.736" for the without-sand case. The 0.70" was, as claimed by the licensee, used for conservatism and the 0.736" is the projected thickness at the start of fuel cycle 14R. The same thicknesses of the shell above the sand region were used for both cases. For the with-sand case, an analysis of the drywell with the original nominal wall thicknesses was made to check the shell stresses with the allowable values established for the re-analyses.

The licensee used the same load combinations as specified in Oyster Creek's final design safety analysis report (FDSAR) for the re-analyses. The licensee made a comparison of the load combinations and corresponding allowable stress limits using the Standard Review Plan (SRP) section 3.8.2 and concluded they are comparable.

The results of the re-analyses indicated that the governing thicknesses are in the upper sphere and the cylinder where the calculated primary membrane stresses are respectively 20,360 psi and 19,850 psi vs. the allowable stress value of 19,300 psi. There is basically no difference, in the calculated stresses at these levels, between the with and without sand cases. This should be expected, because in a steel shell structure the local effect or the edge effect is damped in a very short distance. The stresses calculated exceed the allowable by 3% to 6%, and such exceedance is actually limited to the corroded area as obtained from UT measurements. However, in order to perform the axisymmetric analysis and analysis of the pie slice model, uniform thicknesses were assumed for each section of the drywell. Therefore, the calculated over-stresses may represent only stresses at the corroded areas and the stresses for areas beyond the corroded areas are less and would most likely be within the allowable as indicated in results of the analyses for nominal thicknesses. The diagram in Ref. 6 indicated such a condition. It is to be noted that the stresses for the corroded areas were obtained by multiplying the stresses for nominal thicknesses by the ratios between the corroded and nominal thicknesses.

The buckling analyses of the drywell were performed in accordance with ASME Code Case N-284. The analyses were done on the 36° pie slice model for both with-sand and without-sand cases. Except in the sand cushion area where a shell thickness of 0.7" for the with-sand case and a shell thickness of 0.736" for the without-sand case were used, nominal shell thicknesses were considered for other sections. The load combinations which are critical to buckling were identified as those involving refueling and post accident conditions. By applying a factor of safety of 2 and 1.67 for the load combinations involving refueling and the post-accident conditions respectively, the licensee established for both cases the allowable buckling stresses which are obtained after being modified by capacity and plasticity reduction factors. It is found that the without-sand, case for the post-accident condition is most limiting in terms of buckling with a margin of 14%. The staff and its Brookhaven National Laboratory (BNL) consultants concur with the licensee's conclusion that the Oyster Creek drywell has adequate margin against buckling with no sand support for an assumed sandbed region shell thickness of 0.736 inch.

A copy of BNL's technical evaluation report is attached to this safety evaluation.

## III. <u>CONCLUSION</u>

With the assistance of consultants from BNL, the staff has reviewed and evaluated the responses to the staff's concerns and the detailed re-analyses of the drywell for the with-sand and without-sand cases. The reanalyses by the licensee indicated that the corroded drywell meets the requirements for containment vessels as contained in ASME Section III Subsection NE through summer 1977 addenda. This Code was adopted in the Mark I containment program. The staff agrees with the licensee's justification of using the above mentioned Code requirements with one exception, the use of 1.1 Smc throughout the drywell shell in the criteria for stress analyses. It is the staff's position that the primary membrane stress limit of 1.1 Smc not be used indiscriminately throughout the drywell. The staff accepted the licensee's reanalyses on the assumption that the corroded areas are highly localized as indicated by the licensee's UT measurements. The stresses obtained for the case of reduced thickness can only be interpreted to represent those in the corroded areas and their adjacent regions of the drywell shell. In view of these observations, it is essential that the licensee perform UT thickness measurements at refueling outages and at outages of opportunity for the life of the plant. The measurements should cover not only areas previously inspected but also accessible areas which have never been inspected so as to confirm that the thicknesses of the corroded areas are as projected and the corroded areas are localized. Both of these assumptions are the bases of the reanalyses and the staff acceptance of the reanalysis results.

References:

1. "An ASME Section VIII Evaluation of the Oyster Creek Drywell Part 1, Stress Analysis" GE Report No. 9-1 DRF #00664 November 1990, prepared for GPUN (with sand).

2. "Justification for use of Section III, Subsection NE, Guidance in Evaluating the Oyster Creek Drywell" TR-7377-1, Teledyne Engineering Services, November 1990 (Appendix A to Reference 1).

3. "An ASME Section VIII evaluation of the Oyster Creek Drywell, Part 2, Stability Analysis" GE Report No. 9-2 DRF #00664, Rev. 0, & Rev. 1. November 1990, prepared for GPUN (with sand).

4. "An ASME Section VIII Evaluation of Oyster Creek Drywell for without sand case, Part I, stress analysis" GE Report No. 9-3 DRF #00664, Rev. 0, February 1991. Prepared for GPUN.

5. "An ASME Section VIII Evaluation of Oyster Creek Drywell, for without sand case, Part 2 Stability Analysis" GE Report No. 9-4, DRF #00664 Rev. 0, Rev. 1 November 1990, prepared for GPUN.

6. Diagram attached to a letter from J. C. Devine Jr. of GPUN to NRC dated January 17, 1992 (C321-92-2020, 5000-92-2094).

Principal Contributor: C.P. Tan

Date: April 24, 1992

Attachment:
BNL Technical Evaluation
Report

ATTACHMENT

BROOKHAVEN NATIONAL LABORATORY

TECHNICAL EVALUATION REPORT

ON

# STRUCTURAL ANALYSES OF THE CORRODED OYSTER CREEK STEEL DRYWELL

## 1. Introduction

An inspection of the steel drywell at the Oyster Creek Nuclear Generating Station in November 1986 revealed that some degradation due to corrosion had occurred in the sandbed region of the shell. Subsequent inspections also identified thickness degradations in the upper spherical and cylindrical sections of the drywell. The licensee, GPU Nuclear Corporation, has performed structural analyses to demonstrate the integrity of the drywell for projected corroded conditions that may exist at the start of the fourteenth refueling outage (14R). This outage is expected to start in October 1992. In an attempt to arrest the corrosion, the licensee plans to remove the sand from the sandbed region. Consequently, they have submitted structural analyses of the drywell both with and without sand for drywell wall thicknesses projected to exist at the start of 14R outage.

## 2. Summary of Licensee's Analyses

The analyses performed by the licensee utilized the drywell wall thicknesses summarized in Table 1.

Table 1
Drywell Wall Thicknesses

| Drywell Region | As-Designed Thicknesses (in.) | Projected 95% Confidence 14R Thicknesses (in.) |
|---|---|---|
| Cylindrical Region | 0.640 | 0.619 |
| Knuckle | 2.5625* | 2.5625* |
| Upper Spherical Region | 0.722 | 0.677 |
| Middle Spherical Region | 0.770 | 0.723 |
| Lower Spherical Region Except Sand Bed Area | 1.154 | 1.154 |
| Sand Bed Region | 1.154 | 0.736 |

*NOTE: Table 2-1 of both References 1 and 3 indicates that the knuckle thickness is 2.625". This appears to be a mistake since the knuckle thickness is shown to be 2-9/16" in Figure 1-1 of the same report.

The stress analysis for the "with sand" case is described in Reference 1. For this analysis the licensee utilized the as-designed thicknesses, except for the sandbed region where a thickness of 0.70" was used. The stress results were obtained from a finite element analysis which utilized axisymmetric solid elements and the ANSYS computer program. Later, the stress results were scaled to address the local thinning in areas other than the sandbed region (the projected 95% confidence 14R thicknesses in Table 1). The loads and load combinations considered in the analysis are based on the FSAR Primary Containment Design Report and the 1964 Technical Specification for the Containment. Appendix E of Reference 1 compares the load combinations considered in the analysis with those given in Section 3.8.2 of the NRC Standard Review Plan, Rev. 1, July 1981.

The stress analysis for the "without sand" case is described in Reference 3. For this analysis the licensee also utilized the as-designed thicknesses, except for the sandbed region where a thickness of 0.736" was used. In this case, two finite element models, an axisymmetric and a 36° pie slice model, were used. The axisymmetric model is essentially the same as that used in Reference 1; however, the elements representing the sand stiffness were removed. This model was used to determine the seismic and thermal stresses. The pie slice model was used to determine the dead weight and pressure stresses, as well as the stresses for load combinations. The pie slice model included the effects of the vent pipes and the reinforcing ring in the drywell shell in the vicinity of each vent pipe. The drywell and vent shell were modeled using 3-dimensional elastic-plastic quadrilateral shell elements. At a distance of 76 inches from the drywell shell, beam elements were used to model the remainder of the ventline. The loads and load combinations are the same as those considered in Reference 1.

The code of record for the Oyster Creek drywell is the 1962 Edition of the ASME Code, Section VIII with Addenda to Winter 1963, and Code Cases 1270N-5, 1271N and 1272N-5. The licensee utilized these criteria in evaluating the stresses in the drywell, but also utilized guidance from the NRC Standard Review Plan with regard to allowable stresses for service level C and the post-accident condition. The licensee also used guidance from Subsection NE of Section III of the ASME Code in order to justify the use of a limit of $1.1S_{mc}$ in evaluating the general membrane stresses in areas of the drywell where reduced thicknesses are specified. Based on these criteria the licensee has concluded that the stresses in the drywell shell are within code allowable limits for both the "with sand" and "without sand" cases.

The licensee also performed stability analyses of the drywell for both the "with sand" case (Reference 2) and the "without sand" case (Reference 4). For the "with sand" case the licensee utilized the as-designed thicknesses shown in Table 1, except in the sandbed region where a thickness of 0.700 inch was used. For the "without sand" case the same thicknesses were used , except in the sandbed region where a thickness of 0.736 inch was used. The buckling capability of the drywell for both the "with sand" and "without sand" cases was evaluated by using the 36° pie slice finite element model discussed above. For the "with sand" case spring elements were used in the sandbed region to model the sand support. For the "without sand" case these spring elements were removed. The most limiting load combinations which result in the highest compressive stresses in the sandbed region were considered for the buckling analysis. These are the refueling condition (Dead Weight + Live Load + Refueling Water Weight + External Pressure + Seismic) and the post-accident condition (Dead Weight + Live Load + Hydrostatic Pressure for Flooded Drywell + External Pressure + Seismic).

The buckling evaluations performed by the licensee follow the methodology described in ASME Code Case N-284, "Metal Containment Shell Buckling Design Methods, Section III, Class MC", Approved August 25, 1980. The theoretical elastic buckling stress is calculated by analyzing the three dimensional finite element model discussed above. Then the theoretical buckling stress is modified by capacity and plasticity reduction factors. The allowable compressive stress is obtained by dividing the calculated buckling stress by a factor of safety. In accordance with Code Case N-284 the licensee used a factor of safety of 2.0 for the refueling condition and 1.67 for the post-accident condition. The capacity reduction factors were also modified to take into account the effects of hoop stress. Originally the licensee based the hoop stress modification on data related to the axial compressive strength of cylinders (References 2 and 4). Later the licensee revised the approach based on a review of spherical shell buckling data and recalculated the drywell buckling capacities for both the "with sand" and "without sand" cases (Reference 8). For the "with sand" case, the licensee reports a margin above the allowable compressive stress of 47% for the refueling condition and 40% for the post-accident condition. For the "without sand" case, the licensee reports margins of 24.5% for the refueling condition and 14% for the post-accident condition.

## 3. Evaluation of Licensee's Approach

The analyses performed by the licensee as summarized in Section 2 and discussed more fully in References 1 through 4 have been reviewed and found to provide an acceptable approach for demonstrating the structural integrity of the corroded Oyster Creek drywell. The finite element analyses performed for both the stress and stability evaluations are consistent with industry practice. Except for the use of a limit of $1.1S_{mc}$ in evaluating the general membrane stress in areas of reduced drywell thickness, the loads, load combinations and acceptance criteria used by the licensee are consistent with the guidance given in Section 3.8.2 of the NRC Standard Review Plan, Rev. 1, July 1981. To further support their position, the licensee has provided two appendices to Reference 1.

Appendix A provides a detailed justification for the use of Section III, Subsection NE as guidance in evaluating the Oyster Creek drywell. Appendix E compares the load combinations given in the Final Design Safety Analysis Report (FDSAR) with the load combinations given in SRP 3.8.2 and demonstrates that the load combinations used in the analysis envelop those given in the SRP.

In the areas of the drywell where reduced thicknesses are specified, the licensee has used a limit of $1.1S_{mc}$ to evaluate the general membrane stresses. In support of this position the licensee has cited the provisions of NE-3213.1 of the ASME Code concerning local primary membrane stresses. In effect, the licensee's criteria would treat corroded or degraded areas as discontinuities. For such considerations the code places no limit on the extent of the region in which the membrane stress exceeds $1.0S_{mc}$ but is less than $1.1S_{mc}$. In support of this position the licensee has provided the opinion of Dr. W.E. Cooper, a well known expert on the development of the ASME Code. Dr. Cooper concluded that "given a design which satisfies the general Code intent, as the Oyster Creek drywell does as originally constructed, it is not a violation of Subsection NE requirements for the membrane stress to be between $1.0S_{mc}$ and $1.1S_{mc}$ over significant distances". The licensee has also cited the provisions of IWE-3519.3 which accepts up to a 10% reduction in the thickness of the original base metal.

The licensee's position has merit, but great caution must be exercised to assure that such a position is not applied indiscriminately. In the case of the Oyster Creek drywell the licensee has concluded that "there are very few locations where the calculated stress intensities for design basis conditions, would exceed $1.0S_{mc}$, and in these cases only slightly" (Reference 7). The licensee has provided additional information in Reference 9 to support this conclusion. Based on the information provided by the licensee which demonstrates that the use of the $1.1S_{mc}$ criteria is limited to localized areas, it is concluded that the Oyster Creek drywell meets the intent of the ASME Code.

As discussed in Section 2, the capacity reduction factors used in the buckling analysis are modified to take into account the beneficial effects of tensile hoop stress. As a result of a question raised during the review regarding this matter, the licensee submitted additional information in Reference 5 to support the approach. This information included a report prepared by C.D. Miller entitled "Effects of Internal Pressure on Axial Compression Strength of Cylinders" (CBI Technical Report No. 022891, February 1991). The report presented a design equation which was the lower bound of the test data included in the report. It also demonstrated that the equation used in References 2 and 4 was conservative relative to the proposed design equation. The report presented further arguments that the rules determined for axially compressed cylinders subjected to internal pressure can be applied to spheres. Subsequently the licensee has submitted Reference 8, which indicates that the original approach was not conservative with regard to its application to spherical shapes and recommends a new equation. However, the documentation supporting the use of this equation is not included in Reference 8, but apparently is contained in a referenced report prepared by C.D. Miller entitled "Evaluation of Stability Analysis Methods Used for the Oyster Creek Drywell" (CBI Technical Report Prepared for GPU Nuclear Corporation, September 1991). This report was subsequently submitted and reviewed by the NRC staff. As discussed in Section 2, the use of the revised equation still results in calculated capacities in compliance with the ASME Code provisions; however, the margins beyond those capacities are reduced from those reported by References 2 and 4.

It is noted that the licensee may have "double-counted" the effects of hoop tension, since the theoretical elastic instability stress was calculated from the finite element model using the ANSYS Code. The elastic instability stress calculated by the ANSYS Code may have already taken into account the effects of hoop tensile stress. However, by comparing the theoretical elastic instability stress and the corresponding circumferential stress predicted by the licensee for the refueling and post-accident cases, it appears that the effect of hoop tension in the ANSYS calculations is small and there is sufficient margin in the results to compensate for the potential "double-counting". Furthermore, it is judged that there is sufficient capacity in the drywell to preclude a significant buckling failure under the postulated loading conditions since the licensee's calculations: (a) incorporate factors of safety of 1.67 to 2.0, depending upon the load condition, and (b) utilize a conservative assumption by considering the shell wall thickness to be severely reduced for the full circumference of the drywell throughout the sandbed region.

During the course of the review of the licensee's submittals, a number of other issues were raised regarding the approach. These included: (a) the basis and method of calculating the projected drywell thicknesses, (b) the scaling of the calculated stresses for the nominal thickness case by the thickness ratio, (c) the effect of stress concentrations due to the change of thickness, (d) monitoring of the drywell temperature, (e) sensitivity of stresses due to variations in the sand spring stiffness, (f) sensitivity of the plasticity reduction factor in the buckling analysis, (g) use of the 2 psi design basis external pressure in the buckling analysis, (h) effect of the large displacement method, (i) the treatment of the large concentrated loads considered in the analysis, and (j) the method of applying the seismic loads to the pie slice model. These issues were adequately addressed by the additional information provided by the licensee in References 5 and 6.

## 4. Conclusions

The licensee has demonstrated that the calculated stresses in the Oyster Creek drywell (both with and without the sandbed), as a result of the postulated loading conditions, meet the intent of the ASME Code for projected corroded conditions that may exist at the start of the fourteenth refueling outage. However, if the actual thickness in the sandbed region at 14R is close to the projected thickness of 0.736", there may not be adequate margin left for further corrosion through continued operation unless it is demonstrated that removal of sand will completely stop further thickness reductions. The licensee has also demonstrated that there is sufficient margin in the drywell design (both with and without the sandbed) to preclude a buckling failure under the postulated loading conditions.

It should be recognized that the conclusions reached by the licensee have been accepted for this particular application with due regard to all the assumptions made in the analysis and the available margins. The use of the $1.1S_{mc}$ criteria for evaluating general membrane stress in corroded or degraded areas should be investigated further by the NRC staff and the ASME Code Committee and appropriate bounds established before it is accepted for general use. The licensee's buckling criteria regarding the modification of capacity reduction factors for tensile hoop stress and the determination of plasticity reduction factors should also be investigated in a similar manner.

## 5. References


1. GE Report Index No. 9-1, "An ASME Section VIII Evaluation of the Oyster Creek Drywell - Part 1 - Stress Analysis", November 1990.

2. GE Report Index No. 9-2, "An ASME Section VIII Evaluation of the Oyster Creek Drywell - Part 2 - Stability Analysis," November 1990.

3. GE Report Index No. 9-3, "An ASME Section VIII Evaluation of the Oyster Creek Drywell for Without Sand Case - Part 1 - Stress Analysis," February 1991.

4. GE Report Index No. 9-4, "An ASME Section VIII Evaluation of the Oyster Creek Drywell for Without Sand Case - Part 2 - Stability Analysis," February 1991.

5. GPU Nuclear letter dated March 20, 1991, "Oyster Creek Drywell Containment."

6. GPU Nuclear letter dated June 20, 1991, "Oyster Creek Drywell Containment".

7. GPU Nuclear letter dated October 9, 1991, "Oyster Creek Drywell Containment"

8. GPU Nuclear letter dated January 16, 1992, "Oyster Creek Drywell Containment".

9. GPU Nuclear letter dated January 17, 1992, "Oyster Creek Drywell Containment".

# EXHIBIT 3

Exelon Nuclear



**ATTACHMENT 1**
**Design Analysis Cover Sheet**
**Page 1 of 117**

| | | | |
|---|---|---|---|
| **Design Analysis (Major Revision)** | | **Last Page No.** [5] 117 | |
| **Analysis No.:** [1] C-1302-187-5320-024 | | **Revision:** [2] 1 | |
| **Title:** [3] OC Drywell Ext. UT Evaluation in Sandbed | | | |
| **EC/ECR No.:** [4] 06-00634 | | **Revision:** [6] 0 | |
| **Station(s):** [7] | Oyster Creek | **Component(s):** [14] | |
| **Unit No.:** [8] | 1 | 187 | |
| **Discipline:** [9] | Mechanical/Structural Eng. | | |
| **Descrip. Code/Keyword:** [10] | UT Data Assessments | | |
| **Safety/QA Class:** [11] | Q | | |
| **System Code:** [12] | 187 | | |
| **Structure:** [13] | Drywell Vessel | | |

**CONTROLLED DOCUMENT REFERENCES** [15]

| Document No.: | From/To | Document No.: | From/To |
|---|---|---|---|
| GE # Index 9-4 | From | | |
| GE # Index 9-3 | From | | |
| GE Letter Report: "Sandbed Local Thinning and Raising the Fixity Height Analysis" | From | | |
| | | | |

**Is this Design Analysis Safeguards Information?** [16] Yes ☐ No ☒ If yes, see SY-AA-101-106

**Does this Design Analysis contain Unverified Assumptions?** [17] Yes ☐ No ☒ If yes, ATI/AR#:

**This Design Analysis SUPERCEDES:** [18] N/A **in its entirety.**

**Description of Revision** (list affected pages for partials): [19] Revised Calculation to clarify methods used to evaluate UT Measurements of the external Drywell Shell. Also, reformatted portions of the calculation to bring it inline with the existing calculation procedure at Oyster Creek Generating Station. ~~Revised or added the following pages: 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 23, 25, 27, 30, 32, 33, 34, 35, 36, 37, 39, 40, 42, 43, and 45.~~ Also added Appendix D, NDE Inspection Sheets — ALL PAGES CHANGED. [initials]

**Preparer:** [20] Jeffrey H. Horton (Enercon) (Print Name) — [signature] (Sign Name) — 07/24/06 (Date)

**Method of Review:** [21] Detailed Review ☒ Alternate Calculations (attached) ☐ Testing ☐

**Reviewer:** [22] Omesh Abhat (Enercon) (Print Name) — [signature] (Sign Name) — 07/24/06 (Date)

**Review Notes:** [23] Independent review ☒ Peer review ☐

Review of the revised part of the calculation has been performed and is acceptable. The review (Rev. 1) addresses clarification of the original calculation only as described above under Description of Revision. Analytical buckling inputs are taken from References 3.3 (Table 4.1) and 3.5. They are assumed acceptable inputs for this calculation as provided by the client.

(For External Analyses Only)
**External Approver:** [24] Don Shivas (Enercon) (Print Name) — [signature] (Sign Name) — 07/21/06 (Date)

**Exelon Reviewer:** [25] PT 8/3/06 P. Tamburro (Print Name) — Peter Tamburro (Sign Name) — 8/3/06 9/21/06 (Date)

**Is a Supplemental Review Required?** [26] Yes ☐ No ☒ If yes, complete Attachment 3

**Exelon Approver:** [27] T. NICKERSON * (Print Name) — [signature] (Sign Name) — 9/21/06 (Date)

* ACTING MANAGER FOR F.H. RAY (WITH HIS CONCURRENCE).

**ATTACHMENT 2**
**Owners Acceptance Review Checklist for External Design Analysis**
**Page 1 of 1**

PAGE 1A of 117

**DESIGN ANALYSIS NO.** C-1302-187-5320-024 **REV:** 001

| | | Yes | No | N/A |
|---|---|---|---|---|
| 1. | Do assumptions have sufficient rationale? | ☒ | ☐ | ☐ |
| 2. | Are assumptions compatible with the way the plant is operated and with the licensing basis? | ☒ | ☐ | ☐ |
| 3. | Do the design inputs have sufficient rationale? | ☒ | ☐ | ☐ |
| 4. | Are design inputs correct and reasonable? | ☒ | ☐ | ☐ |
| 5. | Are design inputs compatible with the way the plant is operated and with the licensing basis? | ☒ | ☐ | ☐ |
| 6. | Are Engineering Judgments clearly documented and justified? | ☒ | ☐ | ☐ |
| 7. | Are Engineering Judgments compatible with the way the plant is operated and with the licensing basis? | ☒ | ☐ | ☐ |
| 8. | Do the results and conclusions satisfy the purpose and objective of the Design Analysis? | ☒ | ☐ | ☐ |
| 9. | Are the results and conclusions compatible with the way the plant is operated and with the licensing basis? | ☒ | ☐ | ☐ |
| 10. | Does the Design Analysis include the applicable design basis documentation? | ☒ | ☐ | ☐ |
| 11. | Have any limitations on the use of the results been identified and transmitted to the appropriate organizations? | ☒ | ☐ | ☐ |
| 12. | Are there any unverified assumptions? | ☐ | ☒ | ☐ |
| 13. | Do all unverified assumptions have a tracking and closure mechanism in place? | ☐ | ☐ | ☒ |
| 14. | Have all affected design analyses been documented on the Affected Documents List (ADL) for the associated Configuration Change? | ☒ | ☐ | ☐ |
| 15. | Do the sources of inputs and analysis methodology used meet current technical requirements and regulatory commitments? (If the input sources or analysis methodology are based on an out-of-date methodology or code, additional reconciliation may be required if the site has since committed to a more recent code) | ☒ | ☐ | ☐ |
| 16. | Have vendor supporting technical documents and references (including GE DRFs) been reviewed when necessary? | ☒ | ☐ | ☐ |

**EXELON REVIEWER:** Peter Tamburro / [signature] **DATE:** 8/2/06
Print / Sign

| **AmerGen** | | | **DOCUMENT NO.** C-1302-187-5320-024 |
|---|---|---|---|
| **TITLE:** OC Drywell Ext. UT Evaluation in Sandbed | | | |
| **REV** | **SUMMARY OF CHANGE** | **APPROVAL** | **DATE** |
| 0 | Initial Issue | GPU Nuclear Signatures on File | 04/16/93 |
| 1 | Revised Calculation to clarify methods used to evaluate UT Measurements of the external Drywell Shell. Also, reformatted portions of the calculation to bring it inline with the existing calculation procedure at Oyster Creek Generating Station. ~~Revised or added the following pages: 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 23, 25, 27, 30, 32, 33, 34, 35, 36, 37, 39, 40, 42, 43, and 45.~~ Also added Appendix D, NDE Inspection Sheets<br>A complete Revision PT 9/21/06<br>Revision performed under ECR# 06-00634.<br>(margin: ALL PGS CHANGED) | Jeffrey H. Horton<br>Enercon Services<br>Omesh Abhat<br>Enercon Services<br>Don Shivas<br>Enercon Services | 07/24/06<br>07/24/06<br>07/24/06 |
| | Please Note Originator and Reviewer at the Top of Pages 3 through 117 are associated with Revision 0. Revision 1 originator and Reviewer are documented on page 1 & above. [signature] 9/21/06 | [signature] Peter Tamburro<br>[signature] T. Nickerson (Acting Mgr. for F.H. Ray) | 9/21/06<br>9/21/06 |

## Table of Contents

**Section** **Page**



PT 9/21/06

## 1.0 PROBLEM STATEMENT:

The purpose of this calculation is to evaluate the Ultrasonic Test (UT) thickness measurements taken in the sandbed region during the 14R outage in support of the O.C. drywell corrosion mitigation project. These measurements were taken from the outside of the shell. Access to the sandbed region was achieved by cutting ten holes completely through the shield wall from the torus room.

## 2.0 SUMMARY OF RESULTS:

This calculation demonstrates that the UT thickness measurements for all bays meet the minimum uniform and local required thicknesses.

The evaluation was performed by evaluating the UT measurements for each bay and dispositioning them relative to the uniform thickness of 0.736 inch used in the GE structural analysis reports References 3.2, 3.3 and 3.5. Additional acceptance criteria was developed to address measurements below 0.736 inch. The results are summarized in Table 2-1.

UT measurements for bays 3, 5, 7, 9, and 19 were all above the 0.736 inches and therefore acceptable.

UT measurements for bays 11, 15, and 17 were all above 0.736 inches except for one measurement for each bay. After further evaluation of these three measurements including an examination of adjacent areas, it was determined that they were acceptable as shown on Table 2-1.

UT measurements for bays 1 and 13 were evaluated using detailed criteria described in this calculation and the results are summarized in Table 2-1 below:

# GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 5 of 117 |
| **Originator** Mark Yekta | **Date** 01/12/93 | **Reviewed by** S. C. Tumminelli | | **Date** |

## SUMMARY OF UT EVALUATIONS
## TABLE (2-1)

| Drywell Bay | General Sandbed Shell Thickness[1] | | | Local Sandbed Thickness[2] | | | Comments |
|---|---|---|---|---|---|---|---|
| | Thickness Criteria Inches | Actual Thickness inches | Acceptable Yes/No | Thickness Criteria Inches | Actual Thickness | Acceptable Yes/No | |
| 1 | 0.736" whole Bay | $UT_{Avg}$=0.822<br>$T_{Eval}$=0.766 | Yes<br>Yes | 0.636" over a 12"x12" area | $T_{Eval}$ = 0.692" Over a 4"x4" area | Yes | See Pages 14 through 21 for details of evaluation |
| 3 | 0.736" whole Bay | $UT_{Avg}$=0.868 | Yes | 0.636" over a 12"x12" area | N/A | N/A | No locations in bay are below 0.736". See Pages 22 & 23 |
| 5 | 0.736" whole Bay | $UT_{Avg}$=0.986 | Yes | 0.636" over a 12"x12" area | N/A | N/A | No locations in bay are below 0.736". See Pages 24 & 25 |
| 7 | 0.736" whole Bay | $UT_{Avg}$=1.001 | Yes | 0.636" over a 12"x12" area | N/A | N/A | No Locations in bay are below 0.736" see Pages 26 & 27 |
| 9 | 0.736" whole bay | $UT_{Avg}$=0.915 | Yes | 0.636" over a 12"x12" area | N/A | N/A | No Locations in bay are below 0.736" see Pages 28 and 29 |
| 11 | 0.736" whole bay | $UT_{Avg}$=0.792<br>$T_{Eval}$=0.751 | Yes | 0.636" over a 12"x12" area | N/A | N/A | One location with a thickness less than 0.736" but not greater than 2" in Dia. See Pages 30 to 32 |
| 13 | 0.736" whole bay | $UT_{Avg}$=0.810<br>$T_{Eval}$=0.767 | Yes | 0.636" over a 12"x12" area | $T_{Eval}$=0.693"over a 6"x6" area | yes | See pages 33 through 40 for details of evaluation |
| 15 | 0.736" Whole Bay | $UT_{Avg}$=0.816<br>$T_{Eval}$=0.859 | Yes | 0.636" over a 12"x12" area | N/A | N/A | One location with a thickness less than 0.736" but not greater than 2" in Dia. See Pages 41 to 43 |
| 17 | 0.736" Whole Bay | $UT_{Avg}$=0.918<br>$T_{Eval}$=0.871 | Yes | 0.636" over a 12"x12" area | N/A | N/A | One location with a thickness less than 0.736" but not greater than 2" in Dia. See Pages 44 to 46 |
| 19 | 0.736" Whole Bay | $UT_{Avg}$=0.885 | Yes | 0.636" over a 12"x12" area | N/A | N/A | No Locations in bay are below 0.736" see Pages 47 and 48 |

Notes: 1. $UT_{Avg}$ are the average shell thickness readings using a D-Meter in local areas not less than the buckling design thickness of 0.736" these areas do not exceed 2" in diameter. $T_{Eval}$ is the average calculated Thickness of the shell surrounding areas not exceeding 2" in diameter that have UT D-Meter shell thickness readings less than 0.736". See Section 6, Methods of Analysis, Acceptance Criteria – General Wall (Sandbed Region) for details.

2. Small Areas of reduced thickness 2&½" or less in diameter have a negligible effect on shell buckling. See Section 6 Methods of Analysis, Acceptance Criteria –Very Local Wall (2½ Inches in Diameter) for details.

OCLR00014542

## 3.0 REFERENCE:

3.1 Drywell sandbed region pictures (Appendix C).

3.2 An ASME Section VIII Evaluation of the Oyster Creek Drywell for Without Sand Case Performed by GE – Part 1 Stress Analysis, Revision 0 dated February, 1991 Report 9-3.

3.3 An ASME Section VIII Evaluation of the Oyster Creek Drywell for Without Sand Case Performed by GE – Part 2 Stability Analysis, Revision 2 dated November, 1992 Report 9-4.

3.4 ASME Section III Subsection NE Class MC Components 1989.

3.5 GE letter report "Sandbed Local Thinning and Raising the Fixity Height Analysis (Line Items 1 and 2 In Contract PC-0391407)" dated December 11, 1992.

3.6 GPUN Memo 5320-93-020 From K. Whitmore to J. C. Flynn "Inspection of Drywell Sand Bed Region and Access Hole", Dated January 28, 1993.

3.7 Theory of Elastic Stability, by Stephen P. Timoshenko and James M. Gere, Second Edition, Engineering Societies Monographs, McGraw Hill Book Company, New York, 1961

## 4.0 ASSUMPTIONS AND BASIC DATA:

4.1 Raw UT measurements for each bay are presented in Appendix D and summarized in the body of calculation.

4.2 References 3.2, 3.3 and 3.5 have been design verified and are assumed correct.

## 5.0 DESIGN INPUTS:

5.1 Observations of the outside surface of the drywell shell indicate a rough surface with varying peaks and valleys. In order to characterize an average roughness representing the depth difference of peaks and valleys, two impressions were made at the two lowest UT measurements for bay 13 using Epoxy putty.

Appendix A presents the calculation of the depth of surface roughness using the drywell shell impressions taken in the roughest bay. Two locations in bay 13 were selected since it is the roughest bay. Approximately 40 locations within the two impressions were measured for depth and the average plus one standard deviation was calculated. A value of 0.200 inch was used in this calculation as a conservative depth of uniform roughness for the entire outside surface of the drywell in the sandbed region. This is defined as $T_{rough}$.

5.2 Drywell Design Pressure = 44.0 psig, Oyster Creek, UFSAR Revision 13, Section 3.8.2.8, Page 3.8-61

Drywell Design Temperature = 292°F, Oyster Creek, UFSAR Revision 13, Table 3.11-1

5.3 The required sandbed shell thickness for the Design Pressure and Temperature is defined in paragraph ASME B&PV Code, Subsection NE, paragraph NE-3324.4, Spherical Shells, as:

$$t = \frac{PR}{2S - 0.2P}$$ Where: P = Design Pressure

R = Inside Radius of the Shell = 420 inches

S = Maximum Allowable Stress, SA 212 Grade B
= 19,300 psi (From ASME B&PV Code Section VIII 1962 Edition and Reference 3.2, Section 2.2)

Substituting values in the equation we have:

$$t = \frac{(44.0\text{psig})(420.0")}{2(19{,}300\text{psi}) - 0.2(44.0\text{psig})} = 0.4789 \text{ inches}$$

5.3 Drywell Sandbed buckling design thickness is 0.736 inches. Taken from References 3.3, and 3.5

5.4 Analytical design inputs are taken from References 3.3, 3.4 and 3.5

## 6.0 METHODS OF ANALYSIS:

**Development of "Evaluation Thickness"**

This detailed evaluation is based, in part, on visual observations of the shell surface plus a knowledge of the inspection process. The first part of this evaluation is to arrive at a meaningful value for the general sandbed shell thickness for use in the structural assessment. This meaningful value is referred to as the thickness for evaluation. It is computed by accounting for the depth of the spot where the thickness measurement is taken considering the roughness of the shell surface. The surface of the shell has been characterized as being "dimpled" as in the surface of a golf ball where the dimples are about one half inch in diameter (Appendix C). Also, the surface contains some depressions 12 to 18 inches in diameter not closer than 12 inches apart, edge to edge (Ref. 3.6). Appendix A presents the calculation of the depth of surface roughness using the drywell shell impressions taken in the roughest bay. Two locations in bay 13 were selected since it is the roughest bay. Approximately 40 locations within the two impressions were measured for depth and the average plus one standard deviation was calculated to be at 0.186 inches. A value of 0.200 inch was used in this calculation as a conservative depth of uniform dimples for the entire outside surface of the drywell in the sandbed region.

The inspection focused on the thinnest portion of the drywell, even if it was very local, i.e., the inspection did not attempt to define a shell thickness suitable for structural evaluation. Observations indicate that some inspected spots are very deep. They are much deeper than the normal dimples found, and very local, not more than 1 to 2 inches in diameter. (Typically these observations were made after the spot was surface prepped for UT measurement. This results in a wide dimple to accommodate the meter and slightly deeper than originally found by 0.030 to 0.100 inches). The depth of these areas was measured with a depth gauge and straight edge at 0°, 45°, 90° and 135° around these inspected dimples. The depths obtained were averaged with respect to the tops of the locally rough areas. These depths are referred to herein as the AVG micrometer measurements. As these AVG micrometer measurements are very local in nature their effect on the structural response of the drywell to applied loads is very limited. A more meaningful shell thickness for the drywell structural response to applied loads is the general shell thickness near the UT measured indications. This can be obtained on a smooth shell exterior surface by adding the UT measured thickness at the bottom of the indication and the AVG micrometer measurements of the indication depth. But because the exterior of the drywell shell in the sandbed region is very rough and dimpled the measurement described above would give optimistic general shell thicknesses near the indications (See Figure 6.1). To determine a conservative general shell thickness at the locations of interest Design Input 5.1 of this calculation is subtracted from the combination of the UT measurement and the depth micrometer readings. This thickness is then used to determine the drywell shell susceptibility to buckling by comparing this thickness to the buckling design thickness of 0.736 inches. This thickness is referred to as the evaluation thickness which as described above is computed as:

T (evaluation) = UT (measurement) + AVG (micrometer) - $T_{rough}$
where:
T (evaluation) = General shell thickness used for the evaluation
UT (measurement) = thickness measurement at the area (location)
AVG (micrometer) = average depth of the area relative to its immediate surroundings
$T_{rough}$ = 0.200 inches = a conservative value of depth of typical dimple on the shell surface. See Design Input 5.1.

After this calculation, if the thickness for analysis is greater than 0.736 inches; the area is evaluated as acceptable.

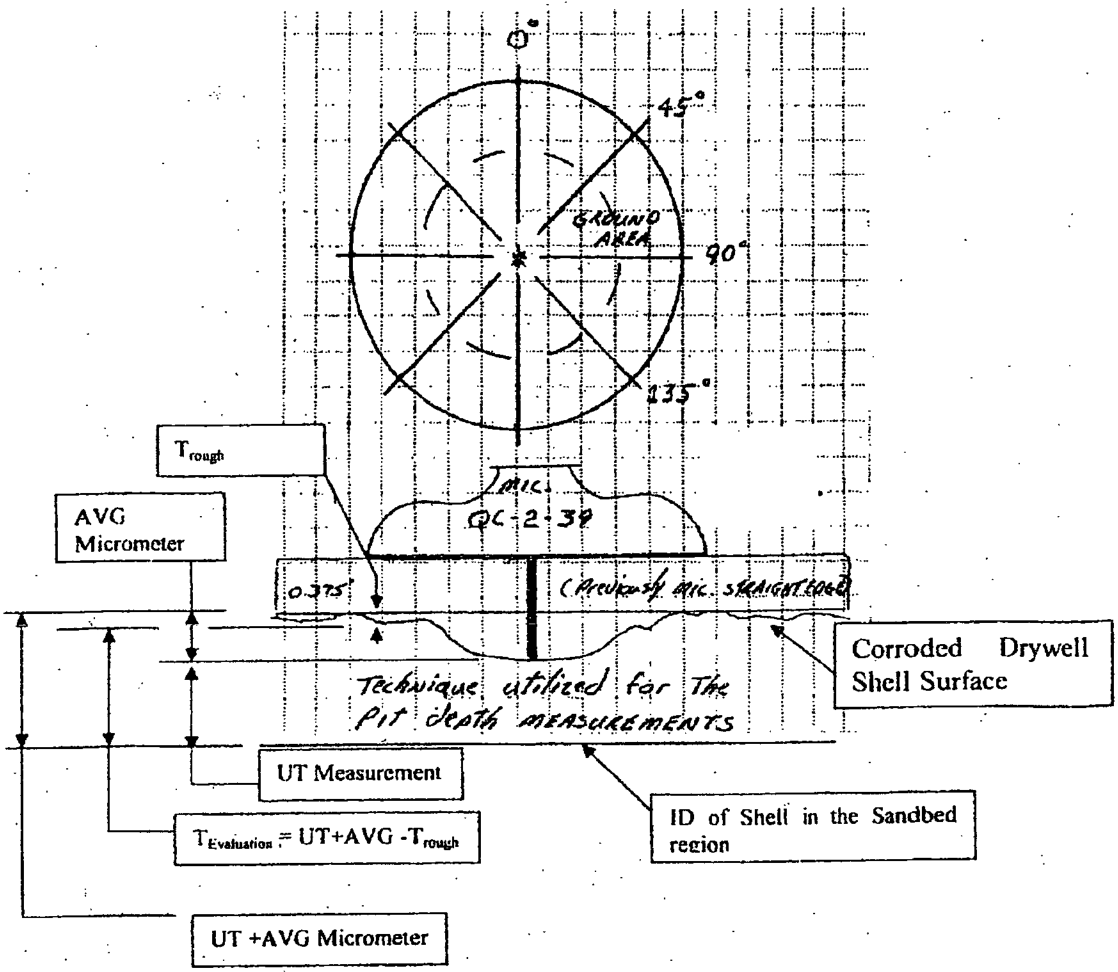

0°
45°
90°
135°
GROUND AREA
T rough
AVG Micrometer
0.375"
Corroded Drywell Shell Surface
Technique utilized for The pit depth measurements
UT Measurement
T Evaluation = UT+AVG -T rough
ID of Shell in the Sandbed region
UT +AVG Micrometer

FIGURE 6.1

**Sandbed General Wall Criteria:**

The acceptance criteria used to evaluate the measured drywell thickness is based upon GE reports 9-3 and 9-4 (Ref. 3.2 & 3.3) as well as other GE studies (Ref.3.5) plus visual observations of the drywell surface (Ref.3.6 and Appendix C). The GE reports used a projected uniform thickness of 0.736 inches in the sandbed area taken from References 3.3, and 3.5. This area is defined to be from the bottom to top of the sandbed, i.e., El. 8'-11½" to El. 12'-3" and extending circumferentially one full bay. Therefore, if all the UT measurements for thickness in one bay are greater than 0.736 inches the bay is evaluated to be acceptable. In bays where measurements are below 0.736 inches, more detailed evaluation is performed.

**Local Wall Criteria:**

If the thickness for evaluation is less than 0.736 inches, then the use of specific GE studies is employed (Ref. 3.5). The studies in Reference 3.5 do not reflect actual drywell shell conditions but are used as assessment tools for areas of the sandbed region that have reduced thicknesses. The methodology used in these studies is provided in reference 3.3 with a excerpt provided here. The studies contain a two step eigenvalue formulation procedure to perform linear elastic buckling analysis of the drywell shell with local areas of reduced thickness. The first step is a static analysis of the structure with all the anticipated loads applied. The structural stiffness matrix, [K], the stress stiffness matrix, [S], and the applied stresses, $\lfloor \sigma_{ap} \rfloor$, are developed and saved from this static analysis. A buckling pass is then run to solve for the lowest eigenvalue or load factor, $\lambda$, for the whole structure at which elastic buckling can occur. This load factor, or eigenvalue is a multiplier for the applied stress state or applied load at which the onset of elastic buckling will theoretically occur. All the applied stresses in the structure are scaled equally by the load factor.

This analysis technique is applied to the drywell pie slice finite element model, with a reduction in thickness of 0.200 inches (below the design buckling thickness of 0.736") in a local area of 12 x 12 inches in the sandbed region, tapering to the original thickness over an additional 12 inches, located to result in the largest reduction in load factor possible. This location is selected at the point of maximum deflection of the eigenvector shape associated with the lowest buckling load. The theoretical load factor / eigenvalue for this case was reduced by 9.5% from 6.14 to 5.56.

It should be noted that this reduction of 0.200 inches is over a 144 square inch area of the shell while the actual surface area including the tapering of the thickness is 36 by 36 inches or 1,296 square inch area with thicknesses that are below the 0.736 inch buckling design thickness. This additional tapered area and its reduced thicknesses also contributed to the 9.5% reduction in load factor.

In addition, to the reported result for the 0.536" or a 27% reduction in thickness buckling analysis, a second buckling analysis was performed for a wall thickness reduction of 13.5% or a thickness 0.636 inches over a one square foot area. The results of this case reduced the load factor and theoretical buckling stress by 3.9% in Reference 3.5. The center of the thinned area was located close to the maximum displacement point in the buckling analysis with uniform thickness 0.736" as per Reference 3.5. Again, although this reduction of 13.5% or 0.636 inches is over a 144 square inch area of the shell, the actual surface area including the tapering of the thickness is a 36 by 36 inch or 1,296 square inch area with thicknesses that are below the buckling design thickness. This additional tapered area and its reduced thicknesses also contribute to the 3.9% reduction in load factor stated previously.

**Very Local Wall Criteria (2½ Inches In Diameter or Less):**

All inspected locations with UT measurements below 0.736 inches have been determined to be in isolated locations less than 2½ inches in diameter.

**Primary Membrane Plus Bending**

The acceptance criteria for these measurements confined to an area less than 2 ½ inches in diameter experiencing primary membrane plus bending stresses is based on ASME B&PV Code, Section III, Subsection NE, Class MC Components, Paragraphs NE-3213.2 Gross Structural Discontinuity, NE-3213.10 Local Primary Membrane Stress, NE-3332.1 Openings not Requiring Reinforcement, NE-3332.2 Required Area of Reinforcement and NE-3335.1 Reinforcement of Multiple Openings. The use of Paragraph NE-3332.1 is limited by the requirements of Paragraphs NE-3213.2 and NE-3213.10. In particular NE-3213.10 limits the meridional distance between openings without reinforcement to $2.5\sqrt{Rt}$. Also Paragraph NE-3335.1 only applies to openings in shells that are closer than 2 times their average diameter.

The implication of these paragraphs are that shell failures at these locations from primary stresses produced by design pressure cannot occur provided openings in shells have sufficient reinforcement. The current design pressure of 44 psig for the drywell requires a thickness of 0.479 inches in the sandbed region of the drywell. A review of all the UT data presented in Appendix D of the calculation indicates that all thicknesses in the drywell sandbed region exceed the required pressure thickness by a substantial margin and there are no openings in the sandbed region of the drywell shell that do not contain the required design pressure reinforcement for the design code of record. Therefore, the requirements specified by the referenced code sections in the previous paragraph are not required for the very local wall thickness evaluation presented in the calculation.

**Buckling**

The effect of these very local wall thickness areas on the buckling of the shell requires some discussion of the buckling mechanism in a shell of revolution under an applied axial and lateral pressure load.

To begin the discussion we will describe the buckling of a simply supported cylindrical shell under the influence of lateral external pressure and axial load. As described in Chapter 11 of Reference 3.7, thin cylindrical shells buckle in lobes in both the axial and circumferential directions. These lobes are defined as half wave lengths of Sinusoidal functions. The functions are governed by the radius, thickness and length of the cylinder. If we look at a specific thin walled cylindrical shell both the length and radius would be essentially constants and if the thickness was reduced locally then this reduction would have to be significant and over a majority of the lobe so that the compressive stress in the lobe would exceed the critical buckling stress under the applied loads, thereby causing the shell to buckle locally. This is demonstrated in Reference 3.5 where a 12 x 12 square inch section of the drywell sandbed region is reduced by 200 mils and a local buckle occurred in the finite element eigenvalue extraction analysis of the drywell.

Now reviewing the stability analyses provided in both References 3.3 and 3.5 and recognizing that the finite elements in the sandbed region of the model are 3" x 3", it is clear that the circumferential buckling lobes for the drywell are substantially larger than the 2 ½ inch diameter very local wall areas. This combined with the local reinforcement surrounding these local areas and the spherical shell being close to the constraint provided by the concrete supporting structure indicates that these areas will have no impact on the buckling margins in the shell.

It is also clear from Reference 3.5 that a uniform reduction in thickness of 27% over a one square foot area followed by a transition zone would only create a 9.5% reduction in the load factor and theoretical buckling load of the drywell. Although this reduction of 27% is only over a 144 square inch area of the shell, the actual surface area including the transition zone to the 0.736 inch buckling design thickness is a 36 inch by 36 inch or 1,296 square inch area. This area of reduced thickness was located in the portion of the sandbed considered most susceptible to buckling, the midpoint of a bay between two vents.

In addition, a second buckling analysis was performed (Reference 3.5) for a wall thickness reduction of 13.5% or a thickness of 0.636 inches over a one square foot area followed by a transition zone from 0.636 inches to 0.736 inches. Again, although this reduction from 0.736 inches to 0.636 inches is over a 144 square inch area of the shell, while the actual surface area including the transition zone to the buckling design thickness is a 36 inch by 36 inch or a 1,296 square inch area. This second buckling analysis resulted in a 3.9% reduction in the load factor.

To bring these analyses results into perspective with the inspected very local areas, a review of the NDE Reports (Appendix D) indicates there are twenty UT measured areas all less than 2½" in diameter or less than 4.9 square inches each in area isolated throughout the entire sandbed region that have thicknesses less than 0.736". Compared to the analyses presented in Reference 3.5 the twenty areas would have to have a minimum area of reduced thickness of 144 square inches with a thickness of 0.636 which represents a 13.5% reduction in wall thickness that equates to a 72.0 cubic inch loss of material located in the portion of the drywell sandbed region most susceptible to buckling to produce a 3.9% reduction in the theoretical buckling load and load factor for the drywell. The review of the NDE Reports also indicated that the average wall thickness of the twenty areas is 0.703 inches which represents a 4.5% reduction in wall thickness that equates to a 3.2 cubic inch loss of material and a total maximum area of 98 square inches if the twenty measured areas where contiguous with each other. This indicates that the twenty isolated areas with thicknesses less than the buckling design thickness would not have a significant effect on the buckling of the OC Drywell Shell.

## 7.0 CALCULATIONS:

### UT EVALUATION BAY #1:

The outside surface of this bay is rough and full of dimples similar to the outside surface of a golf ball. This observation is made by the inspector who located the thinnest areas for the UT examination. This inspection focused on the thinnest areas of the drywell, even if it was very local, i.e., the inspection did not attempt to define a shell thickness suitable for structural evaluation. The shell appears to be relatively uniform in thickness except for a band of corrosion which looks like a "bathtub" ring, located 15 to 20 inches below the vent pipe reinforcement plate, i.e., weld line as shown in Figure 1. (Figure 1 and other like figures presented in this calculation are NOT TO SCALE). The graphical presentation in Figure 1 of measured indications is extracted from Appendix D, Calculation Pages 71 to 76. Based on the inspectors observations the bathtub ring is 12 to 18 inches wide and about 75 inches long located in the center of the bay. Beyond the bathtub ring on both sides, the shell appears to be uniform in thickness at a conservative value of 0.800 inches. Above the bathtub ring the shell exhibits no corrosion since the original lead primer on the vent pipe/reinforcement plate is intact. Measurements 14 and 15 confirm that the thickness above the bathtub ring is at 1.154 inches starting at elevation 11'-00". Below the bathtub ring the shell is uniform in thickness where no abrupt changes in thicknesses are present. Thickness measurements below the bathtub ring (Locations 6, 7, 8, 9, 16, 17, 18, 19, 22 and 23) are all above 0.750 inches (See Table 1-b) except location 7 which is very local area.

**Bay #1 General Wall (Sandbed Region) Thickness Evaluation**

Therefore, taking the average of the UT measured thicknesses of locations 6, 7, 8, 9, 16, 18, 19 and 22 gives a average thickness of 0.816 inches for the shell below the bathtub ring. Based on this a conservative mean thickness of 0.800 inches, is estimated to represent the evaluation thickness for this bay outside the bounds of the bathtub ring. Given a uniform thickness of 0.800 inches for these areas of the bay, it is concluded that these areas are acceptable based on the thickness exceeding the buckling design thickness for the sandbed region of 0.736 inches using the results of Reference 3.3.

Locations 1, 2, 3, 4, 5, 10, 11, 12, 13, 20, and 21 are confined to the bathtub ring as shown in Figure 1. To determine the general shell thickness in the bathtub ring area of this bay the evaluation thicknesses for each of the locations defined above are averaged together. An example of a typical calculation of the general wall thickness defined as the evaluation thickness is presented below for clarity:

$$(\text{AVG Micrometer})_1 = \frac{D_{1-0^0} + D_{1-45^0} + D_{1-90^0} + D_{1-135^0}}{4}$$

Where: $D_{1\text{-}0}{}^{0}$ = Micrometer Depth Reading for location 1 at 0 degrees taken from Appendix D, Calculation Page 74, etc.

$$(\text{AVG Micrometer})_1 = \frac{0.272"+0.204"+0.206"+0.185"}{4} = 0.217"$$

$$T_{(\text{Evaluation})1} = UT_{(\text{Measurement})1} + (\text{AVG Micrometer})_1 - T_{\text{rough}}$$

Where: $UT_{(\text{Measurement})1}$ = 0.720" Taken from Appendix D, Calculation Page 71, Location 1

$T_{\text{rough}}$ = 0.200" See Design Input 5.1 and Section 6, Acceptance Criteria, General Wall.

$$T_{(\text{Evaluation})1} = 0.720"+0.217"-0.200" = 0.737"$$

**Bay 1 AVG Micrometer Calculations**
**Table 1-a**

| Location | Azimuth(1) | | | | AVG |
|---|---|---|---|---|---|
| | $0^0$ | $45^0$ | $90^0$ | $135^0$ | |
| 1 | 0.272" | 0.204" | 0.206" | 0.185" | 0.217" |
| 2 | 0.143" | 0.133" | 0.143" | 0.154" | 0.143" |
| 3 | 0.397" | 0.316" | ------- | 0.329" | 0.347" |
| 5 | 0.330" | 0.290" | 0.304" | 0.330" | 0.313" |
| 7 | 0.208 | 0.281" | 0.246" | 0.330" | 0.266" |
| 11 | 0.200" | 0.211" | 0.225" | 0.211" | 0.212" |
| 12 | 0.299" | 0.316" | 0.261" | 0.328" | 0.301" |
| 21 | 0.222" | 0.202" | 0.238" | 0.183" | 0.211" |

**NOTES: 1. AZIMUTH DATA TAKEN FROM APPENDIX D, CALCULATION PAGE 74.**

An average value of the evaluation thicknesses presented in Table 1-c for this band is as follows;

| Location | Evaluation Thickness |
|---|---|
| 1 | 0.737" |
| 2 | 0.659" |
| 3 | 0.852" |
| 4 | 0.760" |
| 5 | 0.823" |
| 10 | 0.839" |
| 11 | 0.726" |
| 12 | 0.825" |
| 13 | 0.792" |
| 20 | 0.965" |
| 21 | 0.737" |

Average = 0.792"

An average evaluation thickness of 0.792 inches for the bathtub ring may raise concern given that the bathtub ring is noticeable and that the difference between its average evaluation thickness (0.792 inches) and the average thickness taken for the entire region (0.800 inches) is only 0.008 inches. This results from the fact that average micrometer readings were generally not taken for the remainder of the shell since each reading was greater than 0.736 inches. In reality, the remainder of the shell is much thicker than 0.800 inches. The appropriate evaluation thickness cannot be quantified since no micrometer readings were taken.

Again given that the average evaluation thickness of the shell in the bathtub ring area exceeds the buckling design thickness of 0.736 inches the shell area within the bathtub ring is also acceptable using the results of Reference 3.3.

**Bay #1 Local Wall and Very Local Wall Thickness Evaluation**

The individual measured thicknesses must also be evaluated for compliance with the local wall thickness criteria. Table 1-b identifies 23 locations of UT measurements that were selected to represent the thinnest areas, except locations 14 and 15, based on visual examination. These locations are a deliberate attempt to produce a minimum measurement. Locations 14 and 15 were selected to confirm that no corrosion had taken place in the area above the bathtub ring.

Eight locations shown in Table 1-b (1, 2, 3, 5, 7, 11, 12, and 21) have measurements below 0.736 inches. Inspectors observations indicate that these locations were very deep and not more than 1 to 2 inches in diameter. The depth of each of these areas relative to its immediate surroundings was measured at 4 locations around the spot and the average is shown in Table 1-a. Using the general wall thickness acceptance criteria described earlier, the evaluation thickness for all measurements of very local areas below 0.736 inches were found to be above 0.736 inches except for two locations, 2 and 11, as shown in Table 1-c.

Locations 2 and 11 are in the bathtub ring and are about 4 inches apart. This area is characterized as a local area 4 x 4 inches located at about 15 to 20 inches below the vent pipe reinforcement plate with an average thickness of 0.692 inches.

In order to quantify the effect of this local region and to address structural compliance, the GE study on local effects was used (Ref. 3.5). This study contains an analysis of the drywell shell using the pie slice finite element model. The study reduced the thickness of a 12" by 12" area by 0.100 inches (0.636 inches) and included a transition zone of 12 inches all around from 0.636" to 0.736". When compared to a similar area with a buckling design thickness of 0.736" the total reduced area of 1,296 square inches represents a 13.5% reduction in local shell thickness and a material loss of 72.0 cubic inches. The center of the thinned area was located close to the calculated maximum displacement point in the buckling analysis with uniform thickness of 0.736 inch as per Reference 3.5. For this case the theoretical buckling load factor was reduced by 3.9%.

Based on the buckling design thickness of 0.736 inches the "as found" 4" by 4" area with a thickness of 0.692" represents a 6.3% reduction in local shell thickness and a material loss of 0.7 cubic inches. This volumetric consideration provides a quick visualization, while shell buckling depends on various parameters as discussed in Reference 3.3 and 3.7.

Comparison of the "as found" area of 4" x 4" with the "as analyzed" criteria of 0.636" over a 12" x 12" area, with an additional transition zone of 12", and its associated 13.5% reduction in shell wall thickness and a material loss of 72 cubic inches leads to the conclusion that the effect on the theoretical buckling load factor is negligible. Also based on the location of this 4" x 4" area, is almost directly below the vent and vent header assembly (between 12 to 17 inches to the right of the vent centerline and between 22 and 23 inches down from the vent weld line). This is in the area where buckling of the shell is limited due to the stiffening effect of the vent and vent header assembly. This effect can be clearly seen in the buckling analyses presented in References 3.3 and 3.5.

**Remaining Very Local Areas:**

A review of Appendix D, Calculation pages 71, 73 and 75 indicates the remaining very local areas of reduced thickness are isolated from each other and therefore, have a negligible effect on the shell buckling. See Section 6, Very Local Wall Criteria (2 ½ inches in diameter or less) for details. Furthermore, the remaining local areas are centered about the vent which significantly stiffen the shell. This stiffening effect combined with the restraint provided by the concrete support structure limits the shell buckling to a point in the sandbed region which is located at the midpoint between the two vents.

Conclusion

In summary, using a conservative estimate of 0.800 inches for evaluation thickness for the entire bay (except the bathtub ring) and a 0.792 inch evaluation thickness for the bathtub ring , plus the acceptance of the local 4" by 4" area with an evaluation thickness of 0.692" based on the GE study, it is concluded that the bay is acceptable.

**Bay # 1 UT Data**
**Table 1-b**

| Location | D-Meter UT Measurement (inches) | Appendix D on Calculation Page | Average Micrometer (See Table 1-a) (inches) |
|---|---|---|---|
| 1 | 0.720 | 71 | 0.217 |
| 2 | 0.716 | 71 | 0.143 |
| 3 | 0.705 | 71 | 0.347 |
| 4 | 0.760 | 71 | --- |
| 5 | 0.710 | 71 | 0.313 |
| 6 | 0.760 | 71 | --- |
| 7 | 0.700 | 71 | 0.266 |
| 8 | 0.805 | 71 | --- |
| 9 | 0.805 | 71 | --- |
| 10 | 0.839 | 73 | --- |
| 11 | 0.714 | 73 | 0.212 |
| 12 | 0.724 | 73 | 0.301 |
| 13 | 0.792 | 73 | --- |
| 14 | 1.147 | 73 | --- |
| 15 | 1.156 | 73 | --- |
| 16 | 0.796 | 75 | --- |
| 17 | 0.860 | 75 | --- |
| 18 | 0.917 | 75 | --- |
| 19 | 0.890 | 75 | --- |
| 20 | 0.965 | 75 | --- |
| 21 | 0.726 | 75 | 0.211 |
| 22 | 0.852 | 75 | --- |
| 23 | 0.850 | 75 | --- |

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 20 of 117 |
| **Originator** | **Date** | **Reviewed by** | | **Date** |
| Mark Yekta | 01/12/93 | S. C. Tumminelli | | |

**Summary Of Measurements Below 0.736"**
**Table 1-c**

| Location | UT Measurement (1) | AVG Micrometer (2) | Mean Depth/Valley (3) | T (Evaluation) (4)=(1)+(2)-(3) | Remarks |
|---|---|---|---|---|---|
| 1 | 0.720" | 0.217" | 0.200" | 0.737" | Acceptable |
| 2 | 0.716" | 0.143" | 0.200" | 0.659" | Acceptable |
| 3 | 0.705" | 0.347" | 0.200" | 0.852" | Acceptable |
| 5 | 0.710" | 0.313" | 0.200" | 0.823" | Acceptable |
| 7 | 0.700" | 0.266" | 0.200" | 0.766" | Acceptable |
| 11 | 0.714" | 0.212" | 0.200" | 0.726" | Acceptable |
| 12 | 0.724" | 0.301" | 0.200" | 0.825" | Acceptable |
| 21 | 0.726" | 0.211" | 0.200" | 0.737" | Acceptable |

GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 21 of 117 |
| **Originator** | **Date** | **Reviewed by** | | **Date** |
| Mark Yekta | 01/12/93 | S. C. Tumminelli | | |

# BAY #1 DATA

**NOTES:**

1. All "Location" measurements from intersection of the DW shell and vent collar fillet welds.
2. Pit depts are average of four readings taken at 0/45°/90°/135° within 1" band surrounding ground spots. Only measured where remaining wall thk. was below 0.736".

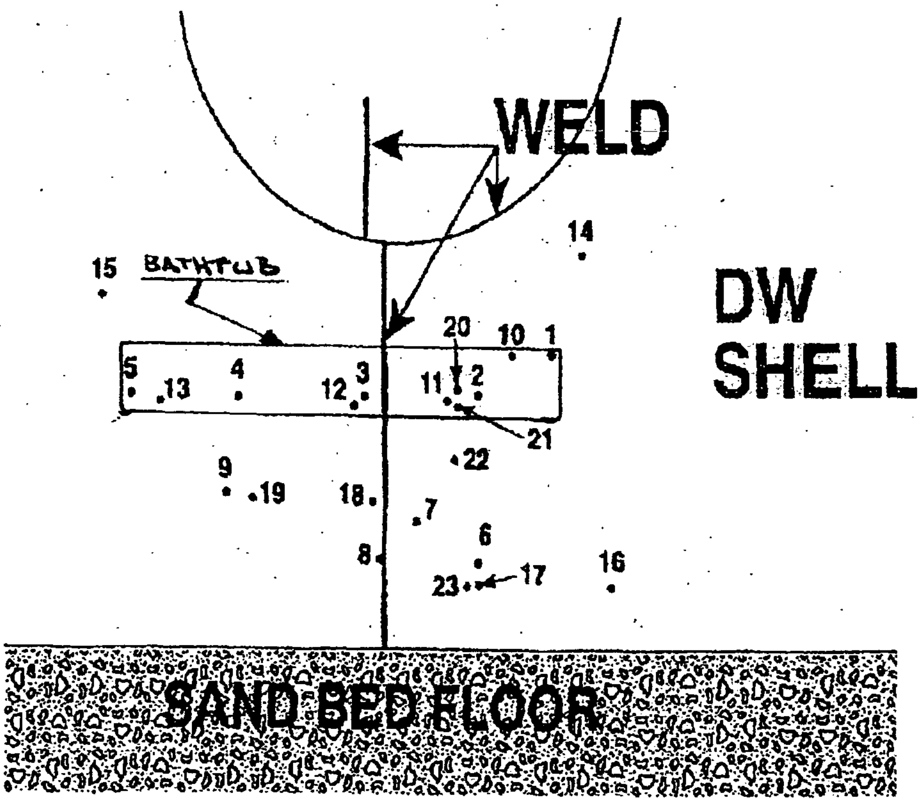



FIGURE (1)

## UT EVALUATION BAY #3:

The outside surface of this bay is rough; similar to bay one, full of dimples comparable to the outside surface of golf ball. This observation is made by the inspector who located the thinnest areas for the UT examination. The shell appears to be relatively uniform in thickness except for a bathtub ring 8 to 10 inches wide approximately 6 inches below the vent header reinforcement plate. The upper portion of the shell beyond the band exhibits no corrosion where the original red lead primer is still intact. Eight locations were selected to represent the thinnest areas based on the visual observations of the shell surface (Fig. 3). These locations are a deliberate attempt to produce a minimum measurement. Table 3 shows measurements taken to measure the thicknesses of the drywell shell using a D-meter. The results indicate that all of the areas have thickness greater than the 0.736 inches.

### Bay #3 General Wall (SandBed Region) Thickness Evaluation

Given an average of the UT measurements presented in Table 3 equal to 0.868 inches, a conservative mean evaluation thickness of 0.850 inches is estimated for this bay. Therefore, it is concluded that the bay is acceptable based on the bay evaluation thickness exceeding the buckling design thickness for the sandbed region of 0.736 inches using results of Reference 3.3.

**Bay # 3 UT Data**
**Table 3**

| Location | D-Meter UT Measurement (inches) | Appendix D on Calculation Page | Average Micrometer (inches) |
|---|---|---|---|
| 1 | 0.795 | 77 | --- |
| 2 | 1.000 | 77 | --- |
| 3 | 0.857 | 77 | --- |
| 4 | 0.898 | 77 | --- |
| 5 | 0.823 | 77 | --- |
| 6 | 0.968 | 77 | --- |
| 7 | 0.826 | 77 | --- |
| 8 | 0.780 | 77 | --- |

# BAY #3 DATA

**NOTES:**

1. All "Location" measurements from intersection of the DW shell and vent collar fillet welds.

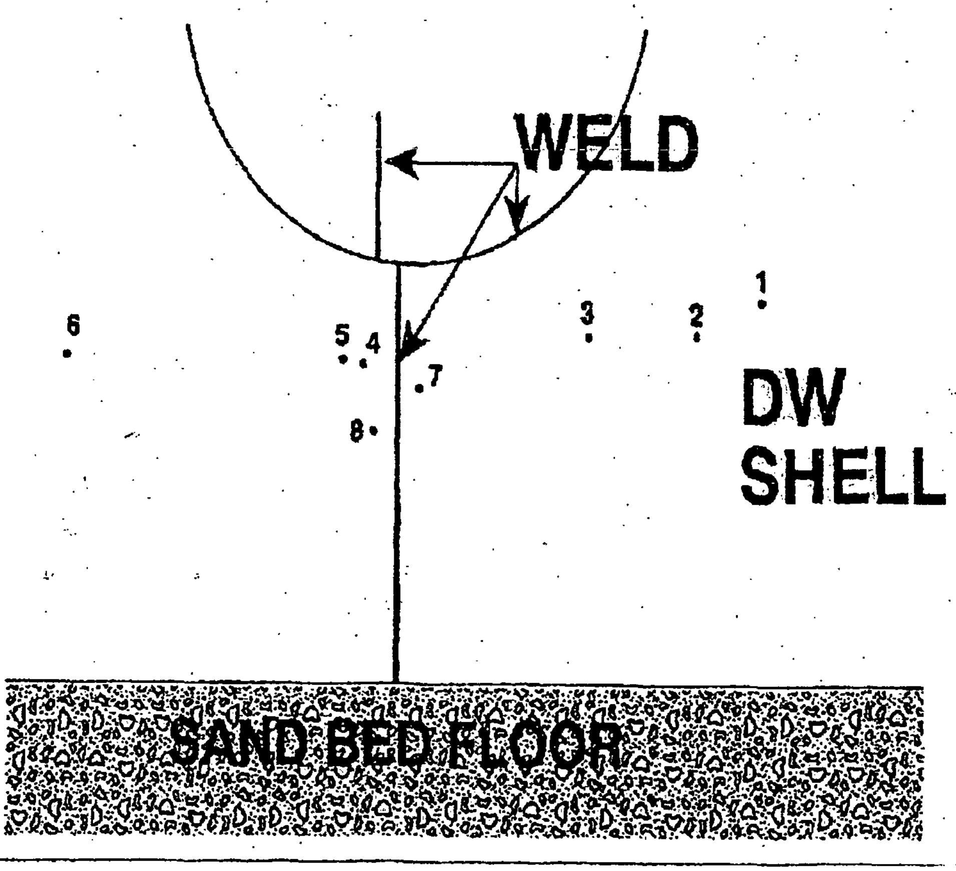



FIGURE (3)

## UT EVALUATION BAY #5:

The outside surface of this bay is rough and very similar to bay 3 except that the local areas are clustered at the junction of bays 3 and 5, at about 30 inches above the floor. The shell surface is full of dimples comparable to the outside surface of a golf ball. This observation is made by the inspector who located the thinnest areas for the UT examination. The shell appears to be relatively uniform in thickness. Eight locations were selected to represent the thinnest areas based on the visual observations of the shell surface (see Fig. 5). These locations are a deliberate attempt to produce a minimum measurement. Table 5 shows readings taken to measure the thicknesses of the drywell shell using a D-meter. The results indicate that all of the areas have thickness greater than the 0.736 inches.

## Bay #5 General Wall (Sandbed Region) Thickness Evaluation

Given an average of the UT measurements presented in Table 5 equal to 0.986 inches, a conservative mean evaluation thickness of 0.950 inches is estimated for this bay. Therefore, it is concluded that the bay is acceptable based on the bay evaluation thickness exceeding the buckling design thickness for the sandbed region of 0.736 inches using the results of Reference 3.3.

**Bay # 5 UT Data**
**Table 5**

| Location | D-Meter UT Measurement (inches) | Appendix D on Calculation Page | Average Micrometer (inches) |
|---|---|---|---|
| 1 | 0.970 | 80 | --- |
| 2 | 1.040 | 80 | --- |
| 3 | 1.020 | 80 | --- |
| 4 | 0.910 | 80 | --- |
| 5 | 0.890 | 80 | --- |
| 6 | 1.060 | 80 | --- |
| 7 | 0.990 | 80 | --- |
| 8 | 1.010 | 80 | --- |

GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 25 of 117 |
| **Originator** | **Date** | **Reviewed by** | | **Date** |
| Mark Yekta | 01/12/93 | S. C. Tumminelli | | |

# BAY #5 DATA

## NOTES:

1. In this bay DW shell (butt) weld is about 6" to the right of C/L of vent tube. Therefore - all measurements were taken from a line drawn on shell which approx. coincide with vent tube C/L.

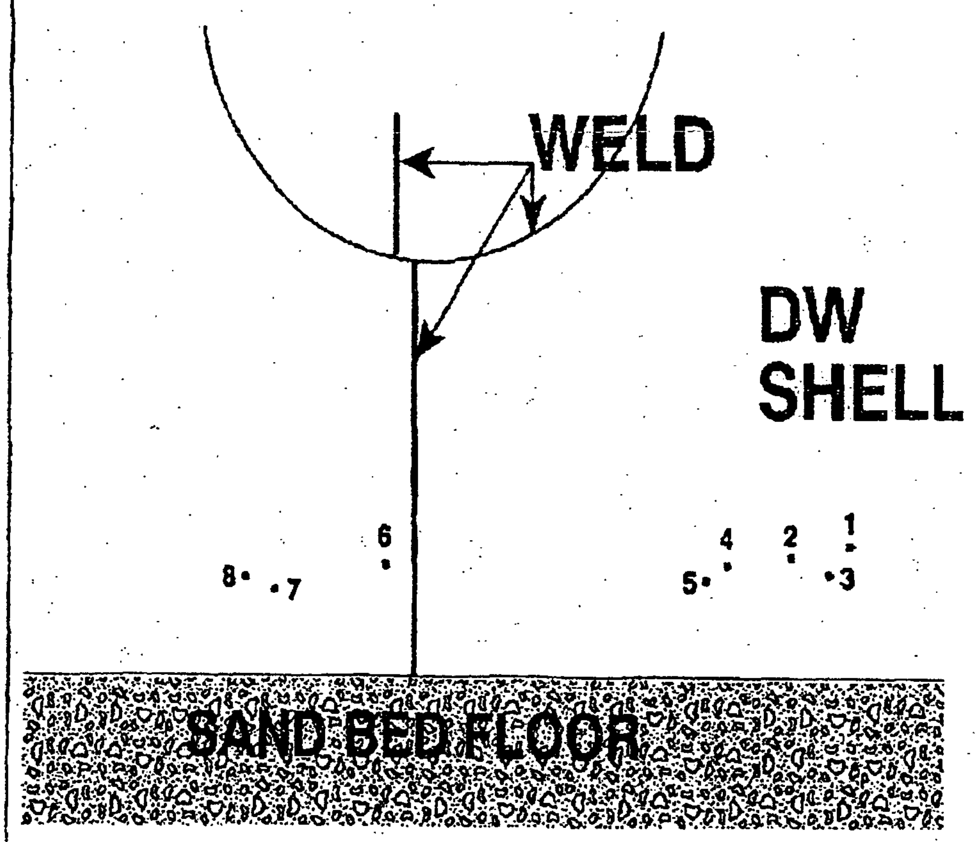



**FIGURE (5)**

## UT EVALUATION BAY #7:

The observation of the drywell surface for this bay showed uniform dimples in the corroded area, but they are shallow compared to those in bay 1. The bathtub ring seen in the other bays was not very prominent in this bay. This observation is made by the inspector who located the thinnest areas for the UT examination. The shell appears to be relatively uniform in thickness. Seven locations were selected to represent the thinnest areas based on the visual observations of the shell surface (Fig. 7). These locations are a deliberate attempt to produce a minimum measurement. Table 7 shows readings taken to measure the thicknesses of the drywell shell using a D-meter. The results indicate that all of the areas have thickness greater than the 0.736 inches.

### Bay #7 General Wall (Sandbed Region) Thickness Evaluation

Given an average of the UT measurements presented in Table 7 equal to 1.001, a mean evaluation thickness of 1.00 inch is estimated for this bay. Therefore, it is concluded that the bay is acceptable based on the bay evaluation thickness exceeding the buckling design thickness for the sandbed region of 0.736 inches using the results of Reference 3.3.

**Bay # 7 UT Data**
**Table 7**

| Location | D-Meter UT Measurement (inches) | Appendix D on Calculation Page | Average Micrometer (inches) |
|---|---|---|---|
| 1 | 0.920 | 84 | --- |
| 2 | 1.016 | 84 | --- |
| 3 | 0.954 | 84 | --- |
| 4 | 1.040 | 84 | --- |
| 5 | 1.030 | 84 | --- |
| 6 | 1.045 | 84 | --- |
| 7 | 1.000 | 84 | --- |

GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 27 of 117 |
| **Originator** Mark Yekta | **Date** 01/12/93 | **Reviewed by** S. C. Tumminelli | | **Date** |

# BAY #7 DATA

## NOTES:

1. All measurements from the intersection of DW shell (butt) and vent collar (fillet) welds.

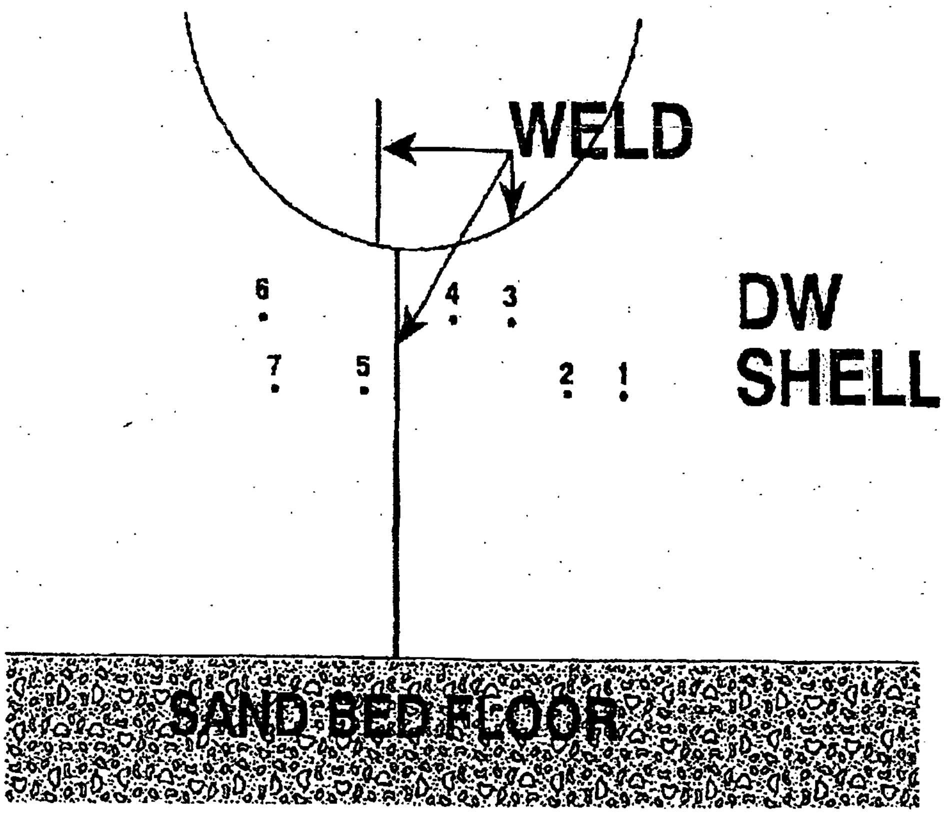



FIGURE (7)

## UT EVALUATION BAY #9:

The observation of the drywell shell for this bay was very similar to bay 7 except that the bathtub ring was more evident in this bay. The shell appears to be relatively uniform in thickness except for a bathtub ring 6 to 9 inches wide approximately 6 to 8 inches below the vent header reinforcement plate. The upper portion of the shell beyond the band exhibits no corrosion where the original red lead primer is still intact. Ten locations were selected to represent the thinnest areas based on the visual observations of the shell surface (Fig. 9). These locations are a deliberate attempt to produce a minimum measurement. Table 9 shows readings taken to measure the thicknesses of the drywell shell using a D-meter. The results indicate that all of the areas have thickness greater than the 0.736 inches.

### Bay #9 General Wall (Sandbed Region) Thickness Evaluation

Given an average of the UT measurements presented in Table 9 equal to 0.915, a conservative mean evaluation thickness of 0.900 inches is estimated for this bay. Therefore, it is concluded that the bay is acceptable based on the bay evaluation thickness exceeding the buckling design thickness for the sandbed region of 0.736 inches using the results of Reference 3.3.

**Bay # 9 UT Data**
**Table 9**

| Location | D-Meter UT Measurement (inches) | Appendix D on Calculation Page | Average Micrometer (inches) |
|---|---|---|---|
| 1 | 0.960 | 85 | --- |
| 2 | 0.940 | 85 | --- |
| 3 | 0.994 | 85 | --- |
| 4 | 1.020 | 85 | --- |
| 5 | 0.985 | 85 | --- |
| 6 | 0.820 | 85 | --- |
| 7 | 0.825 | 85 | --- |
| 8 | 0.791 | 85 | --- |
| 9 | 0.832 | 85 | --- |
| 10 | 0.980 | 85 | --- |

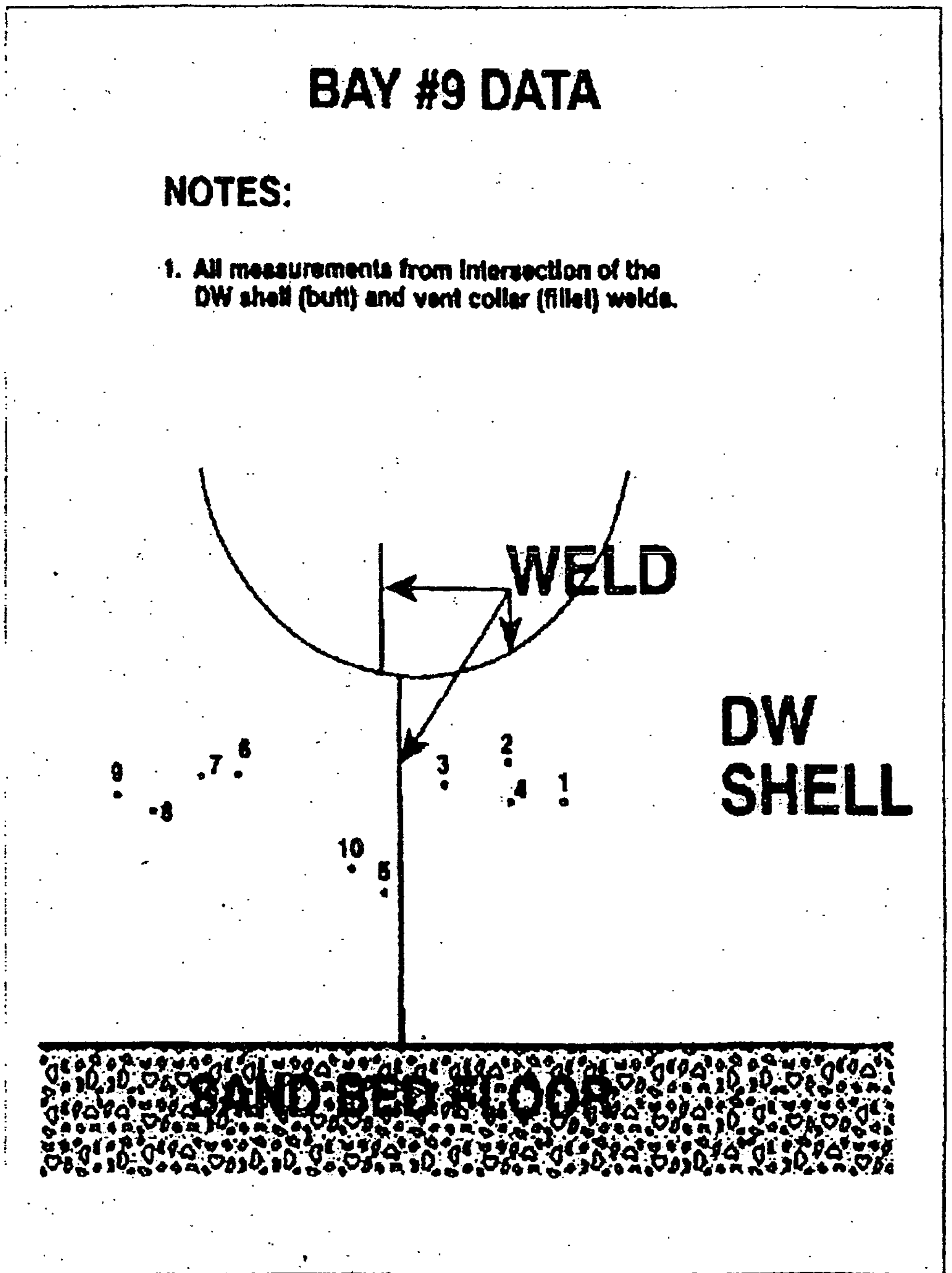

BAY #9 DATA
NOTES:
1. All measurements from intersection of the DW shell (butt) and vent collar (fillet) welds.
WELD
DW SHELL
1
2
3
4
5
6
7
8
9
10
SAND BED FLOOR

FIGURE (9)

## UT EVALUATION BAY #11:

The outside surface of this bay is rough, similar to bay 1, full of uniform dimples comparable to the outside surface of a golf ball. The shell appears to be relatively uniform in thickness except for local areas at the upper right corner of Figure 11, located at about 10 to 12 inches below the vent pipe reinforcement plate.

Eight locations were selected to represent the thinnest areas based on the visual observations of the shell surface (Fig. 11). These locations are a deliberate attempt to produce a minimum measurement. Table 11-a shows readings taken to measure the thicknesses of the drywell shell using a D-meter. The results indicate that all of the areas have thickness greater than the 0.736 inches, except one location. Location 1 as shown in Table 11-a, has a reading below 0.736 inches. Inspectors observations indicate that this location was very deep and not more than 1 to 2 inches in diameter. The depth of area relative to its immediate surrounds was measured at 4 locations around the spot and the average is shown in Table 11-a. As described in Section 6, Methods of Analysis, Very Local Wall Acceptance Criteria, areas of reduced thickness equal to or less than 2 ½ inches are too small to reduce the shell critical buckling load. This combined with the location of the very local indication near the vent reinforcement (See Appendix D, Calculation Page 87) indicates that this area would have a negligible effect on the shell buckling response.

### Bay #11 General Wall (Sandbed Region) Thickness Evaluation

Given an average of the UT measurements presented in Table 11-a equal to 0.792 inches, a conservative mean evaluation thickness of 0.790 inches is estimated for this bay. Therefore, it is concluded that the bay is acceptable based on the bay evaluation thickness exceeding the buckling design thickness for the sandbed region of 0.736 inches using the results of Reference 3.3.

The calculation of the average depth for Bay 11, Location 1 is as follows:

$$(\text{AVG Micrometer})_1 = \frac{D_{1-0^0} + D_{1-45^0} + D_{1-90^0} + D_{1-135^0}}{4}$$

Where: $D_{1\text{-}0}{}^0$ = Micrometer Depth Reading for location 1 at 0 degrees taken from Appendix D, Calculation Page 91, etc.

$$(\text{AVG Micrometer})_1 = \frac{0.289\text{"}+0.338\text{"}+0.157\text{"}+0.200\text{"}}{4} = 0.246\text{"}$$

**Bay # 11 UT Data**
**Table 11-a**

| Location | UT Measurement (inches) | Appendix D Presented on Calculation Page | Average Micrometer (inches) |
|---|---|---|---|
| 1 | 0.705 | 87 | 0.246 |
| 2 | 0.770 | 87 | --- |
| 3 | 0.832 | 87 | --- |
| 4 | 0.755 | 87 | --- |
| 5 | 0.831 | 87 | --- |
| 6 | 0.800 | 87 | --- |
| 7 | 0.831 | 87 | --- |
| 8 | 0.815 | 87 | --- |

**Summary of Measurements Below 0.736 Inches**
**Table 11-b**

| Location | UT Measurement (1) | AVG Micrometer (2) | Mean Depth/Valley (3) | T (Evaluation) (4)=(1)+(2)-(3) | Remarks |
|---|---|---|---|---|---|
| 1 | 0.705" | 0.246" | 0.200" | 0.751" | Acceptable |

# BAY #11 DATA

## NOTES:

1. All measurements from intersection of the DW shell (butt) and vent collar (fillet) welds.
2. Pit depths are average of four readings taken at 0/45°/90°/135° within 1" band surrounding the ground spots. This measurement was only taken when wall thickness was below 0.736".

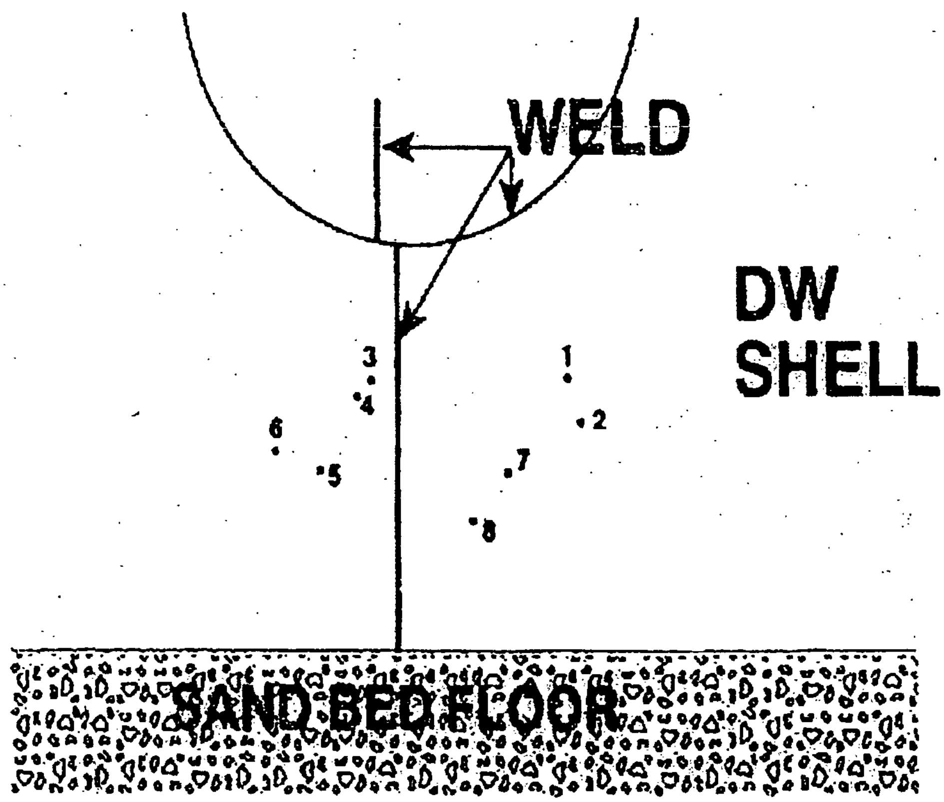



FIGURE (11)

**UT EVALUATION BAY #13:**

The outside surface of this bay is rough and full of dimples similar to bay 1 as shown in Appendix C. This observation is made by the inspector who located the thinnest areas in deep valleys thereby biasing the remaining wall measurements to the conservative side. This inspection focused on the thinnest areas, even if very local, i.e., the inspection did not attempt to define a shell thickness suitable for structural evaluation. The variation in shell thickness is greater in this bay than in the other bays. The bathtub ring below the vent pipe reinforcement plate was less prominent than was seen in other bays. The corroded areas are about 12 to 18 inches in diameter and are at 12 inches apart, located in the middle of the sandbed. Beyond the corroded areas on both sides, the shell appears to be uniform in thickness at a conservative value of 0.800". Near the vent pipe and reinforcement plate the shell exhibits no corrosion since the original lead primer on the vent pipe/reinforcement plate is intact. Measurement 20 confirms that the thickness above the bathtub ring is at 1.154 inches. Below the bathtub ring the shell appears to be fairly uniform in thickness where no abrupt changes in thickness are present. Thickness measurements below the bathtub ring (Locations 3, 4, 9, 12, 13, 16, 17, 18, and 19) are all 0.800 inches or better (See Table 13-b).

**Bay #13 General Wall (Sandbed Region) Thickness Evaluation**

Therefore, given an average of the UT measurements of the locations below the bathtub ring is equal to 0.884 inches, a conservative mean thickness of 0.800 inches is estimated to represent the evaluation thickness for areas of shell in this bay outside the bathtub ring. Given a uniform thickness of 0.800 inches for these areas of the bay it is concluded that these areas are acceptable based on the thickness exceeding the buckling design thickness for the sandbed region of 0.736 inches using the results of Reference 3.3.

Locations 5, 6, 7, 8, 10, 11, 14, and 15 are confined to the bathtub ring as shown in Figure 13. To determine the general shell thickness in the bathtub ring area of this bay the evaluation thicknesses (See Table 13-c) for each of the locations defined above are averaged together. An example of a typical calculation of the general wall thickness defined as the evaluation thickness is presented below for clarity:

$$(\text{AVG Micrometer})_5 = \frac{D_{5-0^0} + D_{5-45^0} + D_{5-90^0} + D_{5-135^0}}{4}$$

Where: $D_{5\text{-}0}{}^0$ = Micrometer Depth Reading for Bay 13, location 5 at 0 degrees taken from Appendix D, Calculation Page 98, etc.

$$(\text{AVG Micrometer})_5 = \frac{0.150"+0.193"+0.230"+0.298"}{4} = 0.217"$$

$$T_{(\text{Evaluation})5} = UT_{(\text{Measurement})5} + (\text{AVG Micrometer})_5 - T_{\text{rough}}$$

Where: $UT_{(\text{Measurement})5}$ = 0.718" Taken from Appendix D, Calc Page 93, Location 5

$T_{\text{rough}}$ = 0.200" See Design Input 5.1 and Section 6, Acceptance Criteria, General Wall.

$$T_{(\text{Evaluation})5} = 0.718"+0.217"-0.200" = 0.735"$$

**Bay 13 AVG Micrometer Calculations**
**Table 13-a**

| Location | Azimuth[1] | | | | AVG |
|---|---|---|---|---|---|
| | $0^0$ | $45^0$ | $90^0$ | $135^0$ | |
| 1 | 0.330" | 0.382" | 0.346" | 0.346" | 0.351" |
| 2 | 0.312" | 0.377" | 0.360" | 0.393" | 0.360" |
| 5 | 0.150" | 0.193" | 0.230" | 0.298" | 0.217" |
| 6 | 0.327" | 0.339" | 0.290" | 0.247" | 0.301" |
| 7 | 0.241 | 0.279" | 0.260" | 0.239" | 0.255" |
| 8 | 0.324" | 0.245" | 0.262" | 0.279" | 0.278" |
| 10 | 0.186" | 0.173" | 0.255" | 0.229" | 0.211" |
| 11 | 0.240" | 0.231" | 0.271" | 0.283" | 0.256" |
| 15 | 0.288" | 0.277" | 0.239" | 0.288" | 0.273" |

Notes: 1. Azimuth data taken from Appendix D, Calculation Page 98.

An average value of the evaluation thicknesses presented in Table 13-c for this band is as follows;

| Location | Evaluation Thickness |
|---|---|
| 5 | 0.735" |
| 6 | 0.756" |
| 7 | 0.675" |
| 8 | 0.796" |
| 10 | 0.739" |
| 11 | 0.741" |
| 12 | 0.885" |
| 14 | 0.868" |
| 15 | 0.756" |
| 16 | 0.829" |
| | Average = 0.778" |

The inspector suspected that some of the above locations in the bathtub ring were over ground. Subsequent locations with suffix A, e.g. 5A, 6A, were located close to the spots in question and were ground carefully to remove the minimum amount of metal but adequate enough for UT examination as shown in Table 13-b. The results indicate that all subsequent measurements were above 0.736 inches. The average micrometer measurements taken for these locations confirm the depth measurements at these locations. In spite of the fact that the original measurements were taken at heavily ground locations they are the ones used in the evaluation.

Again given that the average evaluation thickness of the shell in the bathtub ring area exceeds the buckling design thickness of 0.736 inches the shell area within the bathtub ring is also acceptable based on the results of Reference 3.3.

**Bay #13 Local Wall Thickness Evaluation**

The individual measurements must also be evaluated for compliance with the local wall thickness criteria. Table 13-b identifies 20 locations of UT measurements that were selected to represent the thinnest areas, except location 20, based on visual examination. These locations are a deliberate attempt to produce a minimum measurement. Location 20 was selected to confirm that no corrosion had taken place in the area above the bathtub ring.

Nine locations shown in Table 13-b (1, 2, 5, 6, 7, 8, 10, 11, and 15) have measurements below 0.736 inches. Inspectors observations indicate that these locations were very deep, overly ground, and not more than 1 to 2 inches in diameters. The depth of each of these areas relative to its immediate surroundings was measured at 4 locations around the spot and the average is shown in Table 13-a. Using the general wall thickness acceptance criteria described earlier, the evaluation thickness for all measurements below 0.736 inches were found to be above 0.736 inches except for two locations, 5 and 7, as shown in Table 13-b. In addition, subsequent measurements close to the locations identified above, were taken and they were all above 0.736 inches.

Locations 5 and 7 are in the bathtub ring and are about 30 inches apart. These locations are characterized as local areas located at about 15 to 20 inches below the vent pipe reinforcement plate with an evaluation thicknesses of 0.735 inches and 0.673 inches. The location 5 is near to location 14 for an average value of 0.801 inches and therefore acceptable. Location 7 could conservatively exist over an area of 6 x 6 inches for a thickness of 0.673 inches.

In order to quantify the effect of this local region and to address structural compliance, the GE study on local effects is used (Ref. 3.5). This study contains an analysis of the drywell shell using the pie slice finite element model. The study reduced the thickness of a 12" by 12" area by 0.100 inches (0.636 inches) and included a transition zone of 12 inches all around from 0.636" to 0.736". When compared to a similar area with a buckling design thickness of 0.736" the modeled area represents a 13.5% reduction in local shell thickness and a material loss of 72.0 cubic inches. The center of the thinned area was located close to the calculated maximum displacement point in the buckling analysis with uniform thickness of 0.736 inch as per Reference 3.5. For this case the theoretical buckling load factor was reduced by 3.9%.

Based on the buckling design thickness of 0.736 inches the "as found" 6" by 6" area with a thickness of 0.673" represents a 8.6% reduction in local shell thickness and a material loss of 2.3 cubic inches. The volumetric consideration provides a quick visualization. While shell buckling depends on various parameters as discussed in References 3.3 and 3.7.

Comparison of the "as found" area of 6" x 6" with the "as analyzed" criteria of 0.636" over a 12" x 12" area, with an additional transition zone of 12", and its associated 13.5% reduction in shell wall thickness and a material loss of 72 cubic inches leads to the conclusion that the effect on the theoretical buckling load factor is negligible. Also based on the location of this 6" x 6" area, is almost directly below the vent and vent header assembly (between 20 to 26 inches to the left of the vent centerline and between 14 to 20 inches down from the vent weld line). This is in the area where buckling of the shell is limited due to the stiffening effect of the vent and vent header assembly. This effect can be clearly seen in the buckling analyses presented in References 3.3 and 3.5.

**Remaining Very Local Areas:**

A review of Appendix D, calculation pages 93, 94, 95 and 96 indicates the remaining very local areas of reduced thickness are isolated from each other and therefore, have a negligible effect on the shell buckling. See Section 6, Very Local Wall Criteria (2&½ inches in diameter or less) for details. Furthermore, the remaining local areas are centered about the vent which significantly stiffen the shell. This stiffening effect combined with the restraint provided by the concrete support structure limits the shell buckling to a point in the sandbed region which is located at the midpoint between the two vents.

Conclusion

In summary, using a conservative estimate of 0.800 inches for evaluation thickness for the entire bay (except the bathtub ring) and a 0.778 inch evaluation thickness for the bathtub ring , plus the acceptance of the local 6" by 6" area with an evaluation thickness of 0.673" based on the GE study, it is concluded that the bay is acceptable.

Bay # 13 UT Data

**Table 13-b**

| Location | D-Meter UT Measurement (inches) | Appendix D presented on Calculation Page | Average Micrometer[(1)] (Table 13-a) (inches) |
|---|---|---|---|
| 1/1A | 0.672/0.890 | 93/95 | 0.351 |
| 2/2A | 0.722/0.943 | 93/95 | 0.360 |
| 3 | 0.941 | 93 | --- |
| 4 | 0.915 | 93 | --- |
| 5/5A | 0.718/0.851 | 93/95 | 0.217 |
| 6/6A | 0.655/0.976 | 93/95 | 0.301 |
| 7/7A | 0.618/0.752 | 93/95 | 0.255 |
| 8/8A | 0.718/0.900 | 93/95 | 0.278 |
| 9 | 0.924 | 93 | --- |
| 10/10A | 0.728/0.810 | 93/95 | 0.211 |
| 11/11A | 0.685/0.854 | 93/95 | 0.256 |
| 12 | 0.885 | 93 | --- |
| 13 | 0.932 | 93 | --- |
| 14 | 0.868 | 93 | --- |
| 15/15A | 0.683/0.859 | 93/95 | 0.273 |
| 16 | 0.829 | 93 | --- |
| 17 | 0.807 | 93 | --- |
| 18 | 0.825 | 93 | --- |
| 19 | 0.912 | 93 | --- |
| 20 | 1.170 | 93 | --- |

(1) (1) Average values provided in this column are for locations 1, 2, 5, etc.

(1) (without suffix A) and not for 1A, 2A, 5A, etc. The values are compiled in Table 13-a

**Summary of Measurements Below 0.736 Inches**
**Table 13-c**

| Location | UT Measurement (1) | AVG Micrometer (2) | Mean Depth/Valley (3) | T (Evaluation) (4)=(1)+(2)-(3) | Remarks |
|---|---|---|---|---|---|
| 1 | 0.672" | 0.351" | 0.200" | 0.823" | Acceptable |
| 2 | 0.722" | 0.360" | 0.200" | 0.882" | Acceptable |
| 5 | 0.718" | 0.217" | 0.200" | 0.735" | Acceptable |
| 6 | 0.655" | 0.301" | 0.200" | 0.756" | Acceptable |
| 7 | 0.618" | 0.255" | 0.200" | 0.673" | Acceptable |
| 8 | 0.718" | 0.278" | 0.200" | 0.796" | Acceptable |
| 10 | 0.728" | 0.211" | 0.200" | 0.739" | Acceptable |
| 11 | 0.685" | 0.256" | 0.200" | 0.741" | Acceptable |
| 15 | 0.683" | 0.273" | 0.200" | 0.756" | Acceptable |

GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 40 of 117 |
| **Originator** | **Date** | **Reviewed by** | | **Date** |
| Mark Yekta | 01/12/93 | S. C. Tumminelli | | |

# BAY #13 DATA

## NOTES:

1. All measurements from intersection of the DW shell (butt) and vent collar (fillet) welds.
2. Spots with suffix (e.g. lA or 2A) were located close to the spots in question and were ground carefully to remove minimum amount of metal but adequate enough for UT.
3. Pit depths are average of four readings taken at 0/45°/90°/135° within 1" distance around ground spot. Taken only where remaining wall showed below 0.736".

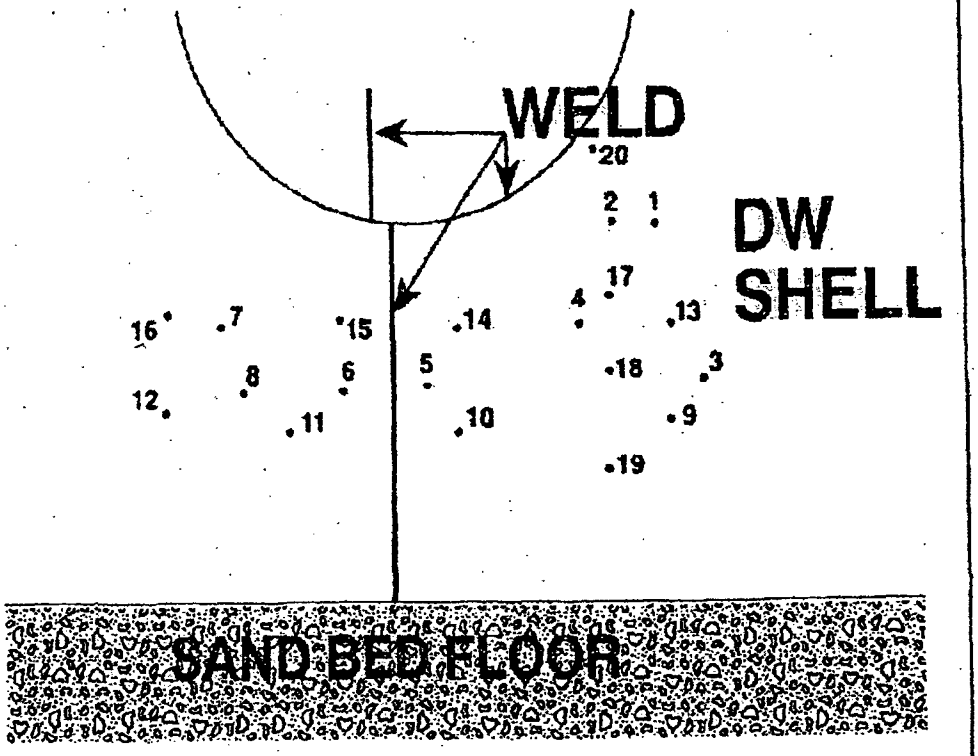



Figure (13)

## UT EVALUATION BAY #15:

The outside surface of this bay is rough, similar to bay 1, full of uniform dimples comparable to the outside surface of golf ball (Appendix C). The bathtub ring seen in the other bays, was not very prominent in this bay. This observation is made by the inspector who located the thinnest areas for the UT examination. The upper portion of the shell beyond the ring exhibits no corrosion where the original red lead primer is still intact. The shell appears to be relatively uniform in thickness.

Eleven locations were selected to represent the thinnest areas based on the visual observations of the shell surface (Fig. 15). These locations are a deliberate attempt to produce a minimum measurement. Table 15-a shows readings taken to measure the thicknesses of the drywell shell using a D-meter. The results indicate that all of the areas have thickness greater than the 0.736 inches, except one location. Location 9 as shown in Table 15-a, has a reading below 0.736 inches. Inspectors observations indicate that this location was very deep and not more than 1 to 2 inches in diameter. The depth of area relative to its immediate surrounding was measured at 4 locations around the spot and the average is shown in Table 15-a. As described in Section 6, Methods of Analysis, Very Local Wall Acceptance Criteria, areas of reduced thickness equal to or less than 2 ½ inches are too small to reduce the shell critical buckling load. This combined with the location of the very local indication near the vent reinforcement (See Appendix D, Calculation Page 99) indicates that this area would have a negligible effect on the shell buckling response.

### Bay #15 General Wall (Sandbed Region) Thickness Evaluation

Given an average of the UT measurements presented in Table 15-a is equal to 0.816 inches, a conservative mean evaluation thickness of 0.800 inches is estimated for this bay. Therefore, it is concluded that the bay is acceptable based on the bay evaluation thickness exceeding the buckling design thickness for the sandbed region of 0.736 inches using the results of Reference 3.3.

The calculation of the average depth for Bay 15, Location 9 is as follows:

$$(\text{AVG Micrometer})_9 = \frac{D_{9-0^0} + D_{9-45^0} + D_{9-90^0} + D_{9-135^0}}{4}$$

Where: $D_{9\text{-}0}{}^0$ = Micrometer Depth Reading for location 9 at 0 degrees taken from Appendix D, Calculation Page 100, etc.

$$(\text{AVG Micrometer})_1 = \frac{0.356"+0.350"+0.359"+0.282"}{4} = 0.337"$$

# GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 42 of 117 |
| Originator<br>Mark Yekta | Date<br>01/12/93 | Reviewed by<br>S. C. Tumminelli | | Date |

**<u>Bay # 15 UT Data</u>**

**<u>Table 15-a</u>**

| Location | D-Meter UT Measurement (inches) | Appendix D on Calculation Page | Average Micrometer (inches) |
|---|---|---|---|
| 1 | 0.786 | 99 | --- |
| 2 | 0.829 | 99 | --- |
| 3 | 0.932 | 99 | --- |
| 4 | 0.795 | 99 | --- |
| 5 | 0.850 | 99 | --- |
| 6 | 0.794 | 99 | --- |
| 7 | 0.808 | 99 | --- |
| 8 | 0.770 | 99 | --- |
| 9 | 0.722 | 99 | 0.337 |
| 10 | 0.860 | 99 | --- |
| 11 | 0.825 | 99 | --- |

**<u>Summary of Measurements Below 0.736 Inches</u>**

**<u>Table 15-b</u>**

| Location | UT Measurement (1) | AVG Micrometer (2) | Mean Depth/Valley (3) | T (Evaluation) (4)=(1)+(2)-(3) | Remarks |
|---|---|---|---|---|---|
| 9 | 0.722" | 0.337" | 0.200" | 0.859" | Acceptable |

# BAY #15 DATA

**NOTES:**

1. All measurements from intersection of the DW shell and vent collar (fillet) welds.
2. Pit depths are average of four readings taken at 0/45°/90°/135° within 1" distance around ground spots. Taken only when remaining wall thickness shown below 0.736".

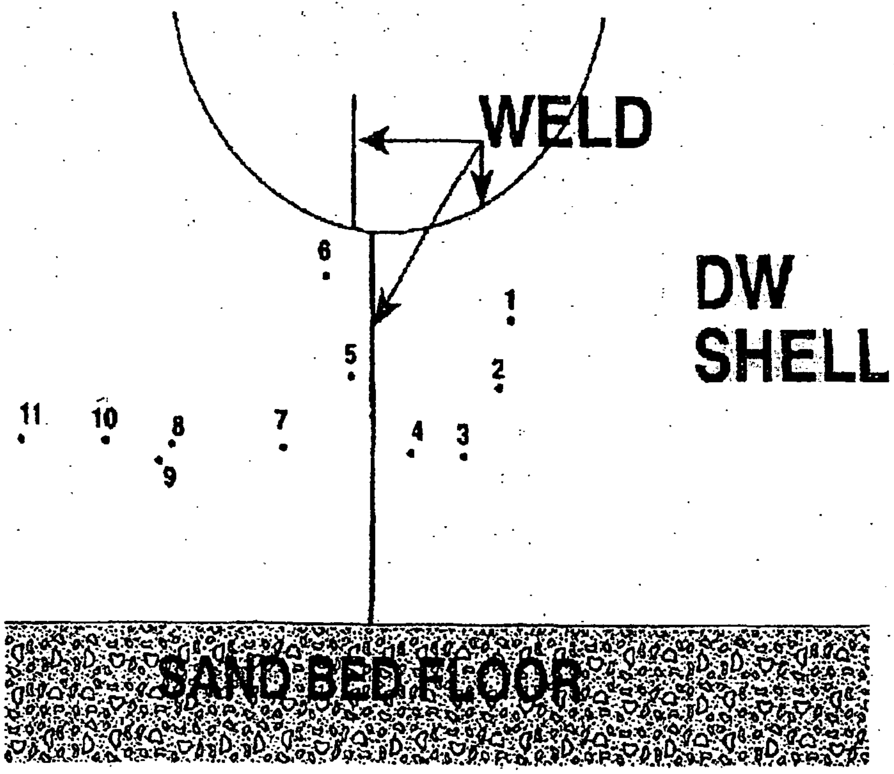



FIGURE (15)

## UT EVALUATION BAY #17:

The outside surface of this bay is rough, similar to bay 1, full of uniform dimples comparable to the outside surface of golf ball. The shell appears to be relatively uniform in thickness except for a band 8 to 10 inches wide approximately 6 inches below the vent header reinforcement plate. The upper portion of the shell beyond the band exhibits no corrosion where the original red lead primer is still intact.

Eleven locations were selected to represent the thinnest areas based on the visual observations of the shell surface (Fig. 17). These locations are a deliberate attempt to produce a minimum measurement. Table 17-a shows readings taken to measure the thicknesses of the drywell shell using a D-meter. The results indicate that all of the areas have thickness greater than the 0.736 inches, except one location. Location 9 as shown in Table 17-a, has a reading below 0.736 inches. Inspectors observations indicate that this location is very deep and not more than 1 to 2 inches in diameter. The depth of area relative to its immediate surroundings was measured at 4 locations around the spot and the average is shown in Table 17-a. As described in Section 6, Methods of Analysis, Very Local Wall Acceptance Criteria, areas of reduced thickness equal to or less than 2 & ½ inches are too small to reduce the shell critical buckling load. This combined with the location of the very local indication near the vent reinforcement (See Appendix D, Calculation Page 103) indicates that this area would have a negligible effect on the shell buckling response.

### Bay #17 General Wall (Sandbed Region) Thickness Evaluation

Given an average of the UT measurements presented in Table 17-a is equal to 0.918 inches, a conservative mean evaluation thickness of 0.900 inches is estimated for this bay. Therefore, it is concluded that the bay is acceptable based on the bay evaluation thickness exceeding the buckling design thickness for the sandbed region of 0.736 inches using the results of Reference 3.3.

The calculation of the average depth for Bay 17, Location 9 is as follows:

$$(\text{AVG Micrometer})_9 = \frac{D_{9-0^0} + D_{9-45^0} + D_{9-90^0} + D_{9-135^0}}{4}$$

Where: $D_{9\text{-}0}{}^{0}$ = Micrometer Depth Reading for location 9 at 0 degrees taken from Appendix D, Calculation Page 105, etc.

$$(\text{AVG Micrometer})_1 = \frac{0.368"+0.407"+0.289"+0.342"}{4} = 0.351"$$

## Bay # 17 UT Data
## Table 17-a

| Location | D-Meter UT Measurement (inches) | Appendix D on Calculation Page | Average Micrometer (inches) |
|---|---|---|---|
| 1 | 0.916 | 104 | --- |
| 2 | 1.150 | 104 | --- |
| 3 | 0.898 | 104 | --- |
| 4 | 0.951 | 104 | --- |
| 5 | 0.913 | 104 | --- |
| 6 | 0.992 | 104 | --- |
| 7 | 0.970 | 104 | --- |
| 8 | 0.990 | 104 | --- |
| 9 | 0.720 | 103 | 0.351 |
| 10 | 0.830 | 103 | --- |
| 11 | 0.770 | 103 | --- |

## Summary of Measurements Below 0.736 Inches

## Table 17-b

| Location | UT Measurement (1) | AVG Micrometer (2) | Mean Depth/Valley (3) | T (Evaluation) (4)=(1)+(2)-(3) | Remarks |
|---|---|---|---|---|---|
| 9 | 0.720" | 0.351" | 0.200" | 0.871" | Acceptable |

# BAY #17 DATA

NOTES:

1. All measurements from intersection of the DW (butt) shell and vent collar (fillet) welds.
2. Pit depths are average of four readings taken at 0/45°/90°/135° within 1" distance around ground spots. Taken only when remaining wall thickness was below 0.736".

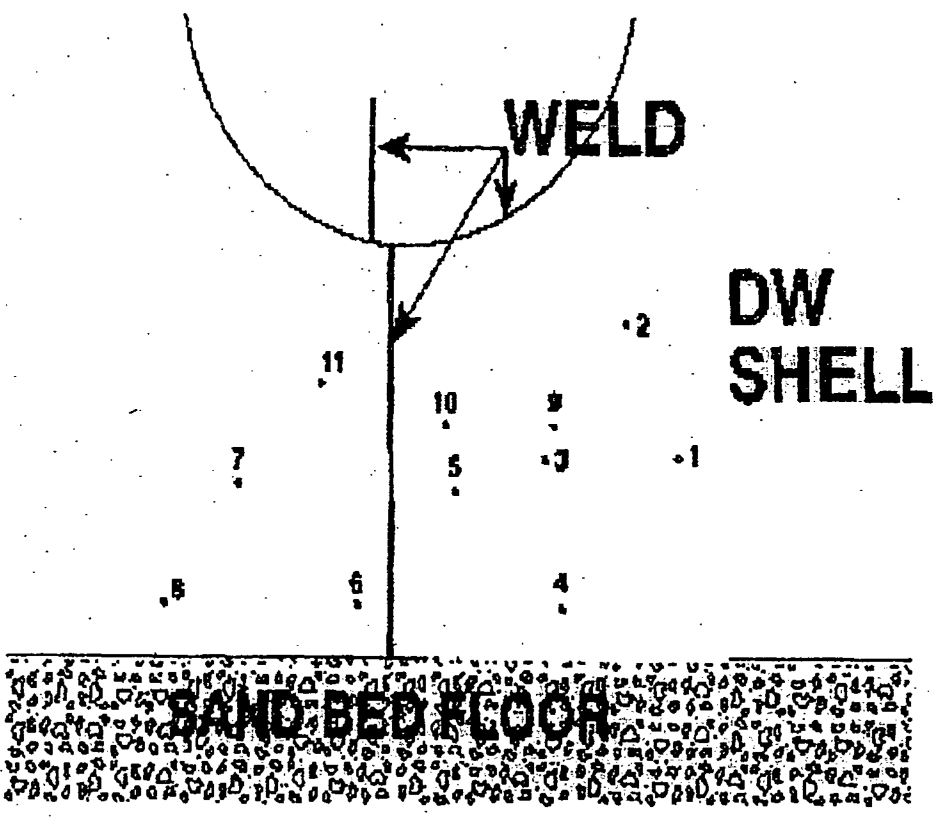



FIGURE (17)

**UT EVALUATION BAY #19:**

The outside surface of this bay is rough and very similar to bay 17. Locations 1 through 7 as shown in Table 19, were ground carefully to minimize loss of good metal. The shell surface is full of dimples comparable to the outside surface of a golf ball. This observation is made by the inspector who located the thinnest areas for the UT examination. The shell appears to be relatively uniform in thickness. Ten locations were selected to represent the thinnest areas based on the visual observations of the shell surface (Fig. 19). These locations are a deliberate attempt to produce a minimum measurement. Table 19 shows readings taken to measure the thicknesses of the drywell shell using a D-meter. The results indicate that all of the areas have thickness greater than the 0.736 inches.

**Bay #19 General Wall (Sandbed Region) Thickness Evaluation**

Given an average of the UT measurements presented in Table 19 is equal to 0.885 inches, a conservative mean evaluation thickness of 0.850 inches is estimated for this bay. Therefore, it is concluded that the bay is acceptable based on the bay evaluation thickness exceeding the buckling design thickness for the sandbed region of 0.736 inches using the results of Reference 3.3.

**Bay # 19 UT Data**
**Table 19**

| Location | D-Meter UT Measurement (inches) | Appendix D on Calculation Page | Average Micrometer (inches) |
|---|---|---|---|
| 1 | 0.932 | 109 | --- |
| 2 | 0.924 | 109 | --- |
| 3 | 0.955 | 109 | --- |
| 4 | 0.940 | 109 | --- |
| 5 | 0.950 | 109 | --- |
| 6 | 0.860 | 109 | --- |
| 7 | 0.969 | 109 | --- |
| 8 | 0.753 | 108 | --- |
| 9 | 0.776 | 108 | --- |
| 10 | 0.790 | 108 | --- |

## GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 48 of 117 |
| **Originator** | **Date** | **Reviewed by** | | **Date** |
| Mark Yekta | 01/12/93 | S. C. Tumminelli | | |

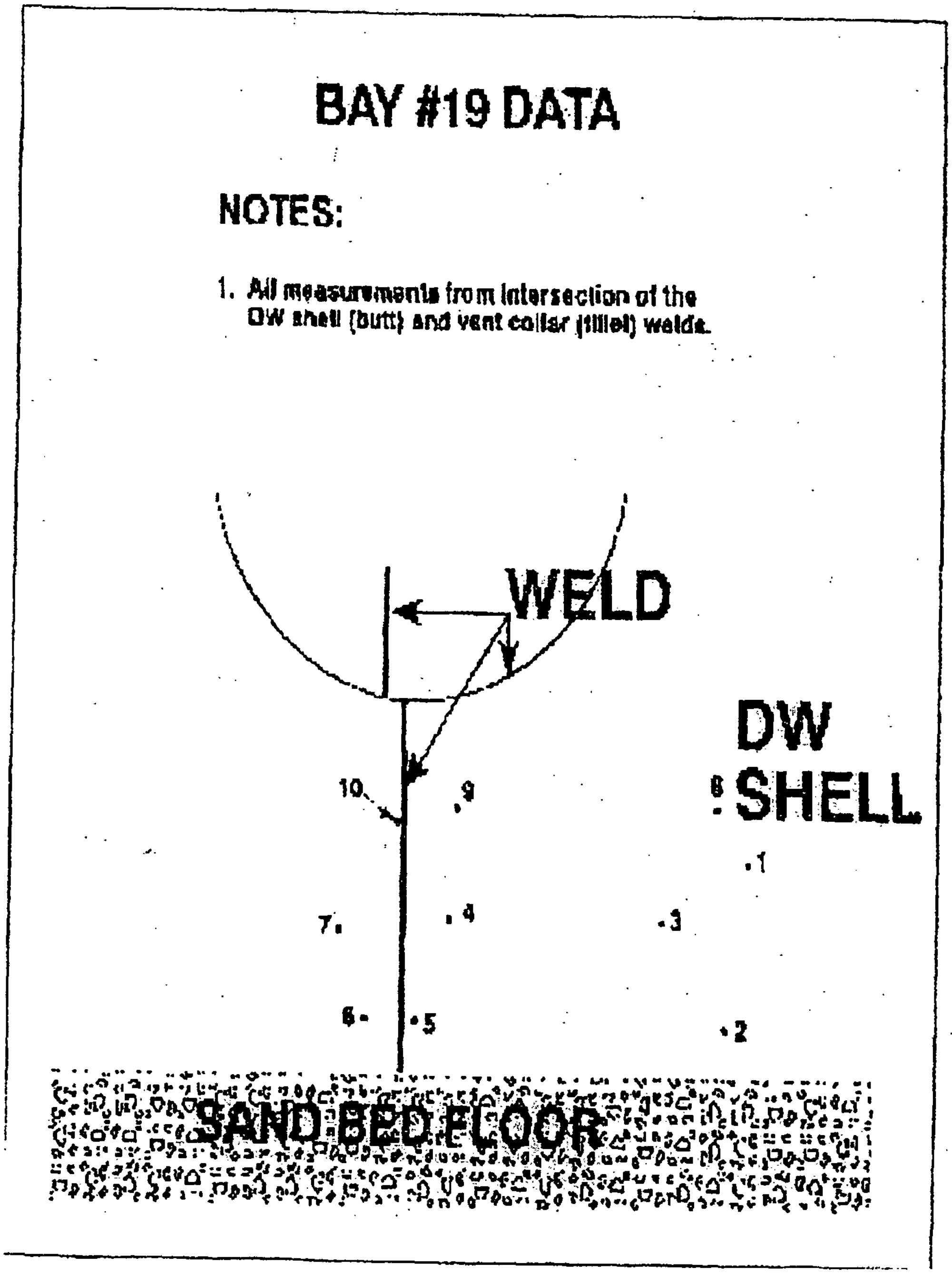



FIGURE (19)

Appendix A: Summary Of Measurements Of Impressions Taken From Bay #13 (3 pages total)

The purpose of this appendix is to characterize the depth of typical uniform dimples on the shell surface. This depth is used in acceptance criteria to quantify the evaluation thickness for an area where the micrometer readings are available.

Two locations in bay 13 were selected since bay 13 is the roughest bay. Impressions of drywell shell surface using DMR_503 Epoxy Replication Putty manufactured by Dyna Mold Inc were made. These impressions were about 10 inches in diameter and about 1 inch thick. The UT locations 7 and 10 in bay 13 were identified in each of these impression as the reference points. This is a positive impression of the drywell shell surface. The depth of the typical dimples were measured as follows;

| **READING** (Location) | **DEPTH #10** (inches) | **DEPTH #7** inches) |
|---|---|---|
| 1 | 0.150 | 0.075 |
| 2 | 0.000 | 0.110 |
| 3 | 0.200 | 0.135 |
| 4 | 0.140 | 0.200 |
| 5 | 0.150 | 0.000 |
| 6 | 0.040 | 0.000 |
| 7 | 0.150 | 0.170 |
| 8 | 0.010 | 0.205 |
| 9 | 0.134 | —— |
| 10 | 0.145 | 0.145 |
| 11 | 0.118 | 0.064 |
| 12 | 0.105 | 0.200 |
| 13 | 0.125 | 0.045 |
| 14 | 0.200 | 0.180 |
| 15 | 0.135 | 0.105 |
| 16 | 0.100 | —— |
| 17 | 0.175 | 0.035 |
| 18 | 0.175 | 0.015 |
| 19 | 0.155 | 0.190 |
| 20 | 0.175 | 0.055 |
| 21 | 0.175 | 0.305 |
| 22 | —— | 0.135 |

Location #10:

| | | |
|---|---|---|
| Mean Value | = | 0.131 |
| Standard Deviation | = | 0.055 |
| Mean Value + One S.D. | = | 0.186 |

Location #7:

| | | |
|---|---|---|
| Mean Value | = | 0.118 |
| Standard Deviation | = | 0.082 |
| Mean Value + One S.D. | = | 0.200 |

Therefore, a value of 0.200 inches was used as the depth of uniform dimples for the entire outside surface of the drywell in the sandbed region.

Appendix B: Buckling Capacity Evaluation For Varying Uniform Thickness Through The Whole Sandbed Region Of The Drywell (5 pages total)

Based Upon GE Buckling Analysis (Reference 3.3)

**Note: Tables on sheets 53 to 56 are not used in this calculation and are provided for historical purpose only from Rev. 0.**

CALCULATION OF BUCKLING MARGIN - REFUELING CASE, NO SAND - GE OYCR1S&T - UNIFORM THICKNESS t=0.736 Inch

| ITEM | PARAMETER | UNITS | VALUE | LOAD FACTOR |
|---|---|---|---|---|
| | *** DRYWELL GEOMETRY AND MATERIALS | | | |
| 1 | Sphere Radius, R | (in.) | 420 | |
| 2 | Sphere Thickness, t | (in.) | 0.736 | |
| 3 | Material Yield Strength, Sy | (ksi) | 38 | |
| 4 | Material Modolus of Elasticity, E | (ksi) | 29600 | |
| 5 | Factor of Safety, FS | | 2 | |
| | *** BUCKLING ANALYSIS RESULTS | | | |
| 6 | Theoretical Elastic Instability Stress, Ste | (ksi) | 46.590 | 6.140 |
| | ***STRESS ANALYSIS RESULTS | | | |
| 7 | Applied Meridional Compressive Stress, Sm | (ksi) | 7.588 | 5.588 |
| 8 | Applied Circumferential Tensile Stress, Sc | (ksi) | 4.510 | 3.300 |
| | *** CAPACITY REDUCTION FACTOR CALCULATION | | | |
| 9 | Capacity Reduction Factor, ALPHAI | | 0.207 | |
| 10 | Circumferential Stress Equivalent Pressure, Peq | (psi) | 15.806 | |
| 11 | 'X' Parameter, X= (Peq/8E) (d/t)^2 | | 0.087 | |
| 12 | Delta C (From Figure - ) | - | 0.072 | |
| 13 | Modified Capacity Reduction Factor, ALPHA,1, mod | | 0.326 | |
| 14 | Reduced Elastic Instability Stress, Se | (ksi) | 15.182 | 2.001 |
| | *** PLASTICITY REDUCTION FACTOR CALCULATION | | | |
| 15 | Yield Stress Ratio, DELTA=Se/Sy | | 0.400 | |
| 16 | Plasticity Reduction Factor, NUi | | 1.000 | |
| 17 | Inelastic Instability Stress, Si = NUi x Se | (ksi) | 15.182 | 2.001 |
| | *** ALLOWABLE COMPRESSIVE STRESS CALCULATION | | | |
| 18 | Allowable Compressive Stress, Sall = SI/FS | (ksi) | 7.591 | 1.000 |
| 19 | Compressive Stress Margin, M-(Sall/Sm -1) x 100% | (%) | 0.0 | |

# GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 54 of 117 |
| **Originator** | **Date** | **Reviewed by** | | **Date** |
| Mark Yekta | 01/12/93 | S. C. Tumminelli | | |

CALCULATION OF BUCKLING MARGIN - REFUELING CASE, NO SAND -
GE OYCRFST01 - UNIFORM THICKNESS t= 0.776 Inch

| ITEM | PARAMETER | UNITS | VALUE | LOAD FACTOR |
|---|---|---|---|---|
| | *** DRYWELL GEOMETRY AND MATERIALS | | | |
| 1 | Sphere Radius, R | (in.) | 420 | |
| 2 | Sphere Thickness, t | (in.) | 0.776 | |
| 3 | Material Yield Strength, Sy | (ksi) | 38 | |
| 4 | Material Modolus of Elasticity, E | (ksi) | 29600 | |
| 5 | Factor of Safety, FS | | 2 | |
| | *** BUCKLING ANALYSIS RESULTS | | | |
| 6 | Theoretical Elastic Instability Stress, Ste | (ksi) | 49.357 | 6.857 |
| | ***STRESS ANALYSIS RESULTS | | | |
| 7 | Applied Meridional Compressive Stress, Sm | (ksi) | 7.198 | 5.588 |
| 8 | Applied Circumferential Tensile Stress, Sc | (ksi) | 4.248 | 3.300 |
| | *** CAPACITY REDUCTION FACTOR CALCULATION | | | |
| 9 | Capacity Reduction Factor, ALPHAI | | 0.207 | |
| 10 | Circumferential Stress Equivalent Pressure, Peq | (psi) | 15.697 | |
| 11 | 'X' Parameter, X= (Peq/8E) (d/t)^2 | | 0.078 | |
| 12 | Delta C (From Figure - ) | - | 0.066 | |
| 13 | Modified Capacity Reduction Factor, ALPHA,1, mod | | 0.316 | |
| 14 | Reduced Elastic Instability Stress, Se | (ksi) | 15.583 | 2.165 |
| | *** PLASTICITY REDUCTION FACTOR CALCULATION | | | |
| 15 | Yield Stress Ratio, DELTA=Se/Sy | | 0.410 | |
| 16 | Plasticity Reduction Factor, NUi | | 1.000 | |
| 17 | Inelastic Instability Stress, Si = NUi x Se | (ksi) | 15.183 | 2.165 |
| | *** ALLOWABLE COMPRESSIVE STRESS CALCULATION | | | |
| 18 | Allowable Compressive Stress, Sall = SI/FS | (ksi) | 7.592 | 1.082 |
| 19 | Compressive Stress Margin, M-(Sall/Sm -1) x 100% | (%) | 8.2 | |

## GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 55 of 117 |
| **Originator** Mark Yekta | **Date** 01/12/93 | **Reviewed by** S. C. Tumminelli | | **Date** |

CALCULATION OF BUCKLING MARGIN - REFUELING CASE, NO SAND -
GPUN EVALUATION FOR UNIFORM THICKNESS t=0.800 Inch USING THICKNESS RATIO

| ITEM | PARAMETER | UNITS | VALUE | LOAD FACTOR |
|---|---|---|---|---|
| | *** DRYWELL GEOMETRY AND MATERIALS | | | |
| 1 | Sphere Radius, R | (in.) | 420 | |
| 2 | Sphere Thickness, t | (in.) | 0.800 | |
| 3 | Material Yield Strength, Sy | (ksi) | 38 | |
| 4 | Material Modolus of Elasticity, E | (ksi) | 29600 | |
| 5 | Factor of Safety, FS | | 2 | |
| | *** BUCKLING ANALYSIS RESULTS | | | |
| 6 | Theoretical Elastic Instability Stress, Ste | (ksi) | 50.884 | 7.288 |
| | ***STRESS ANALYSIS RESULTS | | | |
| 7 | Applied Meridional Compressive Stress, Sm | (ksi) | 6.982 | 5.588 |
| 8 | Applied Circumferential Tensile Stress, Sc | (ksi) | 4.120 | 3.300 |
| | *** CAPACITY REDUCTION FACTOR CALCULATION | | | |
| 9 | Capacity Reduction Factor, ALPHAI | | 0.207 | |
| 10 | Circumferential Stress Equivalent Pressure, Peq | (psi) | 15.697 | |
| 11 | 'X' Parameter, X= (Peq/8E) (d/t)^2 | | 0.073 | |
| 12 | Delta C (From Figure - ) | - | 0.063 | |
| 13 | Modified Capacity Reduction Factor, ALPHA,1, mod | | 0.311 | |
| 14 | Reduced Elastic Instability Stress, Se | (ksi) | 15.824 | 2.266 |
| | *** PLASTICITY REDUCTION FACTOR CALCULATION | | | |
| 15 | Yield Stress Ratio, DELTA=Se/Sy | | 0.416 | |
| 16 | Plasticity Reduction Factor, NUi | | 1.000 | |
| 17 | Inelastic Instability Stress, Si = NUi x Se | (ksi) | 15.824 | 2.266 |
| | *** ALLOWABLE COMPRESSIVE STRESS CALCULATION | | | |
| 18 | Allowable Compressive Stress, Sall = SI/FS | (ksi) | 7.912 | 1.133 |
| 19 | Compressive Stress Margin, M-(Sall/Sm -1) x 100% | (%) | 13.3 | |

## GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 56 of 117 |
| **Originator** Mark Yekta | **Date** 01/12/93 | **Reviewed by** S. C. Tumminelli | | **Date** |

CALCULATION OF BUCKLING MARGIN - REFUELING CASE, NO SAND -
GPUN EVALUATION FOR UNIFORM THICKNESS t= 0.850 Inch USING THICKNESS RATIO

| ITEM | PARAMETER | UNITS | VALUE | LOAD FACTOR |
|---|---|---|---|---|
| | *** DRYWELL GEOMETRY AND MATERIALS | | | |
| 1 | Sphere Radius, R | (in.) | 420 | |
| 2 | Sphere Thickness, t | (in.) | 0.850 | |
| 3 | Material Yield Strength, Sy | (ksi) | 38 | |
| 4 | Material Modolus of Elasticity, E | (ksi) | 29600 | |
| 5 | Factor of Safety, FS | | 2 | |
| | *** BUCKLING ANALYSIS RESULTS | | | |
| 6 | Theoretical Elastic Instability Stress, Ste | (ksi) | 54.063 | 8.227 |
| | ***STRESS ANALYSIS RESULTS | | | |
| 7 | Applied Meridional Compressive Stress, Sm | (ksi) | 6.571 | 5.588 |
| 8 | Applied Circumferential Tensile Stress, Sc | (ksi) | 3.878 | 3.300 |
| | *** CAPACITY REDUCTION FACTOR CALCULATION | | | |
| 9 | Capacity Reduction Factor, ALPHAI | | 0.207 | |
| 10 | Circumferential Stress Equivalent Pressure, Peq | (psi) | 15.697 | |
| 11 | 'X' Parameter, X= (Peq/8E) (d/t)^2 | | 0.065 | |
| 12 | Delta C (From Figure - ) | - | 0.057 | |
| 13 | Modified Capacity Reduction Factor, ALPHA,1, mod | | 0.300 | |
| 14 | Reduced Elastic Instability Stress, Se | (ksi) | 16.257 | 2.474 |
| | *** PLASTICITY REDUCTION FACTOR CALCULATION | | | |
| 15 | Yield Stress Ratio, DELTA=Se/Sy | | 0.428 | |
| 16 | Plasticity Reduction Factor, NUi | | 1.000 | |
| 17 | Inelastic Instability Stress, Si = NUi x Se | (ksi) | 16.257 | 2.474 |
| | *** ALLOWABLE COMPRESSIVE STRESS CALCULATION | | | |
| 18 | Allowable Compressive Stress, Sall = SI/FS | (ksi) | 8.128 | 1.237 |
| 19 | Compressive Stress Margin, M-(Sall/Sm -1) x 100% | (%) | 23.7 | |

Appendix C: Pictures Showing Condition Of The Drywell In The Sandbed Region (9 pages total)

Sand Bed Region - Typical condition found on initial entry.

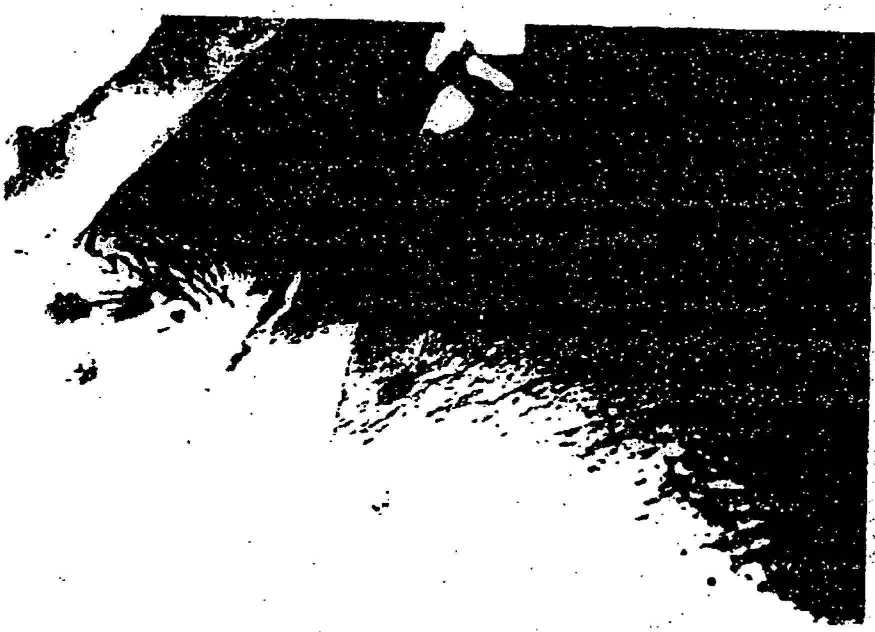
Corrosion product on drywell vessel


Bay #13 - D/W shell showing plug . The plug is located in the middle of the worst corroded area of the shell The plug showed no sign of corrosion.


Bay #13 - D/W shell showed less prominent "Tub Ring" than what was seen in other

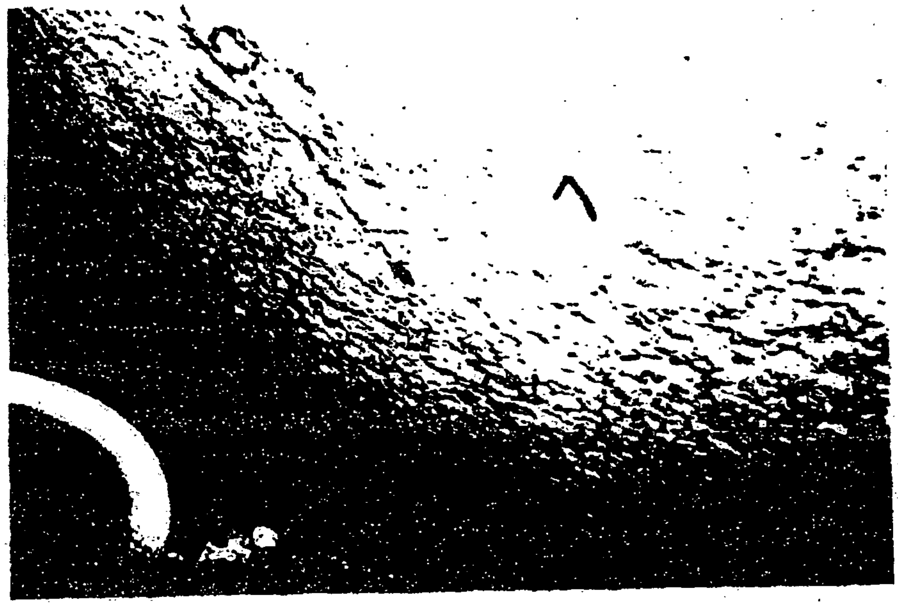
Bay #1 - Looking at the worst corroded area on shell near vent tube collar/ring. The ground spots seen here correspond to UT spot 20:2: 2:3

Bay #13 - Lower Mid portion of the D/W shell showing UT spot 5.6 and 10. This close up photo shows the roughness of the corroded surface and how each UT spot has been picked up in the deep valleys thereby biasing the remaining wall readings to the conservative side

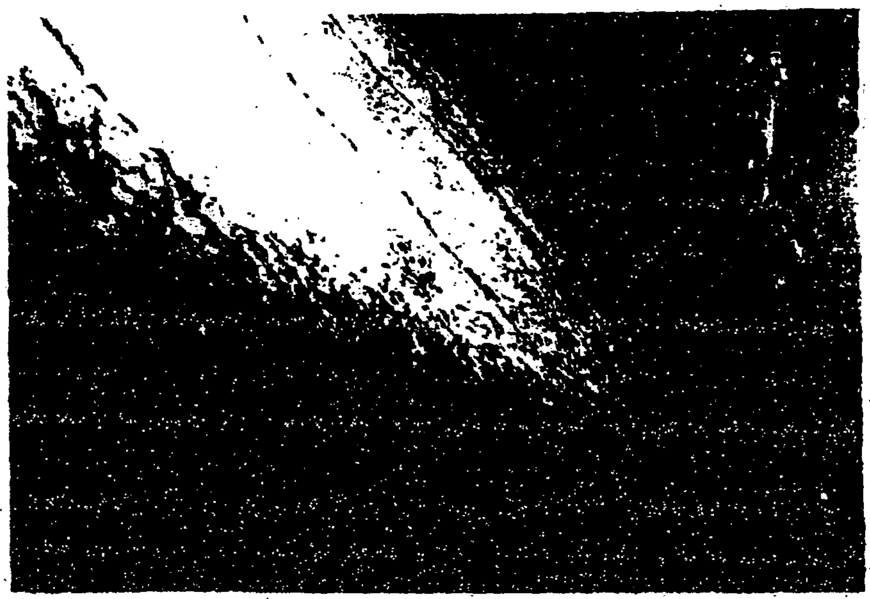


Bay #13 - Looking towards Bay#11 - Upper right corner of D/W shell. Note (1) - Grinding depth on UT spot #1 & 2, (2) - A part of "Bath Tub Ring" as delineated by marking and (3) locations of UT spots 3,4,13 & 17. The photo on right (although blurred by flash reflection) shows 1/8" projection of plug.

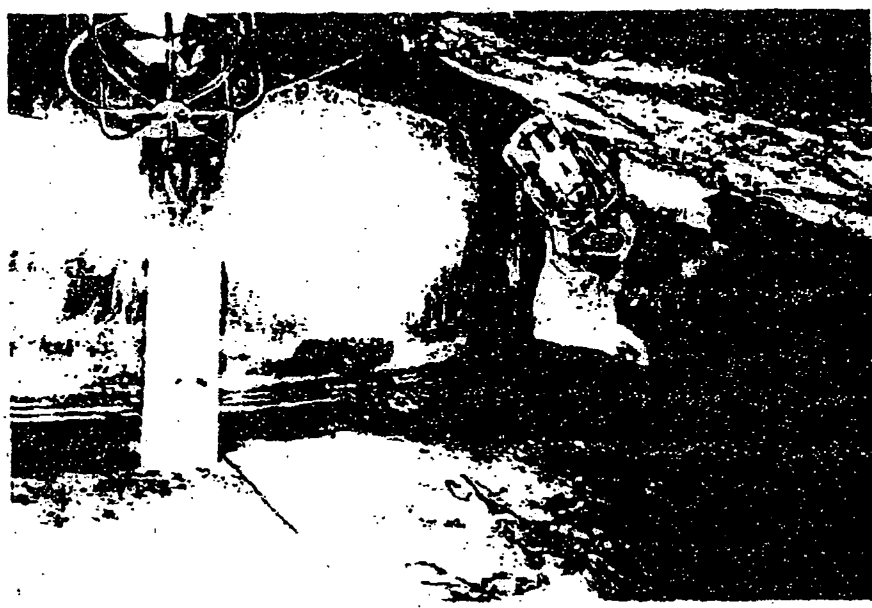
Bay #15 Looking towards **Bay#17** which has been closed with foam for coating work in Bay #17. Note the typical surface of the D.W shell and localized corroded spot



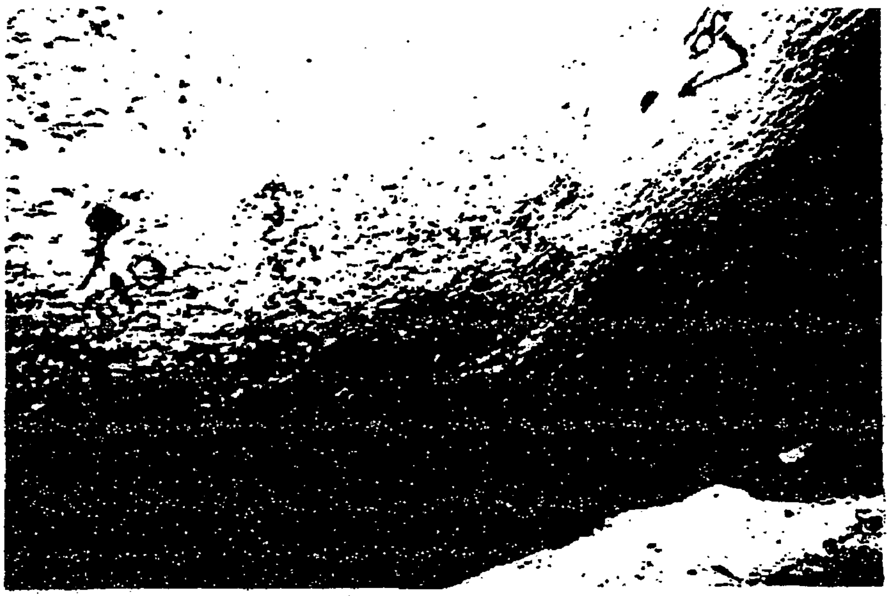
**Bay #13** - Looking toward Bay #15 - Lower left corner showing UT spot #7,12 & 16. This close up has captured the peaks and valleys of the corroded shell in vivid detail. Later NDE inspection revealed [illegible] between peaks and valleys in the 0.25" - 0.40"



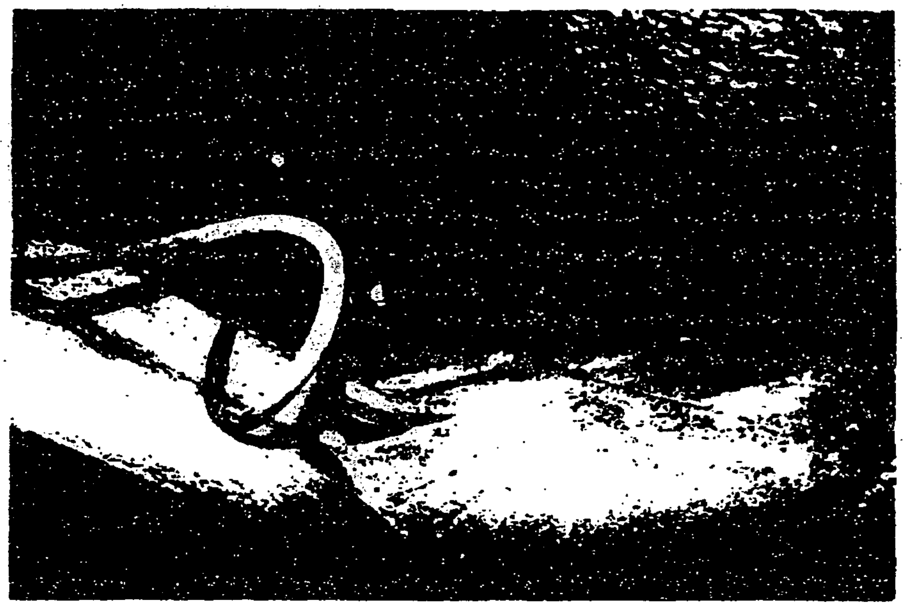
**Bay #15** Looking toward **Bay #13** showing portions of D/W shell and concrete floor, after removal of loose debris / sand / rust. The concrete floor in this bay is one of the better ones. However - Note ① no drainage channel and ② cratered holes near shell corner



**Bay #15** - Note the original lead primer on vent tube OD surface. The "Tub Ring" was less prominent on the shell in this bay except a portion in lower left corner. Also note presence of lead primer on vent collar/ring plate.



**Bay #13** Looking toward **Bay #11** - Lower right corner of D/W shell showing UT spots 9, 10, 18 & 19 Note the location of these spots - all are located in the valleys of the corroded surface This photo also shows the condition of the concrete floor. It appears



**Bay #13** - Looking toward **Bay #15** - This photo captures the concrete floor condition and a portion of lower shell corroded surface in very great detail. The floor in this area

Finished floor, vessel with two top coats - caulking material applied.

Drain after floor has been refurbished

Appendix D: NDE Inspection Sheets for the Drywell Sandbed Region (52 pages total)

## GPU Nuclear — NDE Request, Oyster Creek

QC Charge No. 5514-57307 Request No. 92-075

**1 — To be filled in by Requestor**

| Job Order No. | Short Form No. | BA No. 322295 | Date of Request |
|---|---|---|---|

Job Description: UT THICKNESS OF D/W LINER

System:

Job Location: SAND BED AREA

Applicable Code/Specification: [illegible]

Type of NDE requested:

- ☐ Visual ☐ Liquid Penetrant ☐ Eddy Current ☒ Ultrasonic
- ☐ Leakage ☐ Magnetic Particle ☐ Alloy Separator ☐ Acoustic Emissions
- ☐ Video ☐ Radiographic ☐ Ferrite

| NDE Requested by: J SLITER FOR | Phone No.: | Date 12-[illegible] |
|---|---|---|

Remarks: JOHN FLYNN

**2 — To be filled in by NDE Coordinator**

NDE Coordinator: J SLITER Date:

Instructions:

| UT | PT | MT | RT | VT | ET |
|---|---|---|---|---|---|
| ☒ 0° | Type | Dry | Isotope | ☐ Direct | ☐ Probe |
| ☐ 45° | ☐ A-1 | ☐ Red | ☐ Ir¹⁹² | ☐ Weld Insp | ☐ Double |
| ☐ 60° | ☐ A-2 | ☐ Black | ☐ Co⁶⁰ | INDIRECT/VIDEO | ☐ Single |
| ☐ 70° | ☐ A-3 | ☐ Grey | X-Ray | ☐ Mirror | ☐ Coil |
| ☐ Other | ☐ B-1 | ☐ Other | ☐ 150 KV | ☐ Boroscope | ☐ Double |
| ☐ Acoustic Emissions | ☐ B-2 | Wet | ☐ 250 KV | ☐ Fiberoptic | ☐ Single |
| | ☐ B-3 | ☐ Black | | ☐ Binocular | ☐ Alloy Sep. |
| | | ☐ Flourescent | | ☐ Camera | ☐ Ferrite |

Remarks:

| Results | MNCR #'s open/close/cond. rel. | Proc. No. |
|---|---|---|
| ☒ Accept / Reject / Only | N/A | Proc. No. / Proc. No. |

| Job start date | Job stop date |
|---|---|

| NDE Coordinator | Date Closed [illegible] | Date to DCC |
|---|---|---|

Yellow - Originator Final Copy Gold - Originators Initial Copy N60892 (03-87)
Pink - NDE Field Work Copy

GPU Nuclear

Oyster Creek - QC

NDE/ISI Report Log

Page ____ of ____

NDE Req. #: 92-072

Test: ☐ PT ☐ MT ☒ VT ☐ RT ☐ UT ☐ ______

System/Location: ______

Item: ______

| Report # | Test Type | Date of Test | Results: Acc | Results: Rej | Results: Recordable | Remarks: |
|---|---|---|---|---|---|---|
| 92-072-21 | UT | 1-8-93 | | | | BAY 15 |
| 92-072-22 | UT | 1-7-93 | | | | BAY 9 |
| 92-072-23 | UT | 1/8/93 | | | | BAY 13 |
| 92-072-24 | UT | 1-11-93 | | | | BAY 13 |
| 92-072-25 | UT | 1-11-93 | | | | BAY 13 |
| 92-072-26 | UT | 1-11-93 | | | | BAY 13 |
| 92-072-27 | VT | 1-11-93 | | | | BAY 13 DEPTH GAUGE |
| 92-072-28 | VT | 1-12-93 | | | | BAY 1 DEPTH GAUGE |
| 92-072-29 | VT | 1-12-93 | | | | BAY 17 DEPTH GAUGE |
| 92-072-30 | VT | 1-12-93 | | | | BAY 15 DEPTH GAUGE |
| 92-072-31 | VT | 1-12-93 | | | | BAY 11 DEPTH GAUGE |

Form ID 6123ADM 7230.01-2 (8 82)

A0001537

**GPU Nuclear**

Oyster Creek - QC

NDE/ISI Report Log

Page ____ of ____

NDE Req. #: 92-072

Test: ☐ PT ☐ MT ☐ VT ☐ RT ☒ UT ☐ ______

System/Location: DW LINER SANDBED

Item: ______

| Report # | Test Type | Date of Test | Results: Acc | Results: Rej | Results: Recordable | Remarks: |
|---|---|---|---|---|---|---|
| 92-072-01 | UT | 12-5-92 | | | | BAY 17 |
| 92-072-02 | UT | 12-5-92 | | | | BAY 19 |
| 92-072-03 | UT | 12-14-92 | | | | BAY 19 |
| 92-072-04 | UT | 12-14-92 | | | | BAY 17 |
| 92-072-05 | UT | 12-14-92 | | | | BAY 19 |
| 92-072-06 | UT | 12-14-92 | | | | BAY 17 |
| 92-072-07 | UT | 12-11-92 | | | | BAY 19 |
| 92-072-08 | UT | 12-11-92 | | | | BAY 17 |
| 92-072-09 | UT | 12-22-92 | | | | BAY 11 |
| 92-072-10 | UT | 12-22-92 | | | | BAY 11 |
| 92-072-11 | VT | 12-16-92 | | | | OVERLAY PLATE |
| 92-072-12 | UT | 1-2-93 | | | | BAY 1 |
| 92-072-13 | UT | 1-2-93 | | | | BAY 1 |
| 92-072-14 | UT | 1-2-93 | | | | BAY 3 |
| 92-072-15 | UT | 1-2-93 | | | | BAY 3 |
| 92-072-16 | UT | 1-2-93 | | | | BAY 5 |
| 92-072-17 | UT | 1-2-93 | | | | BAY 5 |
| 92-072-18 | UT | 1-4-93 | | | | BAY 1 |
| 92-072-19 | UT | 1-5-93 | | | | BAY 1 |
| 92-072-20 | UT | 1-8-93 | | | | BAY 7 |

Form ID 6133ADM 7230 01.2 (6 82) A000 1537

| Program | Xducer | Screen | Digital |
|---|---|---|---|
| 1 | 5 mhz 3/4" Single H31900 (SP) | 2" | 2" |
| 2 | 2.25 mhz 3/4" Single F28932 | 2" | 2" |
| 3 | 2 mhz MSEB MC8524 | 2" | 2" |
| 4 | 5 mhz bubbler water delay | 2" delayed | 2" delayed |
| 5 | 5 mhz bubbler water delay | 2" SYNC. SCREEN | NONE |
| 6 | 5 mhz bubbler water delay | 2" SYNC. SCREEN | 2" |
| 7 | 5 mhz 3/4" single H31900(SP) | 1" | 1" |
| 8 | 2 mhz MSEB MC8524 | 1" | 1" |
| 9 | 5 mhz 1/4" delay GO0504 single | 2" | NONE |
| 10 | 5 mhz 1/4" dual O14252 | 1" | 1" |
| 11 | 5 mhz 1/4" dual O14252 | 2" | 2" |

Jamie. For your info. [signature]

**GPU Nuclear** — **Ultrasonic Thickness Data Sheet**

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A | Item: N/A | NDE Request: 92-072 | Data Sheet No.: 92-072-12 |
| Task Description: UT Thickness | | Task No.: N/A | Date: 1/2/93 |
| Comp. Desc.: Drywell Liner | System: 187 | Code/Spec.: ENG. INFO. R. | |
| Procedure/Rev.: 6100-QAP-7209.07 Rev 0 | Drawing No./Rev.: 3E-187-29-001 Rev 0 | | |
| Test Surface: O.D. | Thickness: 1 1/8" | Material: C/S | |
| Examiner Sign: [signature] | Print: J. VanderLinde | ID No.: 154-48-0318 | Level: II |
| Examiner Sign: [signature] | Print: Mark F. Bagnell | ID No.: 553-[illegible] | Level: I |

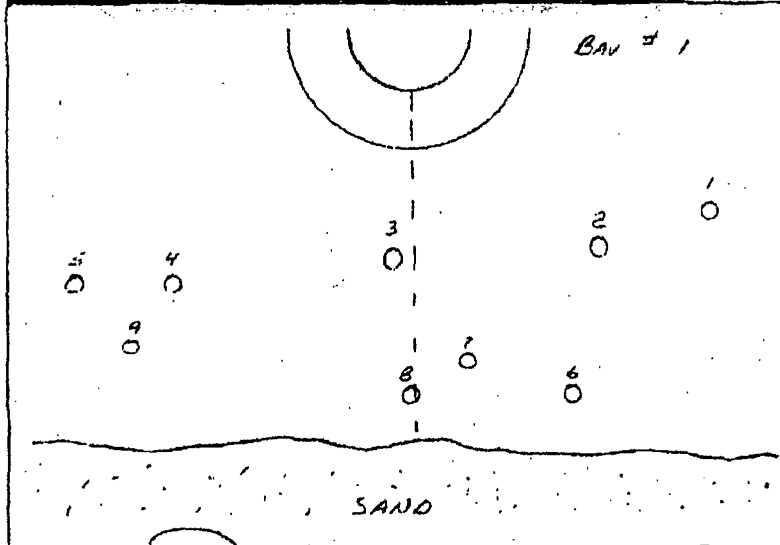
Thermometer S/N 88-081 Part Temperature 22 F D-Meter S/N 92-035
Cal. Blk. S/N 214 Cal. In: N/A AM 21:51 PM
Cal. Blk. Temp. 22 F Cal. Out: N/A AM 22:15 PM

**Calibration Readings (Inches)**

| Cal. Blk. | .5 | .75 | 1.0 | 1.25 | 1.5 | N/A |
|---|---|---|---|---|---|---|
| D-Meter | .5 | .75 | 1.0 | 1.25 | 1.5 | |

**Techniques**: ☐ CRT ☒ D-Meter Other N/A

**Position #/Reading in Inches**




**Drawing**

| | AREA | | MEASUREMENT |
|---|---|---|---|
| 1 | 0-16' | R 30' | .720" |
| 2 | 0-22' | R 17' | .710" |
| 3 | 0-23' | L 3' | .705" |
| 4 | 0-24' | L 33' | .700" |
| 5 | 0-24' | L 45' | .710" |
| 6 | 0-48' | R 16' | .900" |
| 7 | 0-39 | R 5' | .700" |
| 8 | 0-46' | 0' | [illegible] |
| 9 | 0-36' | L 36' | .605" |

Reviewed by: [signature] Level: III Date: 1-3-93 Page 1 of 91

# GPU Nuclear

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 72 of 117 |

| Originator | Date | Reviewed by | Date |
|---|---|---|---|
| Mark Yekta | 01/12/93 | S. C. Tumminelli | |

## GPU Nuclear — Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A | Item: N/A | NDE Request: 92-072 | Data Sheet No.: 92-072-13

Task Description: UT Thickness | Task No.: N/A | Date: 1/2/93

Comp. Desc.: Drywell Liner | System: 187 | Code/Spec.: ENG INFO

Procedure/Rev.: 6100-QAP-7209.07 Rev. 0 | Drawing No./Rev.: 3E-187-29-001 Rev. 0

Test Surface: O.D. | Thickness: 1 1/8" | Material: C/S

| Examiner | Sign: | Print: J. VanDer Linde | ID No.: 154-48-0318 | Level: II |
|---|---|---|---|---|
| Examiner | Sign: | Print: Mark F. Bagnell | ID No.: 553-61-1862 | Level: I |

Thermometer S/N 88-081 Part Temperature 72 F D-Meter S/N 137-113

Cal. Blk. S/N 214 Cal. In: N/A AM 21:51 PM

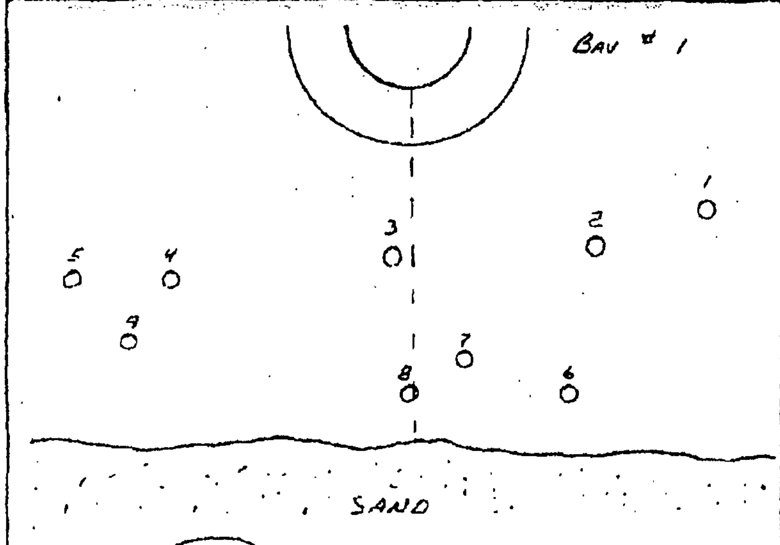
Cal. Blk. Temp. 72 F Cal. Out: N/A AM 22:15 PM

**Calibration Readings (Inches)**

| | | | | | | |
|---|---|---|---|---|---|---|
| Cal. Blk. | .5 | .75 | 1.0 | 1.25 | 1.5 | N/A |
| D-Meter | .5 | .75 | 1.0 | 1.25 | 1.5 | |

Techniques: ☒ CRT ☐ D-Meter Other N/A

**Position #/Reading In Inches**




Drawing

| | AREA | | MEASUREMENT |
|---|---|---|---|
| 1 | 0-16' | R 30' | [illegible] |
| 2 | 0-22' | R 17' | .716 |
| 3 | 0-23' | L 3' | [illegible] |
| 4 | 0-24' | L 33' | [illegible] |
| 5 | 0-24' | L 45' | [illegible] |
| 6 | 0-48' | R 16' | [illegible] |
| 7 | 0-39' | R 5' | [illegible] |
| 8 | 0-46' | 0' | [illegible] |
| 9 | 0-36' | L 38' | [illegible] |

Reviewed by: | Level: III | Date: 1-3-93 | Page 21 of 91

## GPU Nuclear

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 73 of 117 |
| **Originator:** Mark Yekta — **Date:** 01/12/93 | **Reviewed by:** S. C. Tumminelli | | **Date** |

2 Points under

GPU Nuclear

### Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A | Item: N/A | NDE Request: 92-072 | Data Sheet No. 92-072-18 |
| Task Description: UT THICKNESS | | Task No.: N/A | Date: 1-4-93 |
| Comp. Desc.: DRYWELL LINER Bay 1 | System: 187 | | Code/Spec.: ENG. INFO. |
| Procedure/Rev.: 6100-QAP-7209.07 REV. 0 | | Drawing No./Rev.: 3E-187-29-001 | |
| Test Surface: O.D. | | Thickness: 1 1/8" | Material: C.S. |
| Examiner Sign: [signature] | Print: [illegible] | ID No.: [illegible] | Level: II |
| Examiner Sign: [signature] | Print: Mark F. Bagnell | ID No.: 553-61-1602 | Level: I |

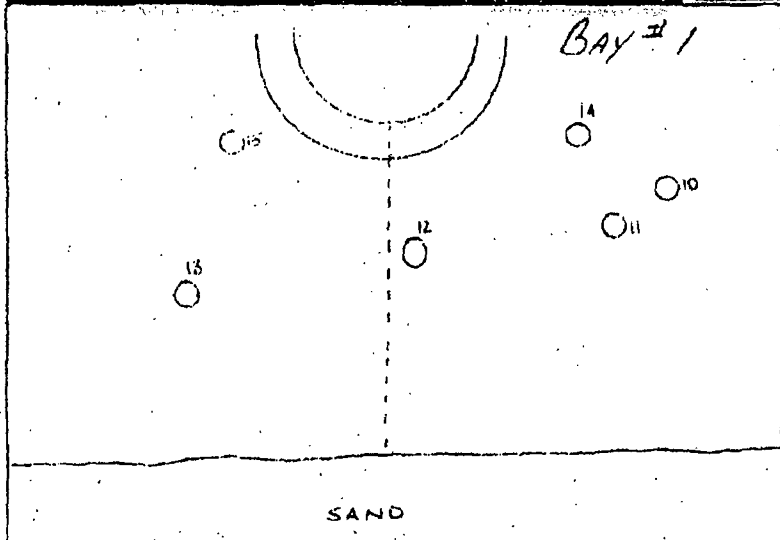
Thermometer S/N 92-068 Part Temperature 76° F D-Meter S/N 92-056
Cal. Blk. S/N INV 219 Cal. In: N/A AM 23:11 PM
Cal. Blk. Temp. 76° F Cal. Out: N/A AM 23:21 PM

**Calibration Readings (inches)**

| Cal. Blk. | .5 | .75 | 1.0 | 1.25 | 1.5 | N/A |
|---|---|---|---|---|---|---|
| D-Meter | .5 | .75 | 1.0 | 1.25 | 1.5 | N/A |

**Techniques:** ☐ CRT ☒ D-Meter Other N/A

**Position #/Reading in Inches**




**Drawing**

| | AREA | | MEASUREMENT |
|---|---|---|---|
| 10 | D 16" | R 23" | .853" |
| 11 | D 23" | R 12" | .711" |
| 12 | D 24" | L 5" | .724" |
| 13 | D 24" | L 40" | .792" |
| 14 | D 2" | R 32" | 1.047" |
| 15 | D 8" | L 51" | 1.156" |

NOTE: ADDITIONAL READINGS TAKEN FOR CONFORMATION OF PREVIOUS INSPECTION

Reviewed by: [signature] Level: II Date: 1-5-93 Page 1 of 1

OCLR00014610

# GPU Nuclear

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 74 of 117 |

| Originator | Date | Reviewed by | Date |
|---|---|---|---|
| Mark Yekta | 01/12/93 | S. C. Tumminelli | |

GPU Nuclear

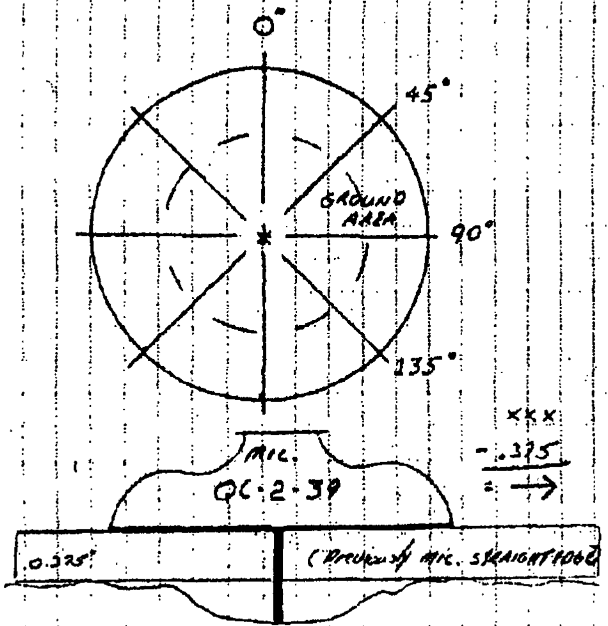
☒ OC ☐ TMI ☐ OTHER ________

**Sketch Form (with grid)**

Component: DRYWELL liner Sandbed AREA
Data Sheet No.: 92-072-28

Location: BAY # 1
Drawing No.: N/A Rev.: N/A

Drawing




Technique utilized for The pit depth MEASUREMENTS

AZIMUTH

| AREA | 0° | 45° | 90° | 135° |
|---|---|---|---|---|
| 1 | .272 | .204 | .206 | .185 |
| 2 | .143 | .137 | .143 | .154 |
| 3 | .377 | .316 | .* | .329 |
| 5 | .330 | .290 | .304 | .330 |
| 7 | .208 | .281 | .246 | .330 |
| 11 | .200 | .211 | .225 | .211 |
| 12 | .279 | .314 | .261 | .328 |
| 21 | .222 | .202 | .238 | .183 |

* VALLEY FROM AREA #12 INTERFERED WITH ~~TAKE~~ TAKING MEANINGFUL MEASUREMENT  [initials] 1/12/93

Prepared by: [signature]
Title: VT LV II
Date: 1-12-93

Reviewed by: [signature]
Level: II
Date: 1-15-93
Page 1 of 1
NDE Request No.: 92-072

see Part under

**GPU Nuclear** — Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A | Item: N/A | NDE Request: 92-072 | Data Sheet No.: 92-072-61 |
| Task Description: UT THICKNESS | | Task No.: N/A | Date: 1-5-93 |
| Comp. Desc.: DRYWELL LINER Bay 1 | System: 187 | Code/Spec.: ENG. INFO. | |
| Procedure/Rev.: 6100 QAP 7209.07 REV. 0 | | Drawing No./Rev.: 3E-187-2E-C40 REV. 0 | |
| Test Surface: O.D. | | Thickness: 1 1/8" | Material: C.S. |
| Examiner Sign: [signature] | Print: Toni Vanderbeck | ID No.: [illegible] | Level: II |
| Examiner Sign: [signature] | Print: Mark C. Bagnell | ID No.: 553-61-1812 | Level: I |

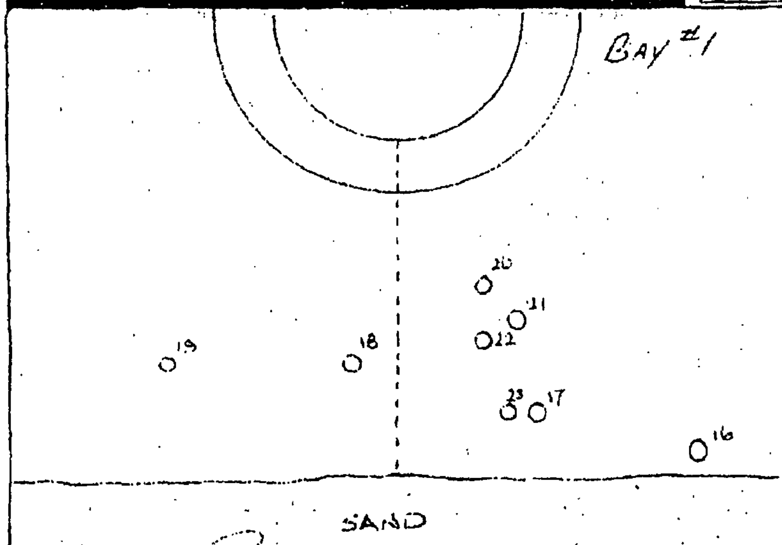
Thermometer S/N 98-081 Part Temperature 72° F D-Meter S/N 92-056
Cal. Blk. S/N INV 214 Cal. In: N/A AM 22:42 PM
Cal. Blk. Temp. 72° F Cal. Out: N/A AM 22:55 PM

Calibration Readings (Inches)

| Cal. Blk. | 5 | .75 | 1.0 | 1.25 | 1.5 | N/A |
|---|---|---|---|---|---|---|
| D-Meter | .5 | .75 | 1.0 | 1.25 | 1.5 | |

Techniques: ☐ CRT ☒ D-Meter Other N/A

Position #/Reading in Inches



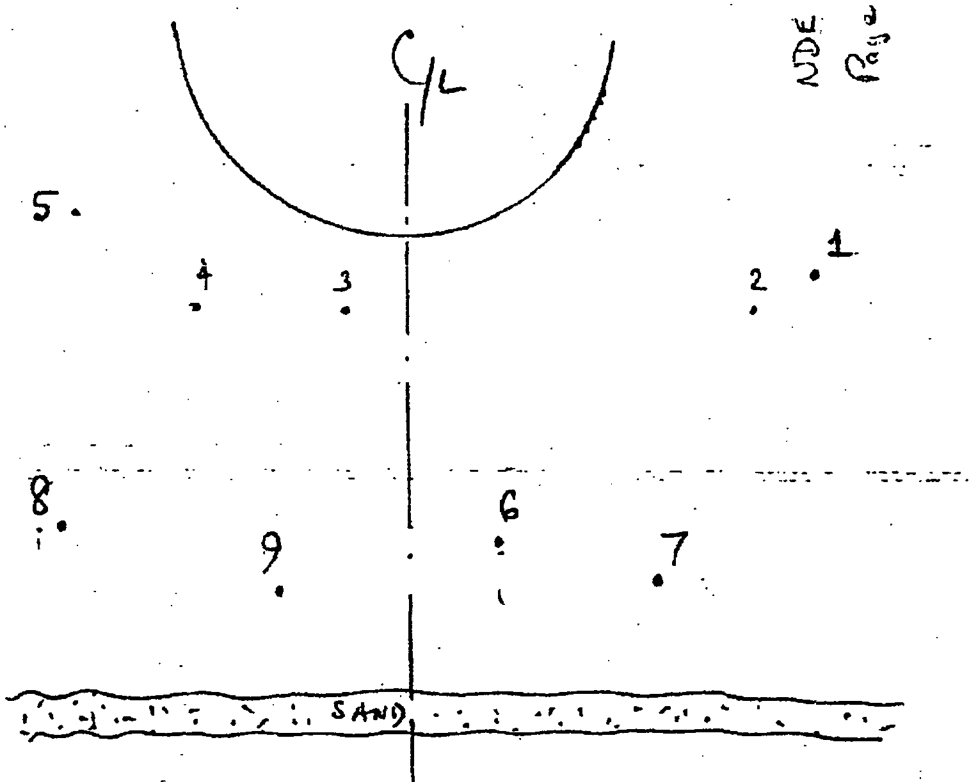

Drawing

| # | AREA | | MEASUREMENT |
|---|---|---|---|
| 16 | D 50" | R 40" | .796" |
| 17 | D 48" | R 16" | .860" |
| 18 | D 38" | L 2" | .917" |
| 19 | D 38" | L 24" | .890" |
| 20 | D 18" | R 13" | .965" |
| 21 | D 24" | R 15" | .726" * |
| 22 | D 32" | R 13" | .852" |
| 23 | D 48" | R 15" | .850" |

Reviewed by: [signature] Level: [illegible] Date: 1-6-93 Page 1 of 1

NS455 (05-89)

NDE Req. 92-072
Page 3 of 9




INSPECTION SPOTS FOR UT
BAY #1

NOTE:

1. GRIND FLAT FOR UT WITH MINIMUM REMOVAL OF SHELL AT THE VALLEY.

## GPU Nuclear

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 77 of 117 |

| Originator | Date | Reviewed by | Date |
|---|---|---|---|
| Mark Yekta | 01/12/93 | S. C. Tumminelli | |

### GPU Nuclear — Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A | Item: N/A | NDE Request: 92-022 | Data Sheet No.: 92-072-14 |
| Task Description: | | Task No.: N/A | Date: 1/2/93 |
| Comp. Desc.: Drywell Liner | System: 187 | Code/Spec.: FINL INFO | |
| Procedure/Rev.: 6100-GAP-7209.02 Rev. 0 | Drawing No./Rev.: 3E-187-29-001 Rev. 0 | | |
| Test Surface: O.D. | Thickness: 1 1/8" | Material: C/S | |
| Examiner Sign: | Print: J. Chalorka Linde | ID No.: | Level: II |
| Examiner Sign: Mark | Print: Mark F. Bagnell | ID No.: 553-61-1862 | Level: I |

Thermometer S/N 65-061 Part Temperature 72 F D-Meter S/N 92-035

Cal. Blk. S/N 214 Cal. In: N/A AM 2:15 PM

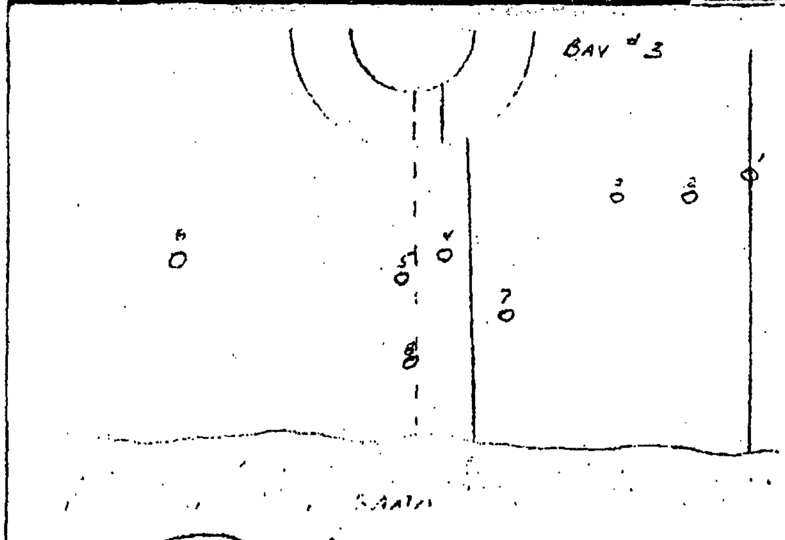
Cal. Blk. Temp. 72 F Cal. Out: N/A AM 2:45 PM

**Calibration Readings (inches)**

| Cal. Blk. | .5 | .75 | 1.0 | 1.25 | 1.5 | N/A |
|---|---|---|---|---|---|---|
| D-Meter | .5 | .75 | 1.0 | 1.25 | 1.5 | |

**Techniques** ☐ CRT ☒ D-Meter Other N/A

Position #, Reading in Inches.




Drawing

| | AREA | MEASUREMENT |
|---|---|---|
| 1 | 0-5" R 63 | .795" |
| 2 | 0-9" R 50 | .806" |
| 3 | 0-9" R 33 | .857" |
| 4 | 0-13" L 5 | .808" |
| 5 | 0-15" L 8 | .823" |
| 6 | 0-15" L 56 | .966" |
| 7 | 0-17" R | .826" |
| 8 | 0-24" L | .780" |

Reviewed by: [signature] Level: III Date: 1-3-93 Page 4 of 21

## GPU Nuclear

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 78 of 117 |
| Originator: Mark Yekta — Date: 01/12/93 | Reviewed by: S. C. Tumminelli | | Date |

## GPU Nuclear — Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A | Item: N/A | NDE Request: 92-072 | Data Sheet No. 92-072-15 |
| Task Description: UT Thickness | | Task No.: N/A | Date: 1/2/93 |
| Comp. Desc.: Drywell Liner | System: 187 | | Code/Spec.: ENG INFO |
| Procedure/Rev.: 6100-QAP-7209.02 Rev. 0 | | Drawing No./Rev.: 3E-187-29-001 Rev. 0 | |
| Test Surface: O.D. | | Thickness: 1 1/8" | Material: C/S |
| Examiner Sign: [signature] | Print: J. VanderLinde | ID No.: 154-48-0318 | Level: II |
| Examiner Sign: [signature] | Print: Mark C. Bagnell | ID No.: 555-[illegible] | Level: I |

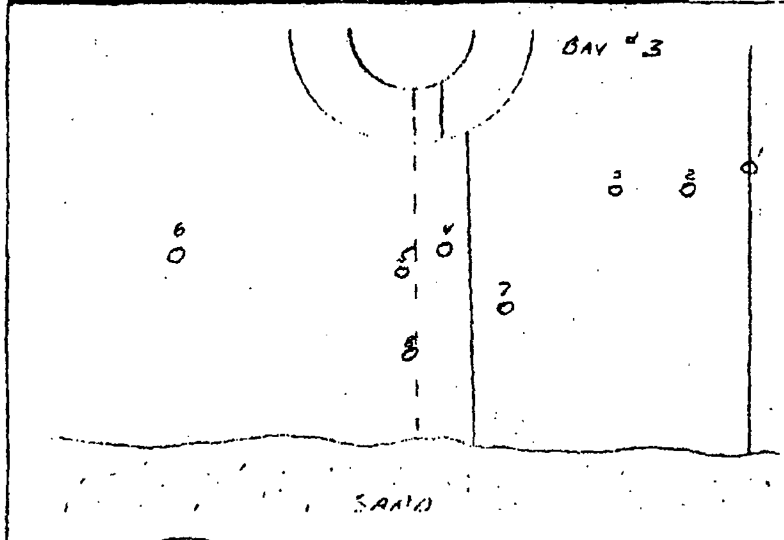
Thermometer S/N 88-081 Part Temperature 72 F D-Meter S/N 177-113
Cal. Blk. S/N 214 Cal. In: N/A AM 11:18 PM
Cal. Blk. Temp. 72 F Cal. Out: N/A AM 2:45 PM

**Calibration Readings (inches)**

| Cal. Blk. | .5" | .75" | 1.0 | 1.25" | 1.5" | N/A |
|---|---|---|---|---|---|---|
| D-Meter | .5" | .75" | 1.0 | 1.25" | 1.5" | |

**Techniques:** ☒ CRT ☐ D Meter Other N/A

Position # Reading in Inches




Drawing

| | AREA | MEASUREMENT |
|---|---|---|
| 1 | 0-5" R-63 | .500" |
| 2 | 0-9" R-50 | " " |
| 3 | 0-9" R-33 | 800" |
| 4 | 0-13" L-5 | .900" |
| 5 | 0-13" L-8 | 840" |
| 6 | 0-15" L-56 | " " |
| 7 | 0-12" R | 840" |
| 8 | 0-24" L | 790" |

Reviewed by: [signature] Level: III Date: 1-3-93 Page 51 of 91

OCLR00014615

## GPU Nuclear — Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 | Class: O1A | Item: O1A | NDE Request: 92-072 |
| Data Sheet No.: 92-012-15 | Date: 1/2/93 | | |
| Task Description: UT Thickness | | Task No.: O1A | |
| Comp. Desc.: Drywell Liner | System: 187 | Code/Spec.: Eng. Info | |
| Procedure/Rev.: 6100-QAP-7209.02 Rev. 0 | Drawing No./Rev.: 3E-187-24-001 Rev. 0 | | |
| Test Surface: O.D. | Thickness: 1 1/8" | Material: C/S | |
| Examiner Sign: [signature] | Print: J. VanderLinde | ID No.: [illegible] | Level: II |
| Examiner Sign: [signature] | Print: Mark F. Bagnell | ID No.: [illegible] | Level: II |

Thermometer S/N 83-001 Part Temperature 72 F D-Meter S/N 157-113

Cal. Blk. S/N 214 Cal. In: N/A AM 21:18 PM

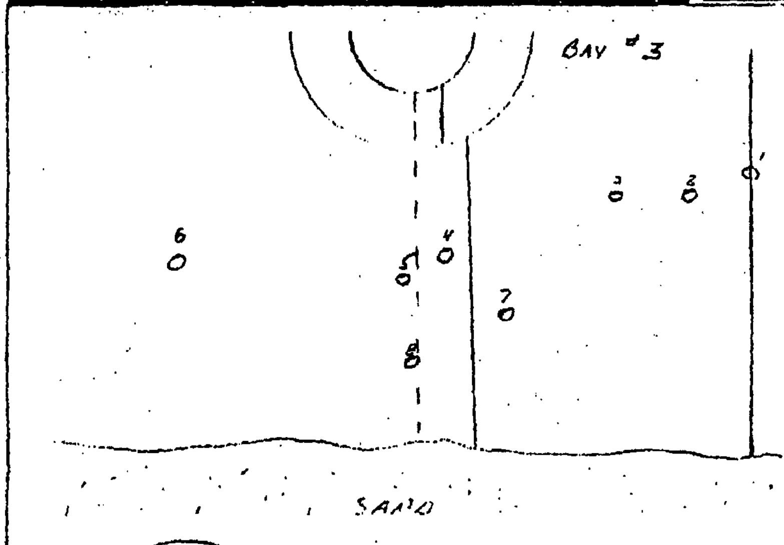
Cal. Blk. Temp. 72 F Cal. Out: N/A AM 21:45 PM

**Calibration Readings (inches)**

| Cal. Blk. | .5" | .75" | 1.0 | 1.25" | 1.5" | N/A |
|---|---|---|---|---|---|---|
| D-Meter | .5" | .75" | 1.0 | 1.25" | 1.5" | |

**Techniques:** ☒ CRT ☐ D Meter Other N/A

**Position # Reading in Inches**




**Drawing**

| | AREA | MEASUREMENT |
|---|---|---|
| 1 | 0-5" R-63 | .8[illegible]" |
| 2 | 0-9" R-50 | [illegible]" |
| 3 | 0-9" R-33 | .860" |
| 4 | 0-13" L-5 | .900" |
| 5 | 0-15" L-8 | .840" |
| 6 | 0-15" L-56 | [illegible]" |
| 7 | 0-17" R | .849" |
| 8 | 0-24" L | .790" |

Reviewed By: [signature] Level: III Date: 1-3-93 Page 51 of 91

## GPU Nuclear

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 80 of 117 |
| **Originator** Mark Yekta / **Date** 01/12/93 | **Reviewed by** S. C. Tumminelli | | **Date** |

### GPU Nuclear — Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A | Item: N/A | NDE Request: 92-072 | Data Sheet No.: 92-072-16 |
| Task Description: UT Thickness | | Task No.: N/A | Date: 1/2/93 |
| Comp. Desc.: Drywell Liner | System: 187 | Code/Spec.: ENG. INFO. R | |
| Procedure/Rev.: 6100-QAP-7209.02 Rev. 0 | | Drawing No./Rev.: 3E-187-29-001 Rev. 0 | |
| Test Surface: O.D. | | Thickness: 1 1/8" | Material: C/S |
| Examiner Sign: [signature] | Print: J. VanderLinde | ID No.: [illegible] | Level: II |
| Examiner Sign: [signature] | Print: Mark F. Burnell | ID No.: 553-61-1602 | Level: I |

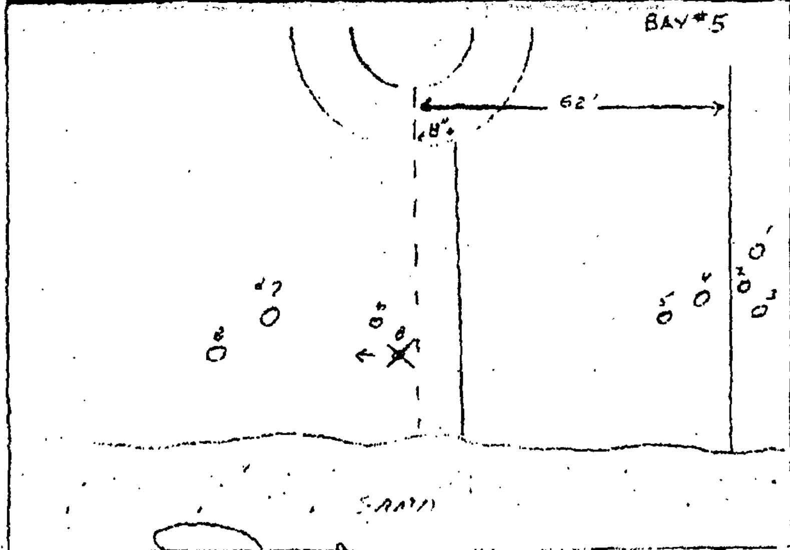
Thermometer S/N 83-031 Part Temperature 72 F D-Meter S/N 91-035
Cal. Blk. S/N 214 Cal. In: N/A AM 12:55 PM
Cal. Blk. Temp. 72 F Cal. Out: N/A AM 12:36 PM

**Calibration Readings (Inches)**

| | | | | | | |
|---|---|---|---|---|---|---|
| Cal. Blk. | .5 | .75 | 1.0 | 1.25 | 1.5 | [initials] |
| D-Meter | .5 | .75 | 1.0 | 1.25 | 1.5 | |

Techniques: ☐ CRT ☒ D-Meter Other N/A

Position # Reading In Inches




Drawing

| | AREA | | MEASUREMENT |
|---|---|---|---|
| 1 | 0-40" | R-13" | .970" |
| 2 | 0-42" | R-8" | 1.440" |
| 3 | 0-44" | R-10" | 1.020" |
| 4 | 0-44" | R-7" | .910" |
| 5 | 0-46" | R-11" | .800" |
| 6 | 0-44" | L-4" | 1.000" |
| 7 | 0-48" | L-24" | .990" |
| 8 | 0-46" | L-28" | 1.010" |

* From weld

Reviewed by: [signature] Level: III Date: 1-3-93 Page 21 of 81

N5455 (05 90)

OCLR00014617

all good

## GPU Nuclear — Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A | Item: N/A | NDE Request: 92-072 | Data Sheet No.: 92-072-11 |
| Task Description: UT Thickness | | Task No.: N/A | Date: 1/12/93 |
| Comp. Desc.: Drywell Liner | System: 187 | Code/Spec.: ENG TOFC 2 | |
| Procedure/Rev.: 6100-QAP 7209.02 Rev. 0 | Drawing No./Rev.: 3E-187-29-001 Rev. 0 | | |
| Test Surface: O.D. | Thickness: 1 1/8" | Material: C/S | |
| Examiner Sign: [signature] | Print: J. VanderLinde | ID No.: 154-48-0318 | Level: II |
| Examiner Sign: Mark F. [signature] | Print: Mark F. Bagnell | ID No.: 553-21-1862 | Level: I |

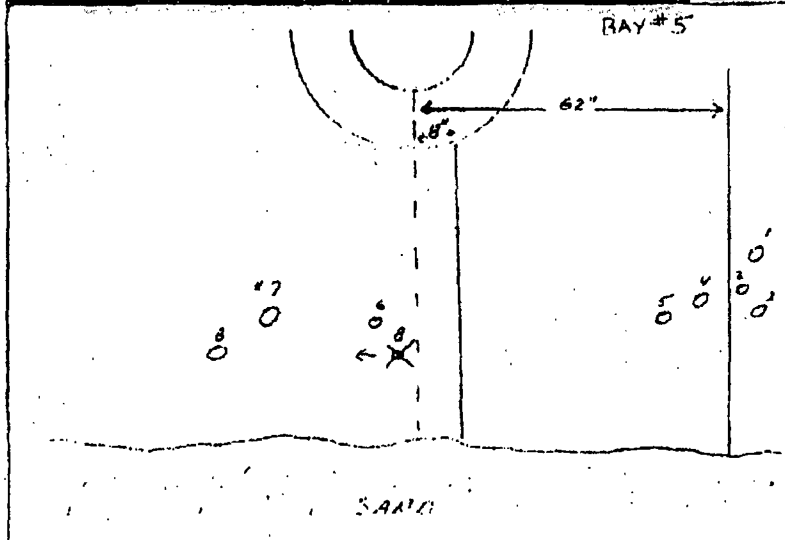
Thermometer S/N 88-001 Part Temperature 72 F D-Meter S/N 137-113
Cal. Blk. S/N 264 Cal. In: N/A AM 22:23 PM
Cal. Blk. Temp. 72 F Cal. Out: N/A AM 22:36 PM

**Calibration Readings (inches)**

| Cal. Blk. | .5" | .75" | 1.0 | 1.25" | 1.5" | N/A |
|---|---|---|---|---|---|---|
| D-Meter | .5" | .75" | 1.0 | 1.25" | 1.5" | |

Techniques: ☒ CRT ☐ D Meter Other N/A

Position # Reading In Inches




Drawing

| | AREA | | Measurement |
|---|---|---|---|
| 1 | 0-40" | *R-13" | .910" |
| 2 | 0-42" | *R-8" | 1.030" |
| 3 | 0-44" | *R-10" | 1.040" |
| 4 | 0-44" | *R-7" | .960" |
| 5 | 0-46" | *R-11" | .850" |
| 6 | 0-44" | L-4" | 1.060" |
| 7 | 0-48" | L-24" | 1.000" |
| 8 | 0-46" | L-28" | 1.020" |

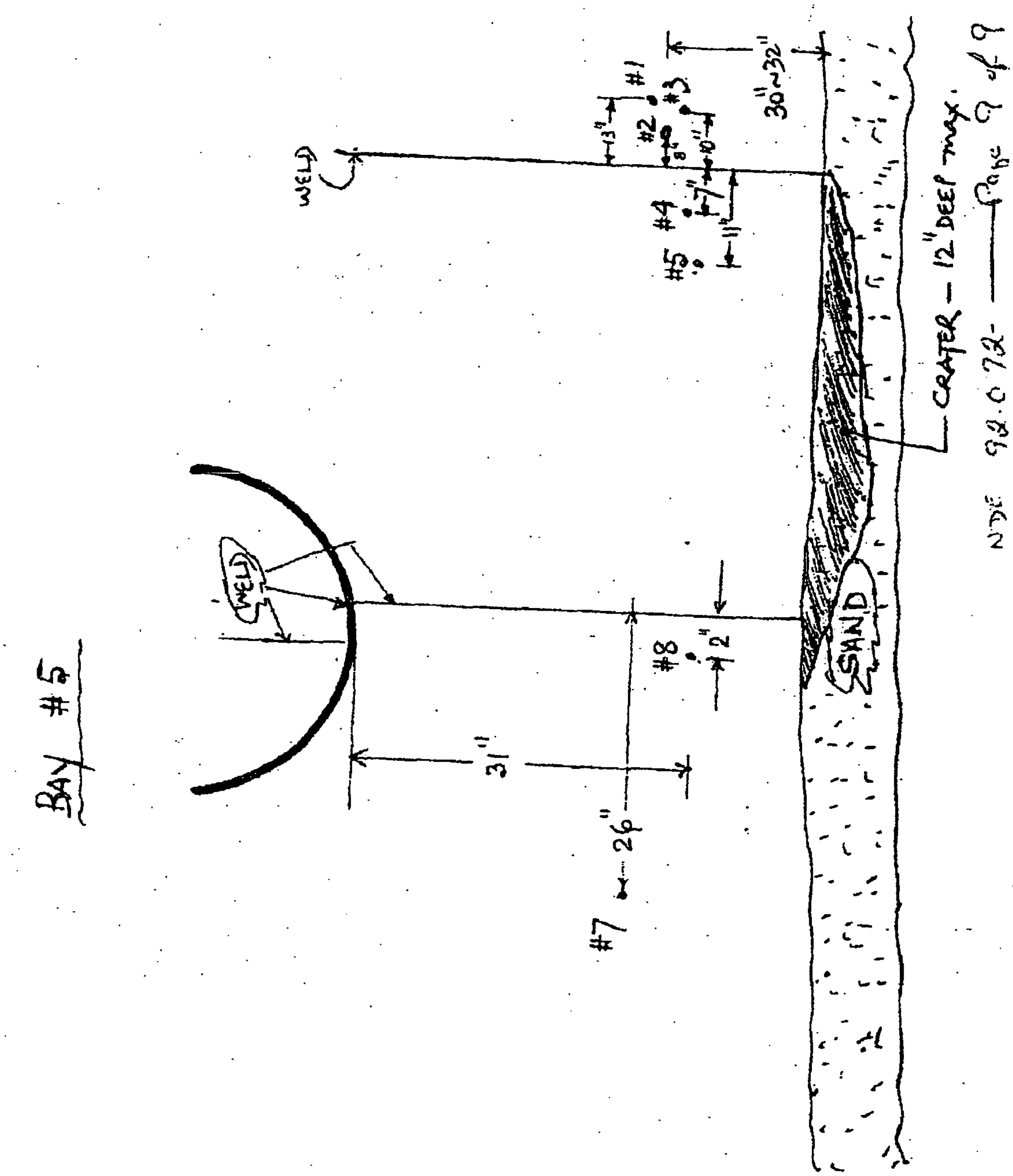
* from weld

[initials]

Reviewed by: [signature] Level: III Date: 1-3-93 Page 81 of 81

**GPU Nuclear**

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 82 of 117 |
| **Originator** | **Date** | **Reviewed by** | | **Date** |
| Mark Yekta | 01/12/93 | S. C. Tumminelli | | |



HOC ITMI

**GPU Nuclear** Calibration Sheet Cal Sheet# 14K-103

| | | | |
|---|---|---|---|
| System 187 | Component Drywell Liner | Procedure 6100-QAP-7209.07 | Rev 0 |
| Examiner: Signature: [signature] | Print: J VanderLinde | Initial: [initials] ID# 154-48-0219 | Level II |
| Examiner: Signature: Mark [signature] | Print: Mark F. Exegnell | Initial: MFE ID# 153-[illegible] | Level I |

**Instrument Settings**
ID# 137-LLI
Model/Manuf SONIC 137 STAVELY

**Gain**
Coarse 65
Fine n/a
Uncal n/a

**Sweep Circuit**
Coarse 2" (Range)
Fine vel 0.231
Delay 0.995
Screen Depth 2"

**Operation** (T&R) Normal
Frequency: 2.25 MHZ
Reject: (x)Off ( )On ___ %
Filter: ( )Off (x)On 1 %
Damping: ( )Off (x)On 100 %
Rep Rate: 1000 Hz

**Cal Standard**
ID# 214
Size n/a Sch. n/a
Thickness .5" to 1.5
S/S (CS)
Temp 72 °F

**System Check**
☐Exit Point
☐Angle +/- 2 N/A

Date 1-2-93

**Search Unit**
ID# MOB524
Type MSEA
Freq 2 MHZ
Size 1/2"
Angle 0 Mode Long

**Cal Direction**
☐Axial ☐Both
☐Circ. ☒Normal

Time 1900

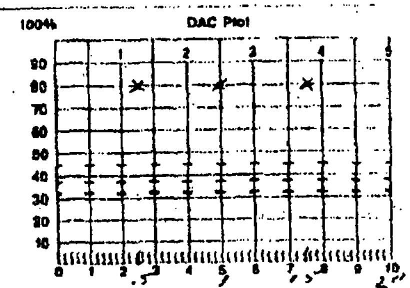
**Search Unit Cable**
Type BNC to Limo Length 2x6'

**Couplant**
Make Soundsafe Batch# 35P-89-1-02

**Thermometer**
S/N: 88-081 Cal Due 1-9-93

| Reflector | Amplitude % of FSH | Screen Reading in Inches |
|---|---|---|
| .5 | 80 | .5 |
| 1.5 | 80 | 1.5 |

DAC Plot




| Time/Date | 2118 1-2-93 | | 2151 1-2-93 | | 2223 1-2-93 | |
|---|---|---|---|---|---|---|
| Reflector | % FSH | Inches | % FSH | Inches | % FSH | Inches |
| .5 | 80 | .5 | 80 | .5 | 80 | .5 |
| 1.5 | 80 | 1.5 | 80 | 1.5 | 80 | 1.5 |
| Initials | [initials] | | [initials] | | [initials] | |

**Remarks:**
Drywell liner Thickness Measurements
Digital utilized

**Components Examined:**
Bays # 1, 3 & 5

**ANI Review**

**Technical Review**
Reviewed By [signature]
Level III Date 1-3-93

NDE Request#: 92-072

N0927 (05-90)

'all good

GPU Nuclear

# Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A | Item: N/A | NDE Request: 92-072 | Data Sheet No.: 92-072-? |
| Task Description: UT Thickness | | Task No.: N/A | Date: 1-8-93 |
| Comp. Desc.: Drywell Liner | System: 187 | | Code/Spec.: Eng. Info. |
| Procedure/Rev.: 6100-QAP-7209.07 Rev. 0 | | Drawing No./Rev.: 3E-187-29-001 | |
| Test Surface: O.D. | | Thickness: 1 1/8" | Material: C/S |
| Examiner Sign: [signature] | Print: [illegible] | ID No.: 157-[illegible] | Level: II |
| Examiner Sign: [signature] | Print: [illegible] | ID No.: 11n-44-2524 | Level: II |

Thermometer S/N 92-066 Part Temperature 70 F D-Meter S/N 92-035

Cal. Blk. S/N 219 Cal. In: 0020 AM ____ PM

Cal. Blk. Temp. 72 F Cal. Out: 0205 AM ____ PM

**Calibration Readings (inches)**

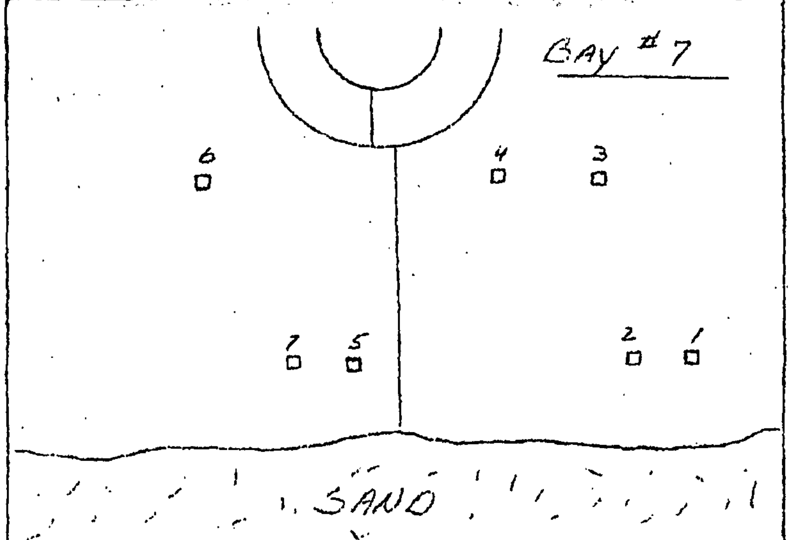
| Cal. Blk. | .5 | 1.0 | 1.5 | | | |
|---|---|---|---|---|---|---|
| D-Meter | .5 | 1.0 | 1.5 | | | |

**Techniques**

☐ CRT ☒ D-Meter

Other ________

**Position #/Reading in Inches**




**Drawing**

| | AREA | | MEASUREMENT |
|---|---|---|---|
| 1 | O-21" | R-39" | 0.95" |
| 2 | O+21" | R-32" | 1.016" |
| 3 | O-10" | R-20" | 0.984" |
| 4 | O+10" | R-10" | 1.04" |
| 5 | O-21" | L-6" | 1.03" |
| 6 | O-10" | L-23" | 1.045" |
| 7 | O-21" | L-12" | 1.0" |

Reviewed by: [signature] Level: II Date: 1-8-93 Page 1 of 1

# GPU Nuclear

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 85 of 117 |

| Originator | Date | Reviewed by | Date |
|---|---|---|---|
| Mark Yekta | 01/12/93 | S. C. Tumminelli | |

All good

## GPU Nuclear — Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 | Class: N/A | Item: N/A | NDE Request: 92-072 | Data Sheet No.: 92-072-3

Task Description: UT Thickness | Task No.: N/A | Date: 1-7-93

Comp. Desc.: Drywell Liner | System: 187 | Code/Spec.: Eng. Info.

Procedure/Rev.: 6100-QAP-7209.07 Rev. 0 | Drawing No./Rev.: 3E-187-24-001 Rev. 0

Test Surface: O.D. Bay #9 | Thickness: 1 1/8" | Material: C/S

Examiner Sign: [signature] | Print: J. Vanche Linde | ID No.: 154-46-0319 | Level: II

Examiner Sign: [signature] | Print: Luis Valenzuela | ID No.: 110-44-2524 | Level: II

Thermometer S/N 92-068 | Part Temperature 72 F | D-Meter S/N 92-009

Cal. Blk. S/N 218 | Cal. In: 0202 AM 0206 PM

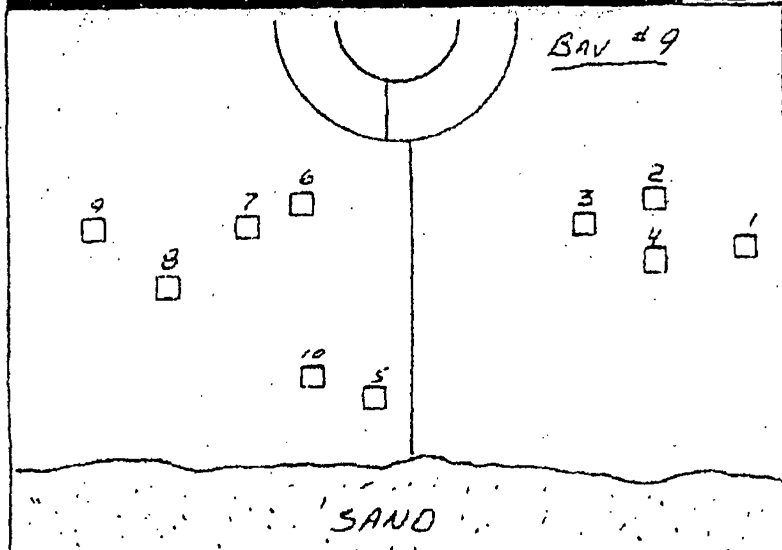
Cal. Blk. Temp. 72 F | Cal. Out: 0415 AM 0415 PM

**Calibration Readings (inches)**

| Cal. Blk. | .5 | 1.0 | 1.5 |
|---|---|---|---|
| D-Meter | .5 | 1.0 | 1.5 |

Techniques: ☐ CRT ☒ D-Meter Other ____

Position #/Reading In Inches




Drawing

| | AREA | | MEASUREMENT |
|---|---|---|---|
| 1 | 0-21 | R-32 | .960 |
| 2 | 0-12 | R-17 | .94 |
| 3 | 0-18 | R-8 | .994 |
| 4 | 0-21 | R-12 | 1.020 |
| 5 | 0-36 | L-4 | .935 |
| 6 | 0-~~34~~ 16 | L-30 | .62 |
| 7 | 0-18 | L- | .825 |
| 8 | 0-22 | L- | .791 |
| 9 | 0-~~50~~ 15 | L-53 | .832 |
| 10 | 0-32 | L-6 | .980 |

Reviewed by: [signature] | Level: II | Date: 1-8-93 | Page 1 of 1

# GPU Nuclear

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 86 of 117 |
| **Originator:** Mark Yekta — **Date:** 01/12/93 | **Reviewed by:** S. C. Tumminelli | | **Date** |

One Point

**GPU Nuclear** — **Ultrasonic Thickness Data Sheet**

| | | | |
|---|---|---|---|
| ☑ OC ☐ TMI-1 ☐ TMI-2 Class: N/A | Item: N/A | NDE Request: 92-072 | Data Sheet No.: 92-072-09 |
| Task Description: [illegible] | | Task No.: N/A | Date: [illegible] |
| Comp. Desc.: Drywell [illegible] Bay 11 | System: 187 | | Code/Spec.: ASME [illegible] XI |
| Procedure/Rev.: [illegible] | | Drawing No./Rev.: 3E-187-29-001 Rev. 0 | |
| Test Surface: [illegible] | | Thickness: 1 1/8" | Material: C/S |
| Examiner Sign: [signature] | Print: J. [illegible] | ID No.: [illegible] | Level: II |
| Examiner Sign: [signature] | Print: Mark F. Bagnell | ID No.: 553-[illegible] | Level: I |

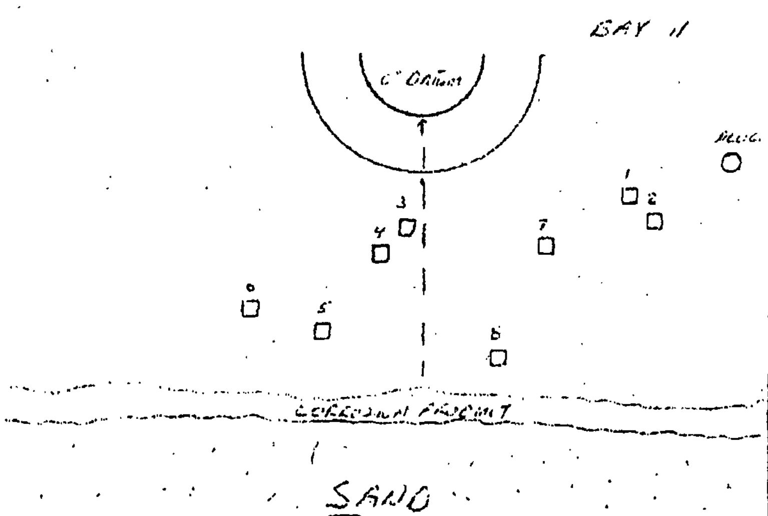
Thermometer S/N [illegible] Part Temperature 65°F D-Meter S/N [illegible]
Cal. Blk. S/N [illegible]  Cal. In: [illegible] AM [illegible] PM
Cal. Blk. Temp. 65 F  Cal. Out: [illegible] AM 3:10 PM

**Calibration Readings (Inches)**

| | | | | | | |
|---|---|---|---|---|---|---|
| Cal. Blk. | .5 | .75 | 1.0 | | | |
| D-Meter | .5 | .75 | 1.0 | | | |

**Techniques:** ☑ CRT ☐ D-Meter Other ____

Position #/Reading in Inches




**Drawing**

[illegible] 15" [illegible]

| | AREA | Thickness |
|---|---|---|
| 1 | 4-20" R-28" | 0.71" |
| 2 | 4-35" R-32" | 0.76" |
| 3 | 4-[illegible]" L-4" | 0.63" |
| 4 | 4-24" L-6" | 0.75" |
| 5 | 4-30" L-14" | 0.84" |
| 6 | 4-27" L-[illegible]" | 0.81" |
| 7 | 4-[illegible] R-20" | 0.83" |
| 8 | 4-40" R-13" | 0.87" |

Reviewed by: [signature]  Level: III  Date: 12-27-92  Page 1 of 1

N5455 (05-90)

# GPU Nuclear

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 87 of 117 |

| Originator | Date | Reviewed by | Date |
|---|---|---|---|
| Mark Yekta | 01/12/93 | S. C. Tumminelli | |

## GPU Nuclear — Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☑ OC ☐ TMI-1 ☐ TMI-2 Class: N/A | Item: N/A | NDE Request: 92-072 | Data Sheet No.: 92-072-10 |
| Task Description: [illegible] | | Task No.: N/A | Date: [illegible] |
| Comp. Desc.: Drywell [illegible] Bay 11 | System: 187 | | Code/Spec.: [illegible] |
| Procedure/Rev.: [illegible] | | Drawing No./Rev.: 3E-187-25-001 R.0 | |
| Test Surface: [illegible] | | Thickness: 1 1/8" | Material: c/s |
| Examiner Sign: [signature] | Print: [illegible] | ID No.: [illegible] | Level: II |
| Examiner Sign: [signature] | Print: Mark F. Bagnell | ID No.: 553-[illegible] | Level: II |

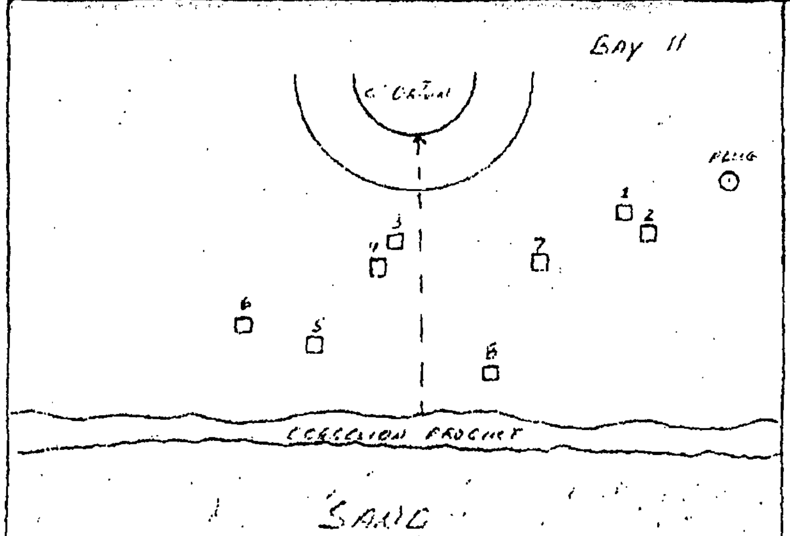
Thermometer S/N 92-0535 Part Temperature 65 °F D-Meter S/N 92-0535
Cal. Blk. S/N 72 Cal. In: [illegible] AM 2:40 PM
Cal. Blk. Temp. 65 °F Cal. Out: [illegible] AM 3:02 PM

**Calibration Readings (Inches)**

| Cal. Blk. | .5" | .75" | 1.0" | | | |
|---|---|---|---|---|---|---|
| D-Meter | .5" | .75" | 1.0" | | | |

**Techniques:** ☐ CRT ☑ D-Meter Other ______

**Position #/Reading in Inches**




**Drawing**

[illegible]

| | Area | Thickness |
|---|---|---|
| 1 | 0-26" 5-4" | 0.[illegible] |
| 2 | 0-25" 5-3" | 0.720 |
| 3 | 0-21" 4-4" | 0.834 |
| 4 | 0-24" 4-6" | 0.785 |
| 5 | 0-32" 4-14" | 0.801 |
| 6 | 0-27" 4-20" | 0.86 |
| 7 | 0-31" 5-24" | 0.831 |
| 8 | 0-40" 5-13" | 0.[illegible] |

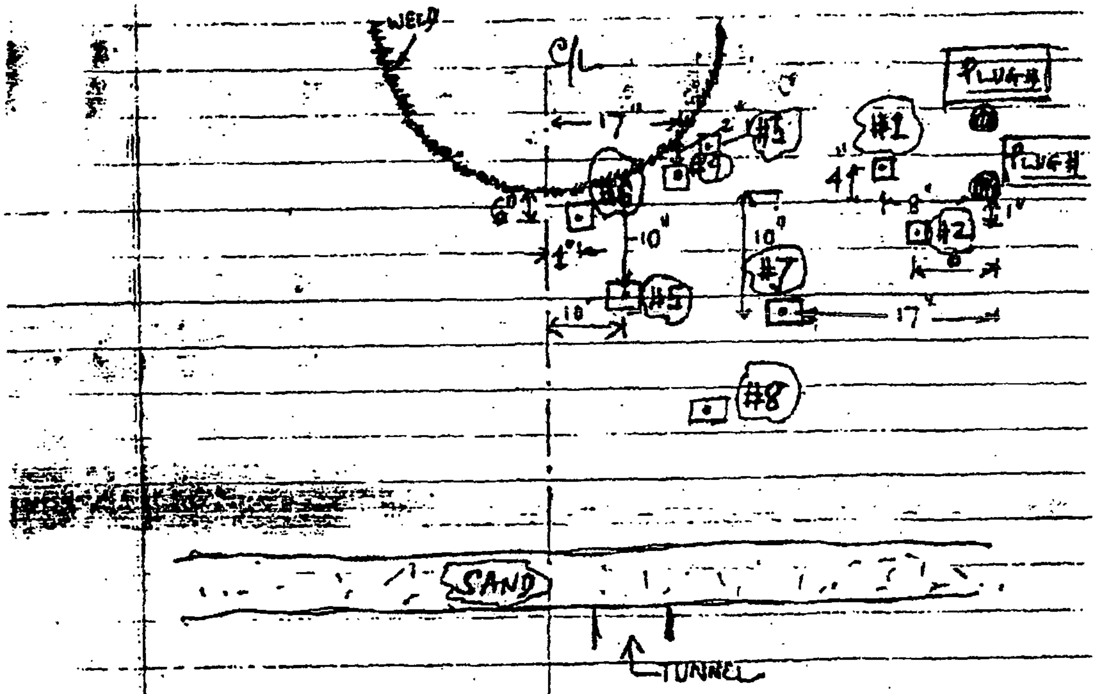
Reviewed by: [signature] Level: III Date: 12-27-92 Page 1 of 1

N5453 (05-90)

OCLR00014624

GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 88 of 117 |
| **Originator** | **Date** | **Reviewed by** | | **Date** |
| Mark Yekta | 01/12/93 | S. C. Tumminelli | | |

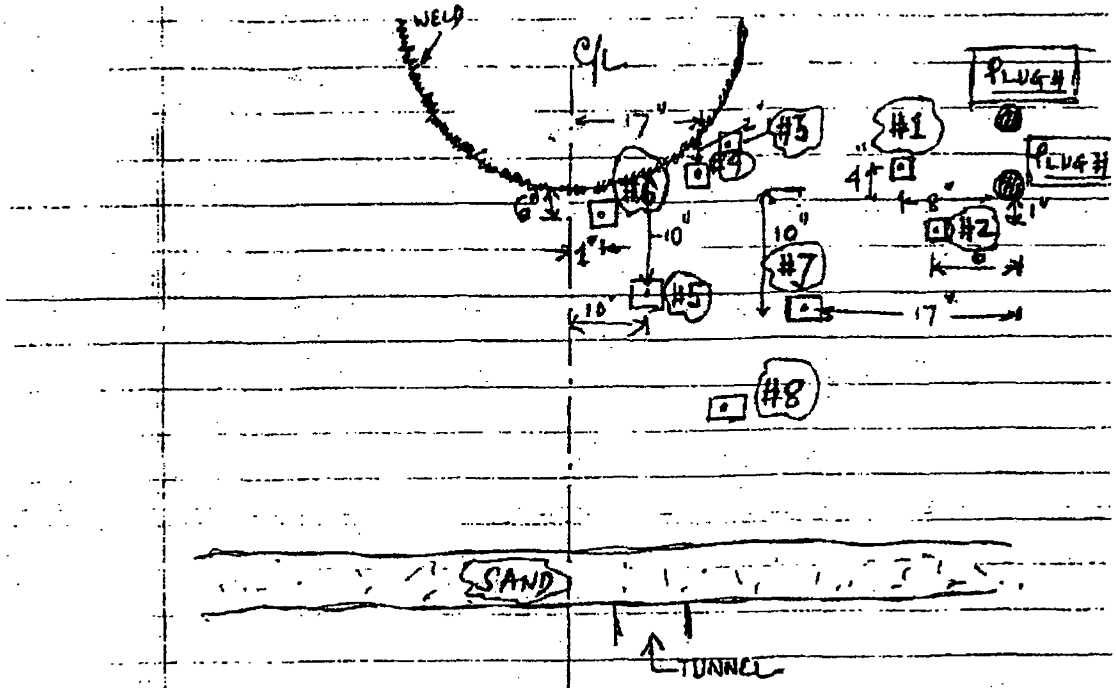



BAY-11 — U.T. SPOTS FOR GRINDING

NOTE: GRIND ONE SPOT AT A TIME. REMARK THE SPOT # AFTER GRINDING.

# GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 89 of 117 |
| Originator: Mark Yekta | Date: 01/12/93 | Reviewed by: S. C. Tumminelli | | Date |




BAY-11 — U.T. SPOTS FOR GRINDING

NOTE: GRIND ONE SPOT AT A TIME. REMARK THE SPOT # AFTER GRINDING.

# GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 90 of 117 |
| **Originator** | **Date** | **Reviewed by** | | **Date** |
| Mark Yekta | 01/12/93 | S. C. Tumminelli | | |

GPU Nuclear

## Calibration Sheet

I-OC  I ITMI

Cal Sheet# 14K-069

| | | |
|---|---|---|
| System 187 | Component Drywell Cont. Bay 11 | Procedure 6100-SRP 7209.03 | Rev 0 |

| Examiner: | Signature: | Print: J Ulrich Linck | Initial: | ID# | Level II |
|---|---|---|---|---|---|
| Examiner: | Signature: Mark Bagnell | Print: Mark F Bagnell | Initial: MFB | ID# | Level I |

**Instrument Settings**
ID# 137-113
Model/Manuf Sonic 137 Staveley

**Gain**
Coarse 22.0
Fine N/A
Uncal N/A

**Sweep Circuit**
Coarse 2 (Range)
Fine N/C C.S.AL
Delay 1
Screen Depth 2

**Operation** (T&R) Normal
Frequency: 2.25 MHZ
Reject: Off On %
Filter: Off On 1 %
Damping: Off On 200 %

Rep Rate: Cal...

**Cal Standard**
ID# 95
Size 4.1" Sch. 40
Thickness .5" .7" 1.0"
S/S CS
Temp 65 °F

**System Check**
☐Exit Point n/a
☐Angle +/- 2

Date 12/12/92

**Search Unit**
ID# MC9334
Type MSEB
Freq 5 MHZ
Size 1/2"
Angle 0 Mode Long

**Cal Direction**
☐Axial ☐Both
☐Circ. ☒Normal

Time 13:05

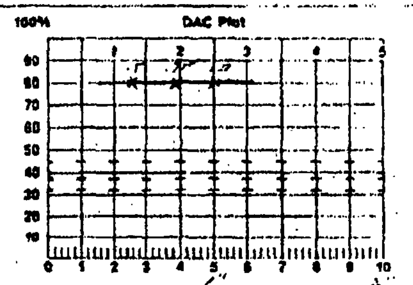
**Search Unit Cable**
Type Dual Coax Length 2x6'

**Couplant**
Make Sonotrak Batch#

**Thermometer**
S/N: 9E-CTS Cal Due 5/8/93

| Reflector | Amplitude % of FSH | Screen Reading in Inches |
|---|---|---|
| .5 | 80 | .5 |
| .75 | 80 | .75 |
| 1.0 | 80 | 1.0 |

DAC Plot



| Time/Date | 13:30 12/12/92 | | / | | / | |
|---|---|---|---|---|---|---|
| Reflector | % FSH | Inches | % FSH | Inches | % FSH | Inches |
| .5 | 80 | .5 | | | | |
| .75 | 80 | .75 | | | | |
| 1.0 | 80 | 1.0 | | | | |
| Initials | MFB | | | | | |

Remarks:

Components Examined:
Bay 11

ANI Review

Technical Review
Reviewed By
Level III Date 12-27-92

NDE Request#: 92-072

N0927 (05-90)

GPU Nuclear

☒ OC ☐ TMI ☐ OTHER ______

## Sketch Form (with grid)

Component: DRYWELL liner SANDBED AREA

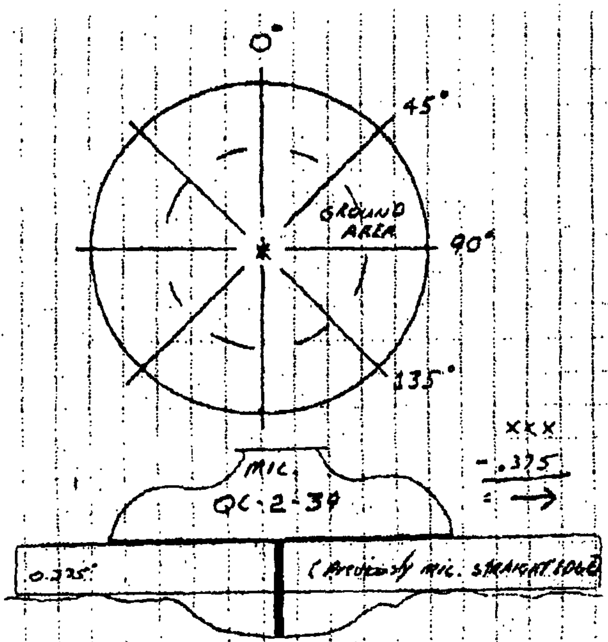
Location: BAY # 11

Data Sheet No.: 92-072-31

Drawing No.: N/A

Rev.: NA

Drawing




Technique utilized for the pit depth measurements

| AREA | AZIMUTH 0° | 45° | 90° | 135° |
|---|---|---|---|---|
| 1 | .289 | .338 | .157 | .200 |

Prepared by: [signature]

Reviewed by: [signature]

Title: VT LV II

Date: 1/12/93

Level: II

Date: 1-13-93

Page 1 of 1

NDE Request No.: 92-072

OCLR00014628

## GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 92 of 117 |
| **Originator** Mark Yekta | **Date** 01/12/93 | **Reviewed by** S. C. Tumminelli | | **Date** |

Four Points under

# GPU Nuclear — Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 · Class: NA | Item: NA | NDE Request: 92-072 | Data Sheet No.: 92-072-23 |
| Task Description: DRYWELL CORROSION CONTROL (LINER THICKNESS) | | Task No.: NA | Date: 1/8/93 |
| Comp. Desc.: DRYWELL LINER BAY 13 | System: DRYWELL | | Code/Spec.: GNL INFO |
| Procedure/Rev.: 6100-QAP-7209.07 Rev 0 | | Drawing No./Rev.: 3E-187-29-001 | |
| Test Surface: OD | | Thickness: 1 1/8" | Material: CS |
| Examiner Sign: [signature] | Print: N. H. SHEARER | ID No.: 217-56-4132 | Level: II |
| Examiner Sign: NA | Print: NA | ID No.: NA | Level: NA |

Thermometer S/N 92-068 Part Temperature 74° F D-Meter S/N 92-009
Cal. Blk. S/N 219 Cal In: NA AM 12:20 PM
Cal. Blk. Temp. 69° F Cal. Out: NA AM 2:30 PM

**Calibration Readings (Inches)**

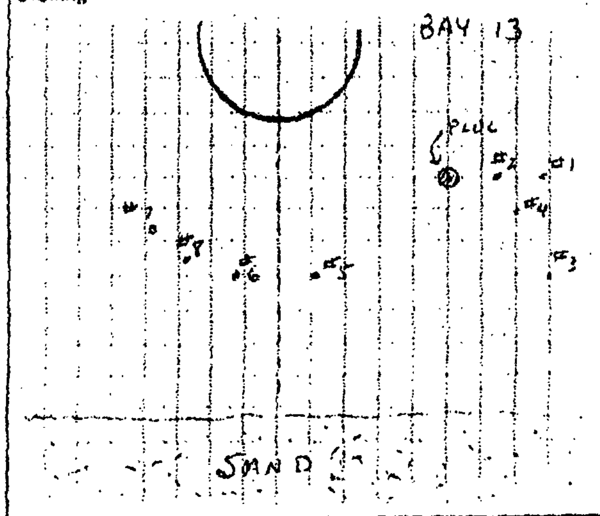
| | | | | | | |
|---|---|---|---|---|---|---|
| Cal. Blk. | .502" | 1.499" | NA | | | |
| D-Meter | .502" | 1.500" | | | | |

Techniques: ☐ CRT ☒ D-Meter Other NA

**Position # Reading In Inches**

| AREA | LOCATION | THK |
|---|---|---|
| 1 | D 6" R 46" | .914" |
| 2 | D 6" R 39" | .615" ✓ |
| 3 | D 16" R 49" | .930" |
| 4 | D 12" R 35" | .914" |
| 5 | D 26" R 6" | .735" ✓ |
| 6 | D 24" L 8" | .633" ✓ |
| 7 | D 17" L 23 | .632" ✓ |
| 8 | D 22" L 20" | .744" |

Drawing




Reviewed by: [signature] Level: N/A Date: 1-8-93 Page 1 of 1

43455 (05-91)

# GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 93 of 117 |
| Originator: Mark Yekta | Date: 01/12/93 | Reviewed by: S. C. Tumminelli | | Date |

## Ultrasonic Thickness Data Sheet

GPU Nuclear

☒ OC ☐ TMI-1 ☐ TMI-2 | Class: N/A | Item: N/A | NDE Request: 92-032 | Data Sheet No.: 92-032-21

Task Description: Drywell Liner Thk. Measurements | Task No.: N/A | Date: 1-11-93

Comp. Desc.: Drywell Liner Bay 13 | System: 187 | Code/Spec.: N/A (Eng. Safor)

Procedure/Rev.: 6100-QAP-7209.07 Rev. 0 | Drawing No./Rev.: 3E-187-24-001

Test Surface: O.D. | Thickness: 1 1/8" | Material: C.S.

Examiner | Sign: [signature] | Print: S. Van der Cruijk | ID No.: 157-92-C-31 | Level: II

Examiner | Sign: [signature] | Print: Luis Valenzuela | ID No.: 80-44-2524 | Level: II

Thermometer S/N 92-065 | Part Temperature 65 F | D-Meter S/N 92-035

Cal. Blk. S/N 219 | Cal. In: 1:1 AM 2:25 PM

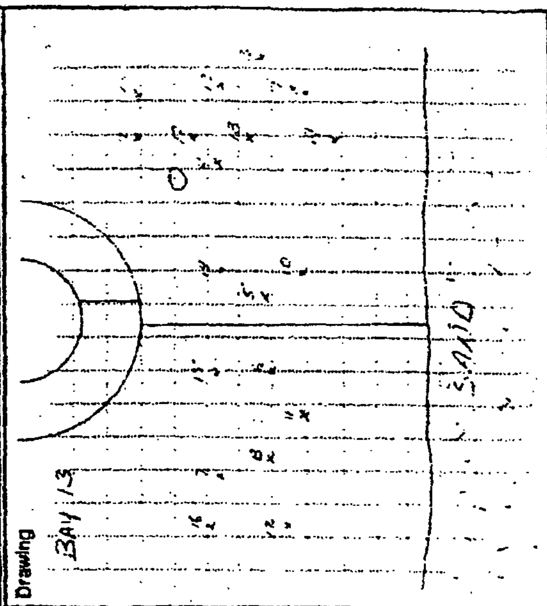
Cal. Blk. Temp. 65 F | Cal. Out: 1:4 AM 2:30 PM

**Calibration Readings (Inches)**

| Cal. Blk. | .5 | 1.0 | 1.5 |
|---|---|---|---|
| D-Meter | .5 | 1.0 | 1.5 |

**Techniques:** ☐ CRT ☒ D-Meter Other ______

**Drawing**




**Position #/Reading in Inches**

| AREA | LOCATION | | THK. |
|---|---|---|---|
| 1 | UP-1" | R-45" | 0.672" * |
| 2 | UP-1" | R-38" | 0.725" |
| 3 | O-21" | R-48" | 0.941" |
| 4 | O-12" | R-36" | 0.915" |
| 5 | O-21" | R-6" | 0.718" * |
| 6 | O-24" | L-8" | 0.655" * |
| 7 | O-17" | L-22" | 0.616" * |
| 8 | O-24" | L-26" | 0.716" * |
| 9 | O-28" | R-41" | 0.924" |
| 10 | O-26" | R-12" | 0.728" * |
| 11 | O-28" | L-15" | 0.685" * |
| 12 | O-26" | L-23" | 0.885" |
| 13 | O-18" | R-40" | 0.922" |
| 14 | O-15" | R-8" | 0.668" |
| 15 | O-20" | L-9" | 0.655" |
| 16 | O-20" | L-29" | 0.839" |
| 17 | O-9" | R-22" | 0.867" |
| 18 | O-22" | R-28" | 0.825" |
| 19 | O-37" | R-38" | 0.912" |

20 [illegible] 1.17" [illegible]

* All the measurement [illegible] on the CRT

Reviewed by: [signature] | Level: III | Date: 1-11-93 | Page 1 of 2

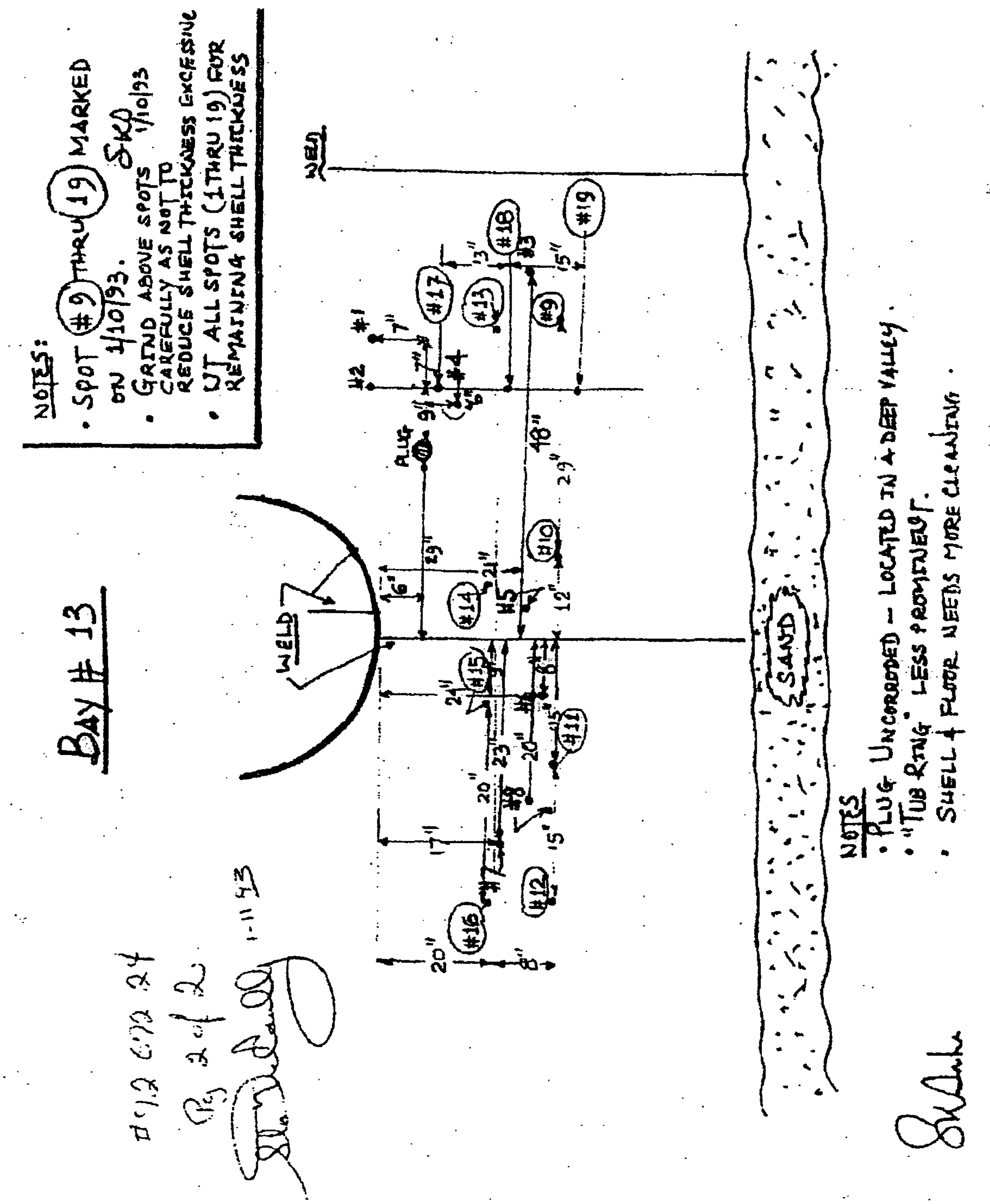
*** [illegible]

7 Points [illegible]

OCLR00014630

## GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 94 of 117 |
| **Originator** | **Date** | **Reviewed by** | | **Date** |
| Mark Yekta | 01/12/93 | S. C. Tumminelli | | |



**GPU Nuclear**

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 95 of 117 |

| Originator | Date | Reviewed by | Date |
|---|---|---|---|
| Mark Yekta | 01/12/93 | S. C. Tumminelli | |

GPU Nuclear

## Ultrasonic Thickness Data Sheet

☑ OC ☐ TMI-1 ☐ TMI-2 Class: N/A Item: NA NDE Request: 92-072 Data Sheet No.: 92-072-15

Task Description: Drywell liner Thk. measurement Task No.: N/A Date: 1/11/93

Comp. Desc.: Drywell liner Bay 13 System: 187 Code/Spec.: Eng Info

Procedure/Rev.: 6100-QAP-7209.07 Rev 0 Drawing No./Rev.: 3E-187-29-001

Test Surface: O.D. Thickness: 1 1/8" Material: C/S

Examiner Sign: [signature] Print: J. VanderLinde ID No.: 157-48-0210 Level: II

Examiner Sign: NA Print: NA ID No.: NA Level: NA

Thermometer S/N 92-062 Part Temperature 70 F D-Meter S/N 92-035

Cal. Blk. S/N 219 Cal. In: NA AM 1030 PM

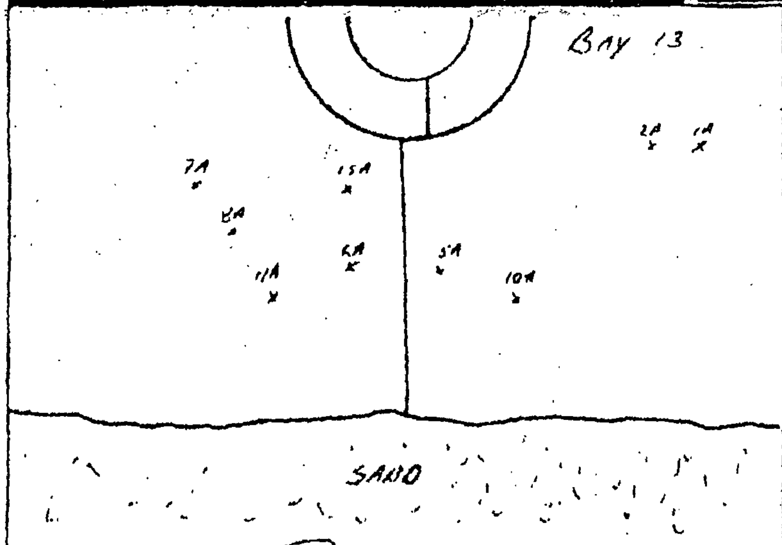
Cal. Blk. Temp. 70 F Cal. Out: NA AM 1045 PM

Calibration Readings (inches)

| Cal. Blk. | .5 | 1.0 | 1.5 | N/A | | |
|---|---|---|---|---|---|---|
| D-Meter | .5 | 1.0 | 1.5 | | | |

Techniques: ☐ CRT ☑ D-Meter Other ______

Position #/Reading in Inches




Drawing

| AREA | Thickness |
|---|---|
| 1A | 0.89" |
| 2A | 0.943" |
| 5A | 0.851" |
| 10A | 0.81" |
| 11A | 0.854" |
| 8A | 0.9" |
| 7A | 0.752" |
| 6A | ~~0.839~~" .776" |
| 15A | ~~0.866~~ .850" |

"A" minimal grind areas adjacent to previous grind/UT locations

Reviewed by: [signature] Level: III Date: 1/11/93 Page 1 of 1

N5455 (05-90)

OCLR00014632

## GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 96 of 117 |
| **Originator** Mark Yekta | **Date** 01/12/93 | **Reviewed by** S. C. Tumminelli | | **Date** |

Aone under

### GPU Nuclear — Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 | Class: NA | Item: NA | NDE Request: 92-072 | Data Sheet No.: 92-072-46

Task Description: Drywell liner Thickness | Task No.: N/A | Date: 1/11/93

Comp. Desc.: Drywell liner Bay 13 | System: 187 | Code/Spec.: Eng. Info.

Procedure/Rev.: 6100-QAP 7209.07 Rev. 0 | Drawing No./Rev.: 3E-187-29-001

Test Surface: O.D. | Thickness: 1 1/8" | Material: C/S

Examiner Sign: [signature] | Print: J. Van der Linde | ID No.: 154-48-0318 | Level: II

Examiner Sign: NA | Print: NA | ID No.: NA | Level: NA

Thermometer S/N 22-068 | Part Temperature 70 F | D-Meter S/N 132-113

Cal. Blk. S/N 219 | Cal. In: NA AM 10:32 PM

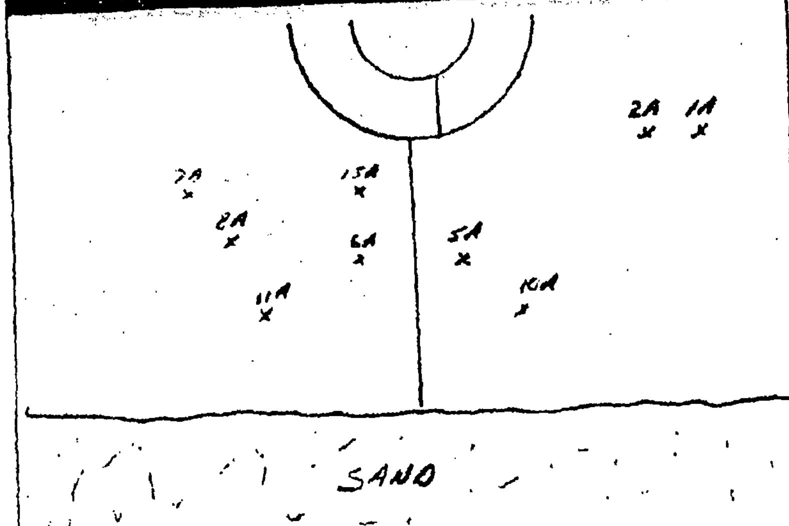
Cal. Blk. Temp. 70 F | Cal. Out: NA AM 11:25 PM

Calibration Readings (inches)

| Cal. Blk. | .5 | 1.0 | 1.5 | N/A | |
|---|---|---|---|---|---|
| D-Meter | .5 | 1.0 | 1.5 | | |

Techniques: ☑ CRT ☑ D-Meter Other ____

Position & Reading in Inches




Drawing

| AREA | Thickness |
|---|---|
| 1A | 0.88 |
| 2A | 0.9 |
| 5A | 0.83 |
| 10A | 0.82 |
| 11A | 0.83 |
| 8A | 0.87 |
| 7A | 0.76 |
| 6A | 0.93 |
| 15A | 0.85 |

"A" minimal grind areas adjacent to previous grind/UT locations.

Reviewed by: [signature] | Level: III | Date 1-11-93 | Page 1 of 1

NS455 (04-90)

GPU Nuclear

## Calibration Sheet

Cal Sheet# 14R-113

| | | | |
|---|---|---|---|
| System 187 | Component BAY 13 Liner | Procedure 6100-QAP-7209.07 | Rev 0 |
| Examiner: Signature: [signature] | Print: J. VanderLinde | Initial: JV | ID# 154-89-0247 / Level II |
| Examiner: Signature: n/a | Print: n/a | Initial: n/a | ID# n/a / Level n/a |

**Instrument Settings**
ID# 137-113
Model/Manuf Sonic 132 Staveley

Gain
Coarse 42.6
Fine n/a
Uncal n/a

Sweep Circuit
Coarse 2" (Range)
Fine n/a 0.224
Delay 0.365"
Screen Depth 2"

Operation (T&R) Normal
Frequency: 5 MHZ
Reject: ( )Off ( )On %
Filter: ( )Off ( )On 1 %
Damping: ( )Off ( )On 100 %

Rep Rate: 280 Hz

**Cal Standard**
ID# 219
Size n/a Sch. n/a
Thickness .5 to 1.5"
S/S (CS)
Temp 70 °F

**System Check**
☐Exit Point
☐Angle +/- 2 n/a

Date 1/11/93

**Search Unit**
ID# B02264
Type KBA Gamma
Freq 5 MHZ
Size .25"
Angle 0 Mode long

**Cal Direction**
☐Axial ☐Both
☐Circ. ☒Normal

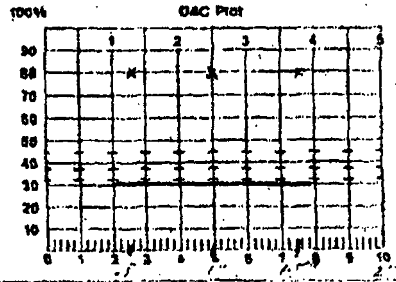
Time 1032 AM

**Search Unit Cable**
Type 5K contact Length 2x6'

**Couplant**
Make Soundsafe Batch# SIP 89-1101

**Thermometer**
S/N: 92-018 Cal Due 5/24/93

DAC Plot



| Reflector | Amplitude % of FSH | Screen Reading in Inches |
|---|---|---|
| .5 | 83 | .5 |
| 1.0 | 80 | 1.0 |
| 1.5 | 80 | 1.5 |

| Time/Date | normal 1/11/93 | | / | | / | |
|---|---|---|---|---|---|---|
| Reflector | % FSH | Inches | % FSH | Inches | % FSH | Inches |
| .5 | 80 | .5 | | | | |
| 1.0 | 80 | 1.0 | | | | |
| 1.5 | 80 | 1.5 | | | | |
| Initials | JV | | | | | |

Remarks:
Digital utilized
Gate at 30% FSH
Refer to UT Thickness
Data sheet 92-072-26

Components Examined:
Drywell liner Bay 13

ANI Review

Technical Review
Reviewed By [signature]
Level [signature] Date 1-11-93

NDE Request#: 92-072

N0327 (05-90)

GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 98 of 117 |
| Originator | Date | Reviewed by | | Date |
| Mark Yekta | 01/12/93 | S. C. Tumminelli | | |

GPU Nuclear

☒ OC ☐ TMI ☐ OTHER ______

Sketch Form (with grid)

Component: DRY WELL LINEAR

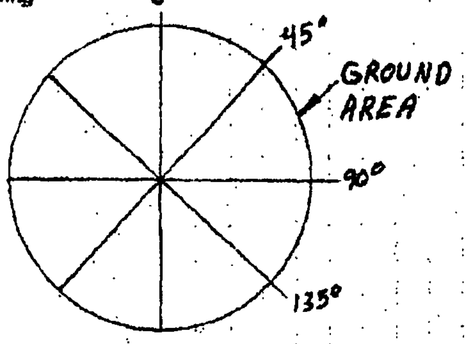
Location: BAY 13

Data Sheet No.: 92-072-24 27

Drawing No.: N/A

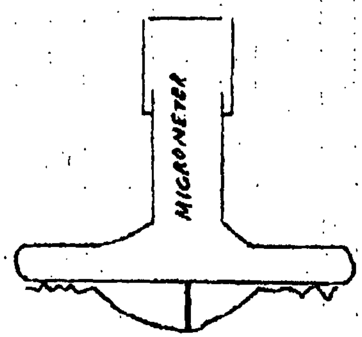
Rev.: N/A

Drawing




| UT READING LOCATIONS | 0° | 45° | 90° | 135° |
|---|---|---|---|---|
| 1 | .330 | .382 | .346 | .346 |
| 2 | .312 | .377 | .360 | .393 |
| 5 | .150 | .193 | .230 | .298 |
| 6 | .327 | .339 | .290 | .247 |
| 7 | .241 | .279 | .260 | .239 |
| 8 | .324 | .245 | .262 | .279 |
| 10 | .186 | .173 | .255 | .229 |
| 11 | .240 | .231 | .271 | .283 |
| 15 | .288 | .277 | .239 | .285 |

DEPTH MICROMETER USED QC-2-39
VERIFIED ON BLOCK 219 & 207




TECHNIQUE USED TO
DETERMINE DETH OF GROUND AREAS

| | | | |
|---|---|---|---|
| Prepared by: [signature] | | Title: VT LEVEL II | Date: 1-11-93 |
| Reviewed by: [signature] | Level: II | Date: 1-13-93 | Page 1 of 1 | NDE Request No.: 92-072 |

FORM 6130-OAP-7200 06 (12-83)

N5454 (05-90)

two shots?

## GPU Nuclear — Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A | Item: N/A | NDE Request: 92-072 | Data Sheet No.: 92-072-31 |
| Task Description: UT Thickness | | Task No.: N/A | Date: 1-8-93 |
| Comp. Desc.: Drywell Liner | System: 187 | Code/Spec.: Eng. Info. | |
| Procedure/Rev.: 6100-QAP-7209.07 Rev. 0 | | Drawing No./Rev.: 3E-187-29-001 | |
| Test Surface: O.D. | | Thickness: 1 1/8" | Material: c/s |
| Examiner Sign: [signature] | Print: Jon VanderLinde | ID No.: 157-48-0319 | Level: II |
| Examiner Sign: [signature] | Print: Luis Valenzuela | ID No.: 110-44-1524 | Level: II |

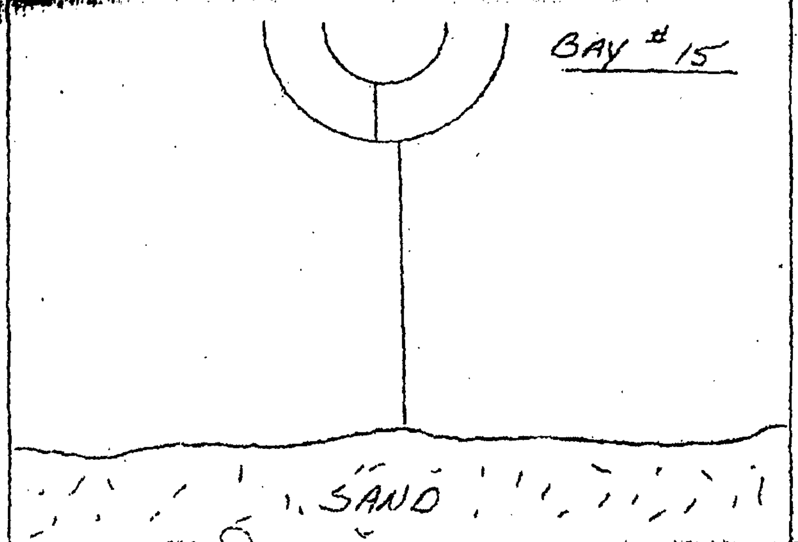
Thermometer S/N 92-065 Part Temperature 70°F D-Meter S/N 92-035
Cal. Blk. S/N 212 Cal. In: 0020 AM ___ PM
Cal. Blk. Temp. 72 F Cal. Out: 0205 AM ___ PM

**Calibration Readings (Inches)**

| | | | | | | |
|---|---|---|---|---|---|---|
| Cal. Blk. | .5 | 1.0 | 1.5 | | | |
| D-Meter | .5 | 1.0 | 1.5 | | | |

**Techniques:** ☐ CRT ☒ D-Meter Other ______

Drawing




| | AREA | MEASUREMENT |
|---|---|---|
| 1 | C-12" R-26" | 0.788" |
| 2 | C-22" R-24" | 0.824" |
| 3 | C-33" R-17" | 0.732" |
| 4 | C-32" R-7" | 0.745" |
| 5 | C-26" L-3 | 0.83" |
| 6 | C-6 L-8" | 0.774" |
| 7 | C-24" L-17" | 0.803" |
| 8 | C-24" L-36" | 0.72 |
| 9 | C-36" L-40" | 0.762" |
| 10 | C-24" L-40" | 0.56" |
| 11 | C-24" L-65" | 0.825" |

Reviewed by: [signature] Level: II Date: 1-8-93 Page 1 of 1

GPU Nuclear

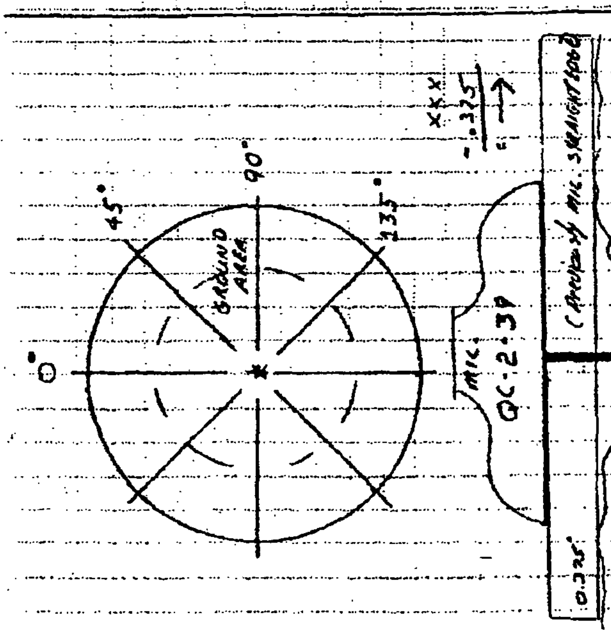
☒ OC ☐ TMI ☐ OTHER ______

**Sketch Form (with grid)**

Component: DRYWELL liner SANDBED AREA | Data Sheet No.: 92-072-30

Location: BAY # 15 | Drawing No.: N/A | Rev.: N/A

Drawing




Technique utilized for The pit depth MEASUREMENTS

AZIMUTH

| AREA | 0° | 45° | 90° | 135° |
|---|---|---|---|---|
| 9 | .356 | .350 | .359 | .282 |

Prepared by: [signature] | Title: VT LV II | Date: 1/12/93

Reviewed by: [signature] | Level: II | Date: 1-13-93 | Page 1 of 1 | NDE Request No.: 92-072

ORM6130-OAP-7200.08 (12-83)

# GPU Nuclear

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 101 of 117 |
| Originator: Mark Yekta / Date: 01/12/93 | Reviewed by: S. C. Tumminelli | | Date |

## GPU Nuclear — Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 Class: n/a | Item: n/a | NDE Request: 92-077 | Data Sheet No.: 92-077-01 |
| Task Description: UT Thickness Measurements | | Task No.: n/a | Date: 12/5/92 |
| Comp. Desc.: Drywell liner Bay 17 | System: 187 | | Code/Spec.: ASME Sect. VIII |
| Procedure/Rev.: 6100-QAP-7209.03 Rev. 0 | | Drawing No./Rev.: 3E-187-29-001 Rev. 0 | |
| Test Surface: O.D. | | Thickness: 1 1/8" | Material: c/s |
| Examiner Sign: [signature] | Print: Jonathan Van der Linde | ID No.: 154-48-0319 | Level: II |
| Examiner Sign: [signature] | Print: Mark F. Bagnell | ID No.: 553-81-1802 | Level: I |

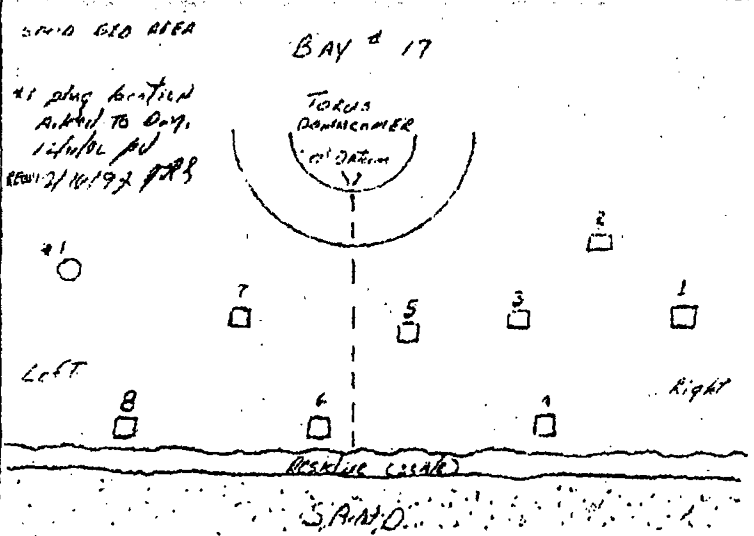
Thermometer S/N 92-007 Part Temperature 65 F D-Meter S/N 152-115
Cal. Blk. S/N 218 Cal. In: 2:10 AM n/a PM
Cal. Blk. Temp. 68 F Cal. Out: 2:35 AM n/a PM

**Calibration Readings (inches)**

| Cal. Blk. | 0.5" | 0.75" | 1.0" | 1.25" | 1.5" | n/a |
|---|---|---|---|---|---|---|
| D-Meter | 0.5" | 0.75" | 1.0" | 1.25" | 1.5" | n/a |

**Techniques:** ☒ CRT ☒ D-Meter Other: Sonic 132

**Position #/Reading in Inches**




**Drawing**

| AREA | *Position | | **UT measurement |
|---|---|---|---|
| 1 | 0.30" | R-52" | 0.98" |
| 2 | 0.12" | R-42" | 1.16" |
| 3 | 0.22" | R-28" | 0.92" |
| 4 | 0.53" | R-30" | 1.02" |
| 5 | 0.36" | R-12" | 0.94" |
| 6 | 0.54" | R-6" | 1.01" |
| 7 | 0.36" | L-26" | 0.97" |
| 8 | 0.52" | L-40" | 1.03" |

*Approximate position measurements
D: Down R: Right L: Left

** uniform backwall reflection indicates uniform surface at I.D. of Liner.

Reviewed by: [signature] Level: III Date: 12-5-92 Page 1 of 1

N5455 (06-90)

All above ...

OCLR00014638

## GPU Nuclear

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 102 of 117 |

| Originator | Date | Reviewed by | Date |
|---|---|---|---|
| Mark Yekta | 01/12/93 | S. C. Tumminelli | |

GPU Nuclear

# Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: n/a | Item: n/a | NDE Request: 92-072 | Data Sheet No.: 92-072-04

Task Description: UT Thickness | Task No.: n/a | Date: 12/14/92

Comp. Desc.: Drywell Liner Bay 17 | System: 187 | Code/Spec.: ASME Sect VIII

Procedure/Rev.: 6100-QAP-7209.03 Rev 0 | Drawing No./Rev.: 3E-187-29-001 Rev. 0

Test Surface: O.D. | Thickness: 1 1/8" | Material: C/S

| Examiner | Sign: [signature] | Print: Jonathan Hawkes Cook | ID No.: 154-90-038 | Level: II |
|---|---|---|---|---|
| Examiner | Sign: n/a | Print: n/a | ID No.: n/a | Level: n/a |

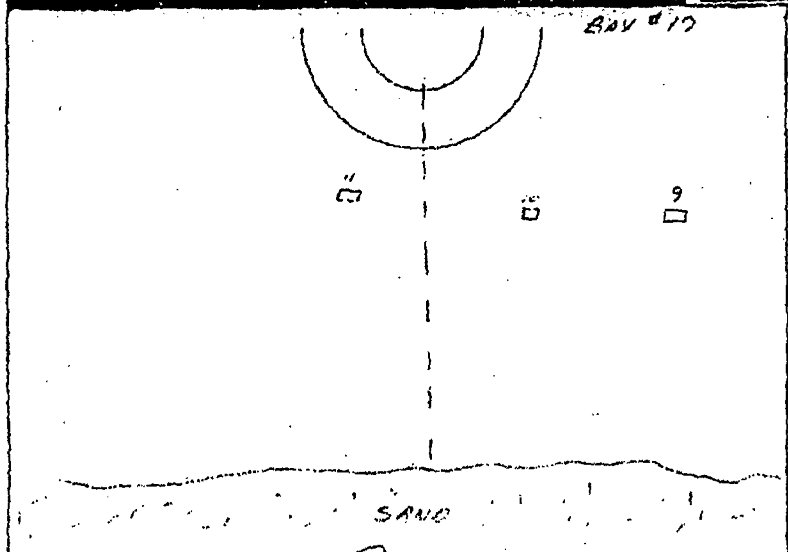
Thermometer S/N 92-057 Part Temperature 68 F D-Meter S/N 92-112
Cal. Blk. S/N 53 Cal. In: n/a AM 1:20 PM
Cal. Blk. Temp. 69 F Cal. Out: n/a AM 1:35 PM

Calibration Readings (inches)

| Cal. Blk. | .5 | .75 | 1.0 | N/A | | |
|---|---|---|---|---|---|---|
| D-Meter | .5 | .75 | 1.0 | | | |

Techniques: ☒ CRT ☒ D-Meter Other ____

Position #/Reading in Inches




Drawing

| Area | | Thickness |
|---|---|---|
| 9 | 0.25" x .30" | 0.76" |
| 10 | 0.25" x .11" | 0.75" |
| 11 | 0.21" x .12" | 0.76" |

Performed after additional grinding

Reviewed by: [signature] Level: III Date: 12-16-92 Page 1 of 1

NS455 (03-90)

OCLR00014639

## GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 103 of 117 |
| **Originator** | **Date** | **Reviewed by** | | **Date** |
| Mark Yekta | 01/12/93 | S. C. Tumminelli | | |

**GPU Nuclear** — **Ultrasonic Thickness Data Sheet**

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 — Class: N/A | Item: N/A | NDE Request: 92-072 | Data Sheet No.: 92-072-06 |
| Task Description: UT Thickness | | Task No.: N/A | Date: 12/14/92 |
| Comp. Desc.: Drywell liner Bay 17 | System: 187 | Code/Spec.: ASME Sect VIII | |
| Procedure/Rev.: 6100-QAP-7209.03 Rev. 0 | | Drawing No./Rev.: 3E-187-29-001 Rev. 0 | |
| Test Surface: O.D. | | Thickness: 1 1/8" | Material: C/S |
| Examiner Sign: [signature] | Print: J. Vancher Linde | ID No.: 154-48-0519 | Level: II |
| Examiner Sign: N/A | Print: N/A | ID No.: N/A | Level: N/A |

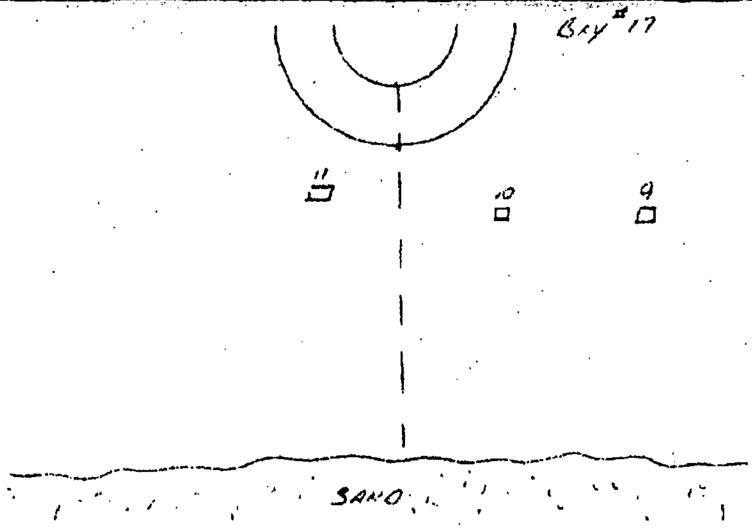
Thermometer S/N 92-057 Part Temperature 65 F ~~D-Meter S/N~~ 92-010
Cal. Blk. S/N 38 Cal. In: N/A AM 1:05 PM
Cal. Blk. Temp. 68 F Cal. Out: N/A AM 1:21 PM

**Calibration Readings (inches)**

| | | | | | |
|---|---|---|---|---|---|
| Cal. Blk. | .5" | .75" | 1.0 | N/A | |
| D-Meter | .5" | .75" | 1.0 | | |

**Techniques**: ☒ CRT ☒ D-Meter Other ______

**Position #/Reading In Inches**




**Drawing**

| Area | | Thickness |
|---|---|---|
| 9 | 0.27" R 32" | 0.72" |
| 10 | 0.26" R 11" | 0.53" |
| 11 | 0.26" L 12" | 0.77" |

Performed after additional grinding was done

Reviewed by: [signature] Level: III Date: 12-16-92 Page 1 of 1

N3455 (05-90)

OCLR00014640

# GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 104 of 117 |
| **Originator** Mark Yekta | **Date** 01/12/93 | **Reviewed by** S. C. Tumminelli | | **Date** |

## GPU Nuclear — Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 — Class: N/A | Item: N/A | NDE Request: 92-072 | Data Sheet No.: 92-072-05 |
| Task Description: UT Thickness Measurements | | Task No.: N/A | Date: 12/11/92 |
| Comp. Desc.: Drywell Liner Bay 187 | System: 187 | | Code/Spec.: ASME Sect. VIII |
| Procedure/Rev.: 6100-QAP-7209.07 Rev. 0 | | Drawing No./Rev.: 3E-187-29-001 Rev. 0 | |
| Test Surface: O.D. | | Thickness: 1 1/8" | Material: C/S |
| Examiner Sign: [signature] | Print: Jonathan VanderLinde | ID No.: 154-48-0318 | Level: II |
| Examiner Sign: [signature] | Print: Mark F. Bagnell | ID No.: 551-81-1862 | Level: II |

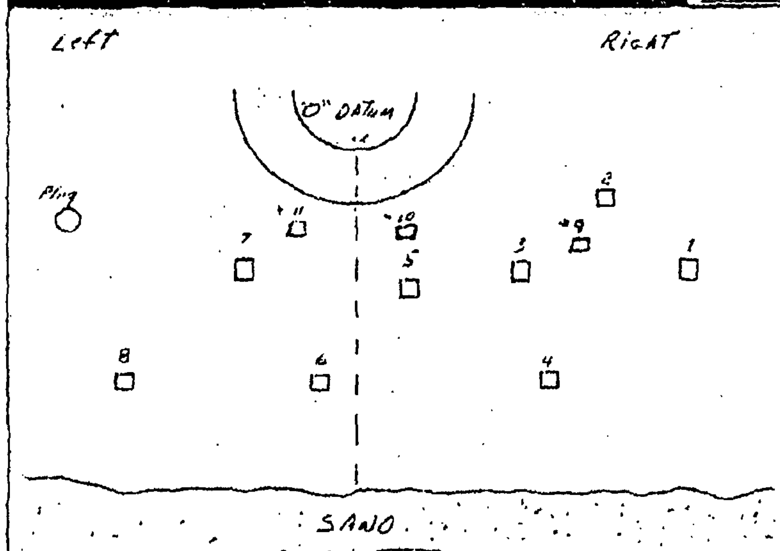
Thermometer S/N 27-013  Part Temperature 72 F  D-Meter S/N 92-010
Cal. Blk. S/N 88  Cal. In: 1145 AM n/a PM
Cal. Blk. Temp. 72 F  Cal. Out: n/a AM 1225 PM

**Calibration Readings (inches)**

| Cal. Blk. | 0.5" | 0.75" | 1.0" | N/A | N/A | N/A |
|---|---|---|---|---|---|---|
| D-Meter | 0.5" | 0.75" | 1.0" | | | |

Techniques: ☐ CRT ☒ D-Meter  Other ____

**Position # Reading in Inches**




Drawing

| Area | Position | | Thickness |
|---|---|---|---|
| 1 | 0-30" | R-52" | 0.916" |
| 2 | 0-12" | R-42" | 1.15" |
| 3 | 0-33" | R-35" | 0.898" |
| 4 | 0-52" | R-30" | 0.954" |
| 5 | 0-36" | R-14" | 0.913" |
| 6 | 0-52" | L-6" | 0.992" |
| 7 | 0-36" | L-26" | 0.92" |
| 8 | 0-52" | L-40" | 0.98" |
| Plug | 0-22" | L-58" | |
| *9 | L-27" | A-30" | 0.83" [illegible] |
| *10 | 0-21" | R-4" | 0.843" [illegible] |
| *11 | 0-21" | L-12 | 0.762" [illegible] |

*Areas Dished - High noise level unable to achieve accuracy

Reviewed by: [signature]  Level: II  Date: 12-16-92  Page 1 of 1

N5455 (05-90)

OCLR00014641

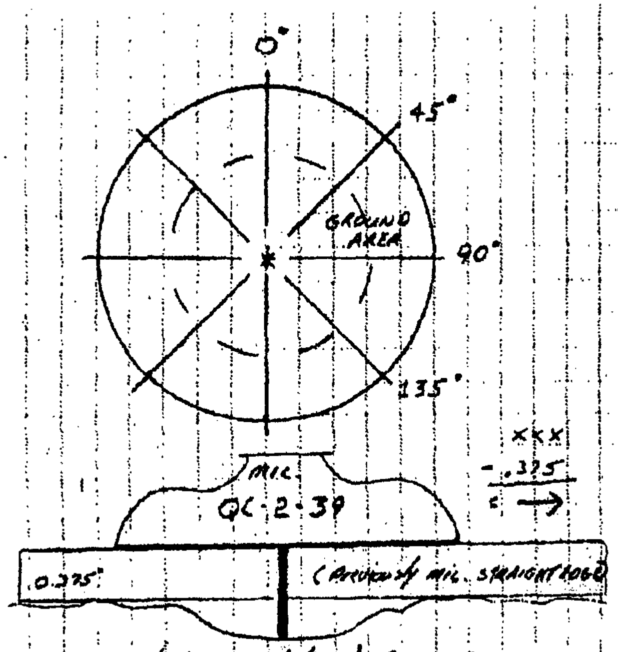
GPU Nuclear

☒ OC ☐ TMI ☐ OTHER ____________

**Sketch Form (with grid)**

| | |
|---|---|
| Component: DRYWELL liner SANDBED AREA | Data Sheet No.: 92-072-29 |
| Location: BAY # 17 | Drawing No.: N/A Rev.: N/A |

Drawing




| | AZIMUTH | | | |
|---|---|---|---|---|
| AREA | 0° | 45° | 90° | 135° |
| 9 | .368 | .407 | .289 | .342 |

| | | | |
|---|---|---|---|
| Prepared by: [signature] | | Title: VT LV II | Date: 1/12/93 |
| Reviewed by: [signature] | Level: II | Date: 1-13-93 | Page 1 of 1 | NDE Request No.: 92-072 |

## GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 106 of 117 |
| Originator: Mark Yekta | Date: 01/12/93 | Reviewed by: S. C. Tumminelli | | Date |

GPU Nuclear

# Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 Class: nh | Item: nh | NDE Request: 92-072 | Data Sheet No.: 92-072-02 |
| Task Description: UT Thickness | | Task No.: nh | Date: 12/5/92 |
| Comp. Desc.: Drywell Liner Bay 19 | System: 187 | Code/Spec.: ASME Sect VIII | |
| Procedure/Rev.: 6100-QAP-7209.07 Rev. 0 | | Drawing No./Rev.: 3E-187-29-001 Rev. 0 | |
| Test Surface: O.D. | | Thickness: 1 1/8" | Material: C/S |
| Examiner Sign: [signature] | Print: Jonathan Vancha Linde | ID No.: 154-42-0319 | Level: II |
| Examiner Sign: [signature] | Print: Mark F. Bagnell | ID No.: 553-81-1802 | Level: I |

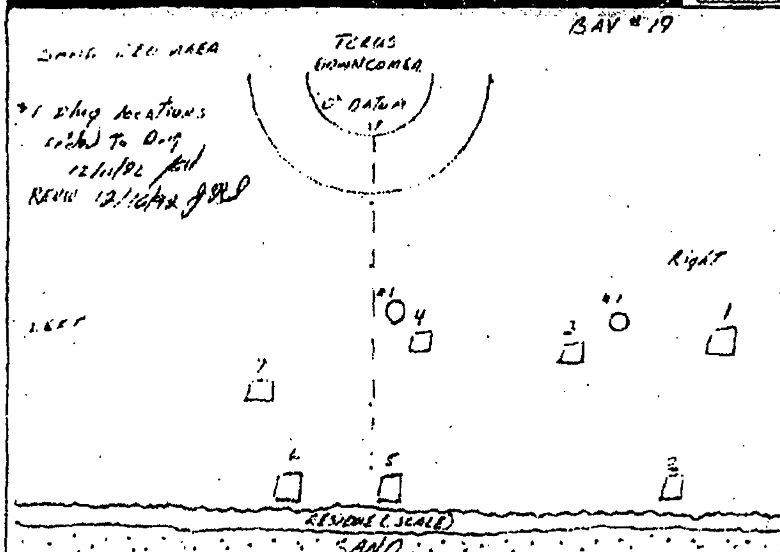
Thermometer S/N 92-077 Part Temperature 68 F D-Meter S/N 132-113
Cal. Blk. S/N 212 Cal. In: 10:20 AM nh PM
Cal. Blk. Temp. 68 F Cal. Out: 10:36 AM nh PM

Calibration Readings (inches)

| Cal. Blk. | 0.5 | 0.25 | 1.0 | 1.25 | 1.5 | |
|---|---|---|---|---|---|---|
| D-Meter | 0.5 | 0.25 | 1.0 | 1.25 | 1.5 | |

Techniques: ☒ CRT ☒ D-Meter Other Sonic 132

Position #/Reading in Inches




Drawing

| AREA | *POSITION | UT MEASUREMENT** |
|---|---|---|
| 1 | D-30" R-70" | 0.94" |
| 2 | D-52" R-66" | 0.96" |
| 3 | D-12" R-49" | 0.98" |
| 4 | D-32" R-11" | 0.99" |
| 5 | D-53" R-2" | 0.95" |
| 6 | D-52" L-6" | 0.86" |
| 7 | D-39" L-12" | 0.93" |

* Position measurements are approximate

** uniform backwall reflection indicates a uniform surface at the I.D. of liner

Reviewed by: [signature] Level: III Date: 12-5-92 Page 1 of 1

N5455 (05-90)

OCLR00014643

**GPU Nuclear** — **Ultrasonic Thickness Data Sheet**

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A | Item: N/A | NDE Request: 92-072 | Data Sheet No.: 92-072-03 |
| Task Description: UT Thickness | | Task No.: N/A | Date: 12/16/92 |
| Comp. Desc.: Drywell Liner Bay # 19 | System: 187 | | Code/Spec.: ASME Sect XI |
| Procedure/Rev.: 6100-QAP-7209.03 Rev 0 | | Drawing No./Rev.: 3E-187-29-001 Rev 0 | |
| Test Surface: O.D. | | Thickness: 1 1/8" | Material: C/S |
| Examiner Sign: [signature] | Print: J. Haverche Lisch | ID No.: 157-38-0315 | Level: II |
| Examiner Sign: N/A | Print: N/A | ID No.: N/A | Level: N/A |

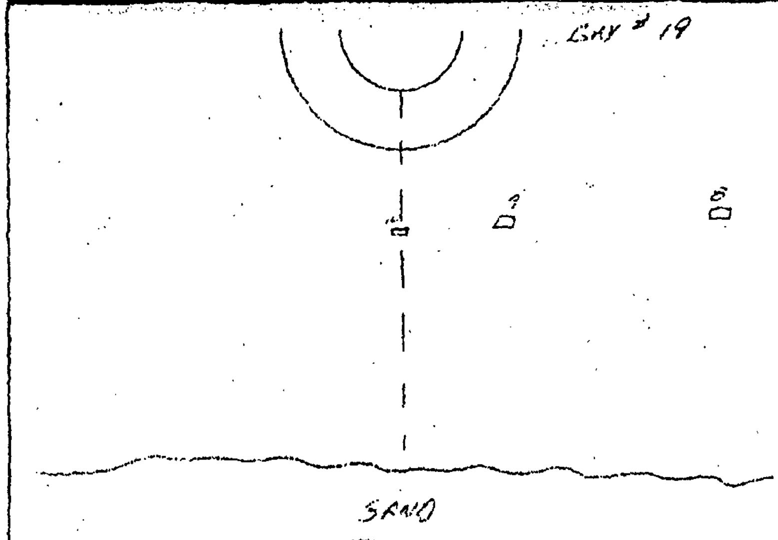
Thermometer S/N 92-057 Part Temperature 65 F D-Meter S/N 137-113
Cal. Blk. S/N 88 Cal. In: N/A AM 1:31 PM
Cal. Blk. Temp. 66 F Cal. Out: N/A AM 2:00 PM

**Calibration Readings (Inches)**

| Cal. Blk. | .5" | .75" | 1.0 | N/A | | |
|---|---|---|---|---|---|---|
| D-Meter | .5" | .75" | 1.0 | | | |

Techniques: ☒ CRT ☒ D-Meter Other ____

**Position #/Reading In Inches**




**Drawing**

| Point | | Thickness |
|---|---|---|
| 8. | 0'-16" R 8.5" | 0.957 |
| 9. | 0'-18" R 12" | 0.785 |
| 10 | 0'-15" R 0" | 0.826 |

Performed after additional grinding

Reviewed by: [signature] Level: III Date: 12-16-92 Page 1 of 1

N3455 (05-90)

GPU Nuclear

## Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 Class: n/a | Item: n/a | NDE Request: 92-572 | Data Sheet No.: 92-572-05 |
| Task Description: UT Thickness | | Task No.: n/a | Date: 12/14/92 |
| Comp. Desc.: Drywell liner Bay 19 | System: 187 | | Code/Spec.: ASME Sect VIII |
| Procedure/Rev.: 6100-QAP-7209.07 Rev. 0 | | Drawing No./Rev.: 3E-187-29-001 Rev. 0 | |
| Test Surface: O.D. | | Thickness: 1 1/8" | Material: c/s |
| Examiner Sign: [signature] | Print: J. VanSickle | ID No.: 15448-0319 | Level: II |
| Examiner Sign: n/a | Print: n/a | ID No.: n/a | Level: n/a |

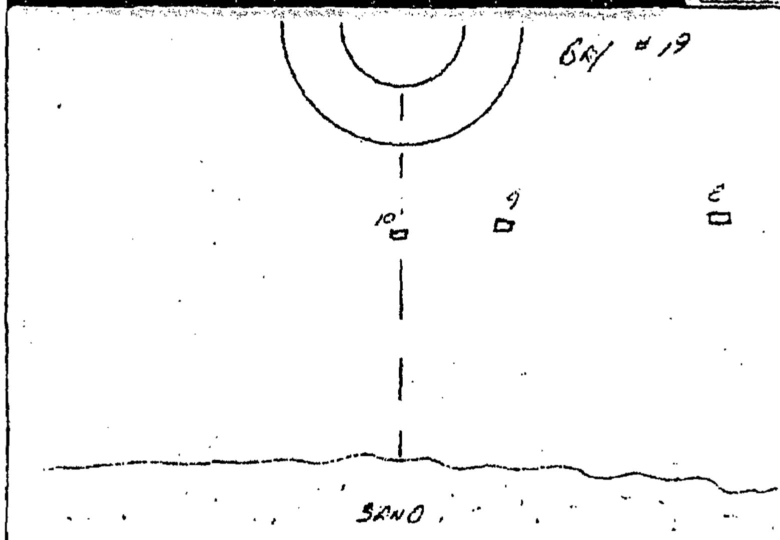
Thermometer S/N 92-017 Part Temperature 65 F D-Meter S/N 92-010
Cal. Blk. S/N 68 Cal. In: n/a AM 1:37 PM
Cal. Blk. Temp. 65 F Cal. Out: n/a AM 2:05 PM

**Calibration Readings (Inches)**

| Cal. Blk. | .5 | .75 | 1.0 | n/a | |
|---|---|---|---|---|---|
| D-Meter | .5 | .75 | 1.0 | | |

**Techniques**: ☒ CRT ☒ D-Meter Other ____

Position #/Reading In Inches




Drawing

| AREA | THICKNESS |
|---|---|
| 8 @ 18" R 63" | 0.757 |
| 9 @ 10" R 12" | 0.776 |
| 10 @ 19" R 0" | 0.790 |

Performed after additional grinding

bak main levels

Reviewed by: [signature] Level: III Date: 12-16-92 Page 1 of 1

# GPU Nuclear

| Subject | | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | | C-1302-187-5320-024 | 1 | 109 of 117 |
| Originator: Mark Yekta | Date: 01/12/93 | Reviewed by: S. C. Tumminelli | | Date |

## GPU Nuclear — Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A | Item: N/A | NDE Request: 92-072 | Data Sheet No.: 92-072-07 |
| Task Description: UT THICKNESS | | Task No.: N/A | Date: 12-11-92 |
| Comp. Desc.: DRYWELL LINER BAY 19 | System: 187 | | Code/Spec.: ASME SEC VIII |
| Procedure/Rev.: 6100-QAP 7209.07 REV 0 | | Drawing No./Rev.: 3E-187-21-001 REV 0 | |
| Test Surface: O.D. | | Thickness: 1 1/8" | Material: C/S |
| Examiner Sign: [signature] | Print: Jonathan Underkircle | ID No.: 157-48-0219 | Level: II |
| Examiner Sign: [signature] | Print: MARK F BAGNELL | ID No.: 553-81-1602 | Level: I |

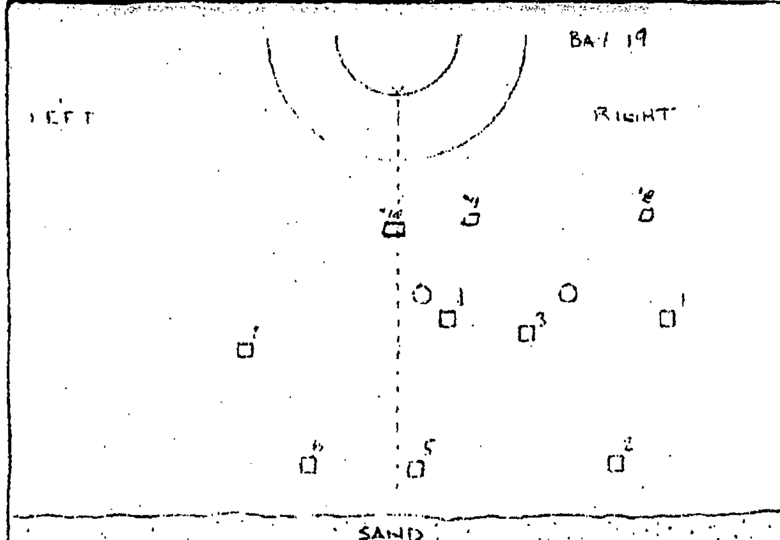
Thermometer S/N E1-052 Part Temperature 72° F D-Meter S/N 92-010
Cal. Blk. S/N EE Cal. In: N/A AM 12:45 PM
Cal. Blk. Temp. 72° F Cal. Out: N/A AM 12:15 PM

**Calibration Readings (Inches)**

| | | | | | | |
|---|---|---|---|---|---|---|
| Cal. Blk. | 0.5 | 0.75 | 1.0 | N/A | N/A | N/A |
| D-Meter | 0.5 | 0.75 | 1.0 | N/A | N/A | N/A |

**Techniques:** ☐ CRT ☒ D-Meter Other N/A

**Position #/Reading In Inches**




**Drawing**

| AREA | LOCATION | | MEASUREMENT |
|---|---|---|---|
| 1 | D 7C | R 10" | 0.132" |
| 2 | D 62" | R 66" | 0.129" |
| 3 | D [illegible] | R 40" | 0.155" |
| 4 | D 42" | R 11" | 0.146" |
| 5 | D 53" | R 2" | 0.156" |
| 6 | D 52" | L 6" | 0.860 |
| 7 | D 31" | L 12" | 0.164" |
| *8 | D 16" | R 63" | ~~0.765~~ |
| *9 | D 18" | R 12" | ~~0.763~~ |
| *10 | D 17" | 9" | ~~0.78~~ |
| Plug #1 | D 21" | R 6" | |
| Plug #2 | D 21" | R 55" | |

[illegible]

* surface chiseled unable to achieve accurate measurement

Reviewed by: [signature] Level: III Date: 12-16-92 Page 1 of 1

OCLR00014646

GPU Nuclear

MOC ITMI

## Calibration Sheet

Cal Sheet# 034

| | | | |
|---|---|---|---|
| System 187 | Component Drywell Liner | Procedure 6100-QAP-7209.07 | Rev 0 |
| Examiner: Signature: [signature] | Print: J VanderLinde | Initial: [initials] ID# 154-43-[illegible] | Level II |
| Examiner: Signature: [signature] | Print: Mark F. Bagnell | Initial: MB ID# 553 [illegible] | Level I |

**Instrument Settings**
ID# 137-113
Model/Manuf Sonic 137 / Staveley

**Gain**
Coarse 60.2
Fine n/a
Uncal n/a

**Sweep Circuit**
Coarse 20" (cycled/[illegible]) (Range)
Fine n/a
Delay 1.0
Screen Depth 2" (Screen ID)

**Operation** (T&R) Normal
Frequency: 2.25 MHZ
Reject: Off On %
Filter: Off On 1 %
Damping: Off On 200 %

Rep Rate: 1000 Hz

**Cal Standard**
ID# 213
Size n/a Sch. n/a
Thickness .5 x 1.5"
S/S CS
Temp 68 °F

**System Check**
☐Exit Point
☐Angle +/- 2 N/A

**Search Unit**
ID# MC0524
Type MSEB
Freq 2 MHZ
Size 1/2"
Angle 0 Mode Long.

**Cal Direction**
☐Axial ☐Both
☐Circ. ☒Normal

**Search Unit Cable**
Type [illegible] dual [illegible] Length 2×6'

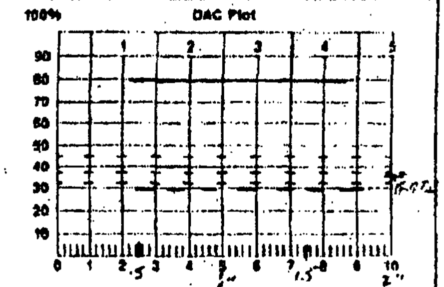
**Couplant**
Make Soundsafe Batch# [illegible]

**Thermometer**
S/N: 92-057 Cal Due 5-24-93

Date 12-5-92 Time 0910

| Reflector | Amplitude % of FSH | Screen Reading in Inches |
|---|---|---|
| .5 | 80 | .5 |
| .75 | 80 | .75 |
| 1.0 | 80 | 1.0 |
| 1.25 | 80 | 1.25 |
| 1.5 | 80 | 1.5 |

DAC Plot



| Time/Date | 0936 / 12-5-92 | | 1020 / 12-5-92 | | 1036 / 12-5-92 | |
|---|---|---|---|---|---|---|
| Reflector inches | % FSH | Inches | % FSH | Inches | % FSH | Inches |
| .5 | 80 | .5 | 80 | .5 | 80 | .5 |
| .75 | 80 | } | 80 | } | 80 | } |
| 1.0 | 80 | | 80 | | 80 | |
| 1.25 | 80 | | 80 | | 80 | |
| 1.5 | 80 | 1.5 | 80 | 1.5 | 80 | 1.5 |
| Initials | [initials] | | [initials] | | [initials] | |

**Remarks:**
* Reflections adjusted to 80% FSH as required
** Digital calibration independent of CRT
min .5"
max 1.5"

**Components Examined:**
Bay 17 → Bay 19

ANI Review

Technical Review
Reviewed By [signature]
Level III Date 12-5-92

NDE Request#: 92-72

N0927 (05-90)

## GPU Nuclear

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 111 of 117 |
| **Originator** Mark Yekta / **Date** 01/12/93 | **Reviewed by** S. C. Tumminelli | | **Date** |

**GPU Nuclear** — **Calibration Sheet**

Cal Sheet# [illegible]

| System | Component | Procedure | Rev |
|---|---|---|---|
| 187 | Drywell Shell | [illegible] | [illegible] |

| | Signature | Print | Initial | ID# | Level |
|---|---|---|---|---|---|
| Examiner: | [signature] | J. VanderLinde | JV | 154-48-0519 | II |
| Examiner: | [signature] | Mark F. Bagnell | MB | 153-81-1862 | I |

**Instrument Settings**
ID# [illegible]
Model/Manuf DL 26 Panametrics

Gain
Coarse n/a
Fine n/a
Uncal n/a

Sweep Circuit (Range)
Coarse n/a
Fine n/a
Delay n/a
Screen Depth n/a

Operation (T&R)
Frequency: n/a Normal MHZ
Reject: [ ]Off [ ]On n/a %
Filter: [ ]Off [ ]On n/a %
Damping: [ ]Off [ ]On n/a %

Rep Rate: n/a

**Cal Standard**
ID# 86
Size n/a Sch. n/a
Thickness .5/.75/1.0"
S/S (CS)
Temp 72 °F

**System Check**
[ ]Exit Point n/a
[ ]Angle +/- 2

Date 12/11/92

**Search Unit**
ID# 92-028
Type [illegible]
Freq 5 MHZ
Size [illegible]
Angle 0 Mode long

**Cal Direction**
[ ]Axial [ ]Both
[ ]Circ. [X]Normal

Time 1145

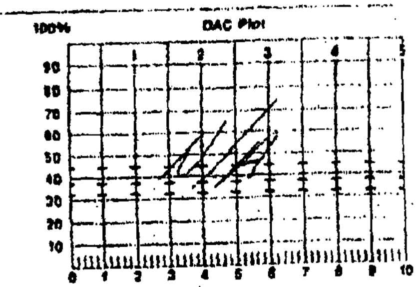
| Reflector | Amplitude % of FSH | Screen Reading in Inches |
|---|---|---|
| .5 | n/a | n/a |
| .75 | n/a | n/a |
| 1.0 | n/a | n/a |

**Search Unit Cable**
Type [illegible] Length 6 x 6'

**Couplant**
Make Soundsafe Batch# [illegible]

**Thermometer**
S/N: 87-053 Cal Due 1-9-93

DAC Plot



ANI Review

| Time/Date | 1225 / 12/11/92 | | 1245 / 12/11/92 | | 1315 / 12/11/92 | |
|---|---|---|---|---|---|---|
| Reflector | % FSH | Inches | % FSH | Inches | % FSH | Inches |
| .5 | n/a | .5 | n/a | .5 | n/a | .5 |
| .75 | n/a | .75 | n/a | .75 | n/a | .75 |
| 1.0 | n/a | 1.0 | n/a | 1.0 | n/a | 1.0 |
| Initials | JV | | JV | | JV | |

Remarks:

Components Examined: Bay 17-19

Technical Review
Reviewed By [signature]
Level III Date 12-16-92

NDE Request#: 92-072

N0927 (05-90)

OCLR00014648

GPU Nuclear

☐OC ☐TMI

## Calibration Sheet

Cal Sheet# [illegible]

System: 187 | Component: Drywell liner | Procedure: 6100-QAP-7209.07 | Rev 0

| Examiner: | Signature: [signature] | Print: J Vander Linde | Initial: [illegible] | ID# 157-48-0319 | Level II |
|---|---|---|---|---|---|
| Examiner: | Signature: n/a | Print: n/a | Initial: n/a | ID# n/a | Level n/a |

**Instrument Settings**
ID# 92-010
Model/Manuf: DL-26 Panametrics

**Gain**
Coarse: n/a
Fine: n/a
Uncal: n/a

**Sweep Circuit**
Coarse: n/a (Range)
Fine: n/a
Delay: n/a
Screen Depth: n/a

**Operation** (T&R) Normal
Frequency: n/a MHZ
Reject: ☐Off ☐On n/a %
Filter: ☐Off ☐On n/a %
Damping: ☐Off ☐On n/a %
Rep Rate: n/a

**Cal Standard**
ID# 88
Size n/a Sch. n/a
Thickness .5 - 1.0
S/S (CS)
Temp 68 °F

**System Check**
☐Exit Point n/a
☐Angle +/- 2

**Search Unit**
ID# 92-228
Type [illegible]
Freq 5 MHZ
Size [illegible]
Angle 0 Mode [illegible]

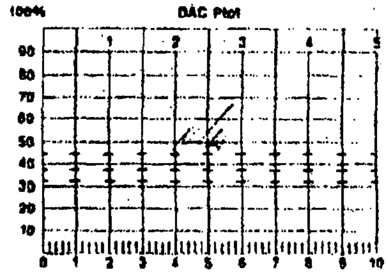
**Cal Direction**
☐Axial ☐Both
☐Circ. ☒Normal

**Search Unit Cable**
Type [illegible] Length [illegible]

**Couplant**
Make [illegible] Batch# [illegible]

**Thermometer** n/a
S/N: 92-057 Cal Due 5-24-93

DAC Plot



Date 12/14/92 | Time 1305

| Reflector | Amplitude % of FSH | Screen Reading in Inches |
|---|---|---|
| .5 | n/a | n/a |
| .75 | n/a | n/a |
| 1.0 | n/a | n/a |

| Time/Date | 1325 12/14/92 | | 1337 12/14/92 | | 1405 12/14/92 | |
|---|---|---|---|---|---|---|
| Reflector | % FSH | Inches | % FSH | Inches | % FSH | Inches |
| .5 | n/a | .5 | n/a | .5 | n/a | .5 |
| .75 | n/a | .75 | n/a | .75 | n/a | .75 |
| 1.0 | n/a | 1.0 | n/a | 1.0 | n/a | 1.0 |
| Initials | [initials] | | [initials] | | [initials] | |

Remarks:

Components Examined: BAY 17&19

ANI Review

Technical Review
Reviewed By [signature]
Level III Date 12-16-92

NDE Request#: 92-072

N0927 (05-90)

# GPU Nuclear

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 113 of 117 |

| Originator | Date | Reviewed by | Date |
|---|---|---|---|
| Mark Yekta | 01/12/93 | S. C. Tumminelli | |

GPU Nuclear

## Calibration Sheet

MOC 111MI

Cal Sheet# [illegible]

| | | | |
|---|---|---|---|
| System 187 | Component Drywell Liner | Procedure 6100-QAP-7209.07 | Rev 0 |
| Examiner: Signature: [signature] | Print: J. Vander Linde | Initial: [initials] ID# 154-98-0319 | Level II |
| Examiner: Signature: n/a | Print: n/a | Initial: n/a ID# n/a | Level n/a |

**Instrument Settings**
ID# 137-113
Model/Manuf Sonic 132 Staveley

Gain
Coarse 60.2
Fine n/a
Uncal n/a

Sweep Circuit
Coarse 2.0" (vel 0.231"/μs) (Range)
Fine n/a
Delay 1.0
Screen Depth 2"

Operation
(T&R) Normal
Frequency: 2.25 MHZ
Reject: Off On %
Filter: Off On 1 %
Damping: Off On 200 %

Rep Rate: 1000 Hz

**Cal Standard**
ID# 88
Size n/a Sch. n/a
Thickness .5 - 1.0
S/S (CS)
Temp 68 °F

**System Check**
☐ Exit Point
☐ Angle +/- 2
n/a

**Search Unit**
ID# M08524
Type MSWS
Freq 2 MHZ
Size 1/2"
Angle 0 Mode Long

**Cal Direction**
☐ Axial ☐ Both
☐ Circ. ☒ Normal

Date 12/14/92 Time 1300

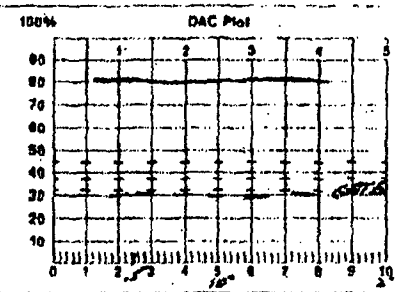
| Reflector | Amplitude % of FSH | Screen Reading In Inches |
|---|---|---|
| .5 | 80 | .5 |
| .75 | 80 | .75 |
| 1.0 | 80 | 1.0 |

**Search Unit Cable**
Type dual line Length 3x6'

**Couplant**
Make Sonotech Batch# USE A-1-02

**Thermometer**
S/N: 92-052 Cal Due 5-24-93

DAC Plot




| Time/Date | 1330 12/14/92 | | 1335 12/14/92 | | 1400 12/14/92 | |
|---|---|---|---|---|---|---|
| Reflector | % FSH | Inches | % FSH | Inches | % FSH | Inches |
| .5 | 80 | .5 | 80 | .5 | 80 | .5 |
| .75 | 80 | .75 | 80 | .75 | 80 | .75 |
| 1.0 | 80 | 1.0 | 80 | 1.0 | 80 | 1.0 |
| Initials | [initials] | | [initials] | | [initials] | |

Remarks:
× backwall maintained at 80% FSH

Components Examined:
Bay 17 + 19

ANI Review

Technical Review
Reviewed By [signature]
Level III Date 12-16-92

NDE Request#: 92-072

N0927 (05-90)

OCLR00014650

# GPU Nuclear — Ultrasonic Thickness Data Sheet

| | | | |
|---|---|---|---|
| ☒ OC ☐ TMI-1 ☐ TMI-2 Class: n/a | Item: n/a | NDE Request: 92-072 | Data Sheet No.: 92-072-11 |
| Task Description: DRY WALL LINER MOCK-UP | | Task No.: n/a | Date: 12-16-92 |
| Comp. Desc.: WELD OVERLAY TEST PLATE | System: 187 | | Code/Spec.: ASME SECT VIII |
| Procedure/Rev.: 6100-QAP-7209.07 / 0 | | Drawing No./Rev.: -NA- | |
| Test Surface: OD | | Thickness: 3/4" | Material: C/S |
| Examiner Sign: [signature] | Print: J. Van der Linde | ID No.: [illegible] | Level: II |
| Examiner Sign: [signature] | Print: JAMES PHILLIPPI | ID No.: 462277035 | Level: I |

Thermometer S/N 92-063 Part Temperature 68° F D-Meter S/N 92-010
Cal. Blk. S/N 214 Cal. In: N/A AM 1420 PM
Cal. Blk. Temp. 68° F Cal. Out: N/A AM 1440 PM

Calibration Readings (inches)

| Cal. Blk. | .502 | .752 | 1.001 | 1.251 | | |
|---|---|---|---|---|---|---|
| D-Meter | .502 | .751 | 1.000 | 1.250 | | |

Techniques: ☐ CRT ☒ D-Meter Other -NA-

Position #/Reading in inches

Drawing

| | A-SCAN | 26 DL |
|---|---|---|
| BASE METAL | .73 | .728 |
| 1 PASS | .94 | .927 |
| 2 PASS | 1.12 | 1.114 |

Reviewed by: [signature] Level: III Date: 12-22-92 Page 1 of 1

N5499 (05-90)

## GPU Nuclear

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 115 of 117 |
| **Originator:** Mark Yekta — **Date:** 01/12/93 | **Reviewed by:** S. C. Tumminelli | | **Date:** |

### GPU Nuclear — Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 | Class: n/a | Item: n/a | NDE Request: 92-072 | Data Sheet No.: 92-072-11

Task Description: DRY WALL LINER MOCK-UP | Task No.: n/a | Date: 12-16-92

Comp. Desc.: WELD OVERLAY TEST PLATE | System: 187 | Code/Spec.: ASME SECT VIII

Procedure/Rev.: 6100-QAP-7209.07 / 0 | Drawing No./Rev.: -NA-

Test Surface: OD | Thickness: 3/4" | Material: C/S

Examiner Sign: [signature] | Print: J. VanderLinde | ID No.: 154465031 | Level: II

Examiner Sign: [signature] | Print: JAMES PHILLIPPI | ID No.: 462277035 | Level: I

Thermometer S/N 92-063 | Part Temperature 68° F | D-Meter S/N 92-010

Cal. Blk. S/N 214 | Cal. In: NA AM 1420 PM

Cal. Blk. Temp. 68° F | Cal. Out: NA AM 1440 PM

**Calibration Readings (Inches)**

| | | | | | | |
|---|---|---|---|---|---|---|
| Cal. Blk. | .502 | .752 | 1.001 | 1.251 | | |
| D-Meter | .502 | .751 | 1.000 | 1.250 | | |

Techniques: ☐ CRT ☒ D-Meter | Other -NA-

Position #/Reading in Inches

Drawing

| | A-SCAN | 26 DL |
|---|---|---|
| BASE METAL | .73 | .728 |
| 1 PASS | .94 | .927 |
| 2 PASS | 1.12 | 1.114 |

Reviewed by: [signature] | Level: III | Date: 12-22-92 | Page 1 of 1

# GPU Nuclear

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 116 of 117 |
| **Originator:** Mark Yekta — **Date:** 01/12/93 | **Reviewed by:** S. C. Tumminelli | | **Date** |

1-6C 1 ITMI

**GPU Nuclear** — **Calibration Sheet** — Cal Sheet# 14L-05-2

| | | | |
|---|---|---|---|
| System 187 | Component DRYWELL LINER | Procedure 6100-QAP-7209.07 | Rev 0 |
| Examiner: Signature: [signature] | Print: J Vanderlinde | Initial: [initials] ID# 54-48-0-18 | Level II |
| Examiner: Signature: [signature] | Print: JAMES PHILLIPPI | Initial: [initials] ID# 4622770355 | Level I |

**Instrument Settings**
ID# 137-113
Model/Manuf SONIC 137 / STAVELEY

**Gain**
Coarse 602 dB
Fine N/A
Uncal N/A

**Sweep Circuit**
Coarse 2.0" (VEL = .231 "/µs) (Range)
Fine N/A
Delay 1.0
Screen Depth 2"

**Operation**
T&R Normal
Frequency: 2.25 MHZ
Reject: ☒Off ☐On N/A %
Filter: ☐Off ☒On FILT 1 %
Damping: ☐Off ☒On 200Ω %

Rep Rate:

**Cal Standard**
ID# 214
Size NA Sch. NA
Thickness .5-1.25
S/S (CS) NA
Temp 68 °F

**System Check**
☐Exit Point N/A
☐Angle +/- 2

**Search Unit**
ID# M08524
Type MSER
Freq 2.0 MHZ
Size .5"
Angle 0 Mode Long

**Cal Direction**
☐Axial ☐Both
☐Circ. ☒Normal

**Search Unit Cable**
Type DUAL LIMO Length 2 x 6'

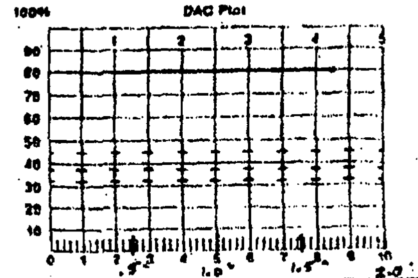
**Couplant**
Make SOUNDSAFE Batch# SSP-89-1-02

**Thermometer**
S/N: 92-063 Cal Due 5-24-93

Date 12-16-92 Time 1410

| Reflector | Amplitude % of FSH | Screen Reading in Inches |
|---|---|---|
| .5 | 80 | .5 |
| .75 | 80 | .75 |
| 1.0 | 80 | 1.0 |
| 1.25 | 80 | 1.25 |

DAC Plot




| Time/Date | 1415 / 12-16-92 | | 1425 / 12-16-92 | | / | |
|---|---|---|---|---|---|---|
| Reflector | % FSH | Inches | % FSH | Inches | % FSH | Inches |
| .5 | 80 | .5 | 80 | .5 | | |
| .75 | 80 | .75 | 80 | .75 | | |
| 1.0 | 80 | 1.0 | 80 | 1.0 | | |
| 1.25 | 80 | 1.25 | 80 | 1.25 | | |
| Initials | [initials] | | [initials] | | | |

Remarks:

Components Examined:
Drywell Liner weld overlay Test Plate

ANI Review

Technical Review
Reviewed By [signature]
Level III Date 12-27-92

NDE Request#: 92-072

N0927 (05-90)

OCLR00014653

# GPU Nuclear

| Subject | Calc No. | Rev. No. | Sheet No. |
|---|---|---|---|
| O.C. Drywell Ext. UT Evaluation in Sandbed | C-1302-187-5320-024 | 1 | 117 of 117 |

| Originator | Date | Reviewed by | Date |
|---|---|---|---|
| Mark Yekta | 01/12/93 | S. C. Tumminelli | |

Examiner: Signature: *James Phillippi* Print: JAMES PHILLIPPI Initial: JP ID# 462277035 Level I

**Instrument Settings**
ID# 92-010
Model/Manuf DL-26 PANAMETRICS

Gain
Coarse N/A
Fine N/A
Uncal N/A

Sweep Circuit
Coarse N/A (Range)
Fine N/A
Delay N/A
Screen Depth N/A

Operation
T&R Normal
Frequency: N/A MHZ
Reject: [ ]Off [ ]On N/A %
Filter: [ ]Off [ ]On N/A %
Damping: [ ]Off [ ]On N/A %

Rep Rate: N/A

**Cal Standard**
ID# 214
Size N/A Sch. N/A
Thickness .5 + 1.5
S/S (CS) N/A
Temp 68 °F

System Check N/A
[ ]Exit Point A
[ ]Angle +/- 2

Date 12-16-92

**Search Unit**
ID# 92-038
Type D790 SM
Freq 5 MHZ
Size .312
Angle 0 Mode LONG.

Cal Direction
[ ]Axial [ ]Both
[ ]Circ. [X]Normal

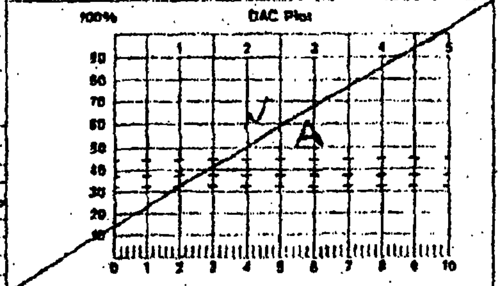
Time 1412

| Reflector | Amplitude % of FSH | Screen Reading in Inches |
|---|---|---|
| .5 | N/A | N/A |
| .73 | N/A | N/A |
| 1.0 | N/A | N/A |
| 1.23 | N/A | N/A |

**Search Unit Cable**
Type SELF CONTAINED Length 2 x 6"

Couplant
Make SOUNDSAFE Batch# SSD-89-1-02

Thermometer
S/N: 92-063 Cal Due 5-24-93




| Time/Date | 1420 12-16-92 | | 1440 12-16-92 | | | |
|---|---|---|---|---|---|---|
| Reflector | % FSH | Inches | % FSH | Inches | % FSH | Inches |
| .5 | N/A | .5 | N/A | .5 | | |
| .75 | N/A | .75 | N/A | .75 | | |
| 1.0 | N/A | 1.0 | N/A | 1.0 | | |
| 1.25 | N/A | 1.25 | N/A | 1.25 | | |
| Initials | JP | | JP | | | |

Remarks:

Components Examined: Drywell Liner weld overlay Test plate

ANI Review

Technical Review
Reviewed By *[signature]*
Level II Date 12-27-92

NDE Request#: 92-072

N0927 (05-90)

OCLR00014654

# EXHIBIT 4

Report No.: SIR-06-482
Revision No.: 0
Project No.: OC-12
File No.: OC-12-402
December 2006

**Statistical Analysis of Oyster Creek Drywell Thickness Data**

*Prepared for:*

AmerGen Energy Company, LLC
Oyster Creek Generating Station
Forked River, NJ
Expert Witness Agreement Letter, 3-28-06

*Prepared by:*

Structural Integrity Associates, Inc.
San Jose, California

| | | | |
|---|---|---|---|
| *Prepared by:* | George J. Licina | Date: | 1-3-07 |
| *Reviewed by:* | Ryan Perry | Date: | 1-4-07 |
| *Approved by:* | George J. Licina | Date: | 1-4-07 |

Structural Integrity Associates, Inc.

## REVISION CONTROL SHEET

Document Number: SIR-06-482

Title: Statistical Analysis of Oyster Creek Drywell Thickness Data

Client: Exelon

SI Project Number: OC-12

| Section | Pages | Revision | Date | Comments |
|---|---|---|---|---|
| 1.0 | 1-1 | 0 | 1/4/07 | Initial Issue |
| 2.0 | 2-1 – 2-2 | | | |
| 3.0 | 3-1 | | | |
| 4.0 | 4-1 – 4-10 | | | |
| 5.0 | 5-1 – 5-2 | | | |
| 6.0 | 6-1 – 6-2 | | | |
| 7.0 | 7-1 | | | |

Table of Contents

List of Tables

List of Figures

# 1.0 INTRODUCTION

In 1986, Oyster Creek experienced a problem with corrosion of the exterior of their drywell at the "sand cushion". The problem that was determined at that time was that the sand cushion had become wet from leakage that dripped along the outside of the drywell, the sand remained wet, and the exterior of the carbon steel drywell began to corrode.

The plant performed extensive analysis to demonstrate that loading of the drywell would remain within acceptable limits even without the sand cushion to disperse the loads from the drywell to the ground. The plant then removed all of the sand and sealed off the steel-concrete interface on the exterior of the drywell to make sure it remained dry. In addition, several trenches were jack-hammered into the concrete inside the drywell to permit UT thickness measurements of the steel to be performed from inside the drywell. In the 1986 time frame, thickness measurements from the ID and from the OD all confirmed that the minimum thickness of the drywell exceeded minimum required thickness at all locations.

Now that the plant has applied for license renewal, the issue of the condition of the drywell steel has been reopened. During the most recent refueling outage (October 2006), the concrete in the trenches was found to be wet (one trench had 5" of standing water) so the question of the condition of the steel in the (former) sand bed region, above the sand bed, and embedded in the concrete was raised again.

## 2.0 BACKGROUND

The drywell (see Figure 2-1) is a huge (30' diameter or more where it intersects the concrete) but thin steel structure. The portion that is embedded in concrete (much of it has concrete on its interior as well) is basically a hemisphere. The drywell structure itself is shaped like a light bulb (upside down) with the reactor vessel, pumps, piping, etc. inside. The drywell is a secondary containment structure for radionuclides (fuel cladding, then the reactor vessel, then the containment). Because the containment and drywell are key safety features, the condition of the containment and drywell receives significant regulatory scrutiny and attention from the public.

### 2.1 Objective

Plant and corporate personnel from Exelon have indicated that a thorough and statistically based review of drywell thickness data is required. For example, the UT thickness methods applied in 1986, 1992, and 2006 are all different; the prior examinations (1986 and 1992) were done on bare steel while the 2006 examination was done with a different technique and was done through the coating. Questions associated with repeat UT thickness determinations always have some uncertainty regarding whether the exact locations were examined at the different points in time. Further, the limited data from Zone 4 (above the 12'4" elevation; an area that should never have been wet) appears to exhibit a thinning between the 1992 and 2006 inspections. That observation, as well as the use of the different UT techniques, suggests that a bias may exist between the 1992 and 2006 measurements. A key objective of this evaluation was to determine whether there was indeed a bias between those two different time points, to quantify the magnitude of the bias, and to determine how best to compare the thickness measurements between 2006 and 1992. For example, is it reasonable to simply subtract the bias from all of the apparent deltas to account for the technique differences?

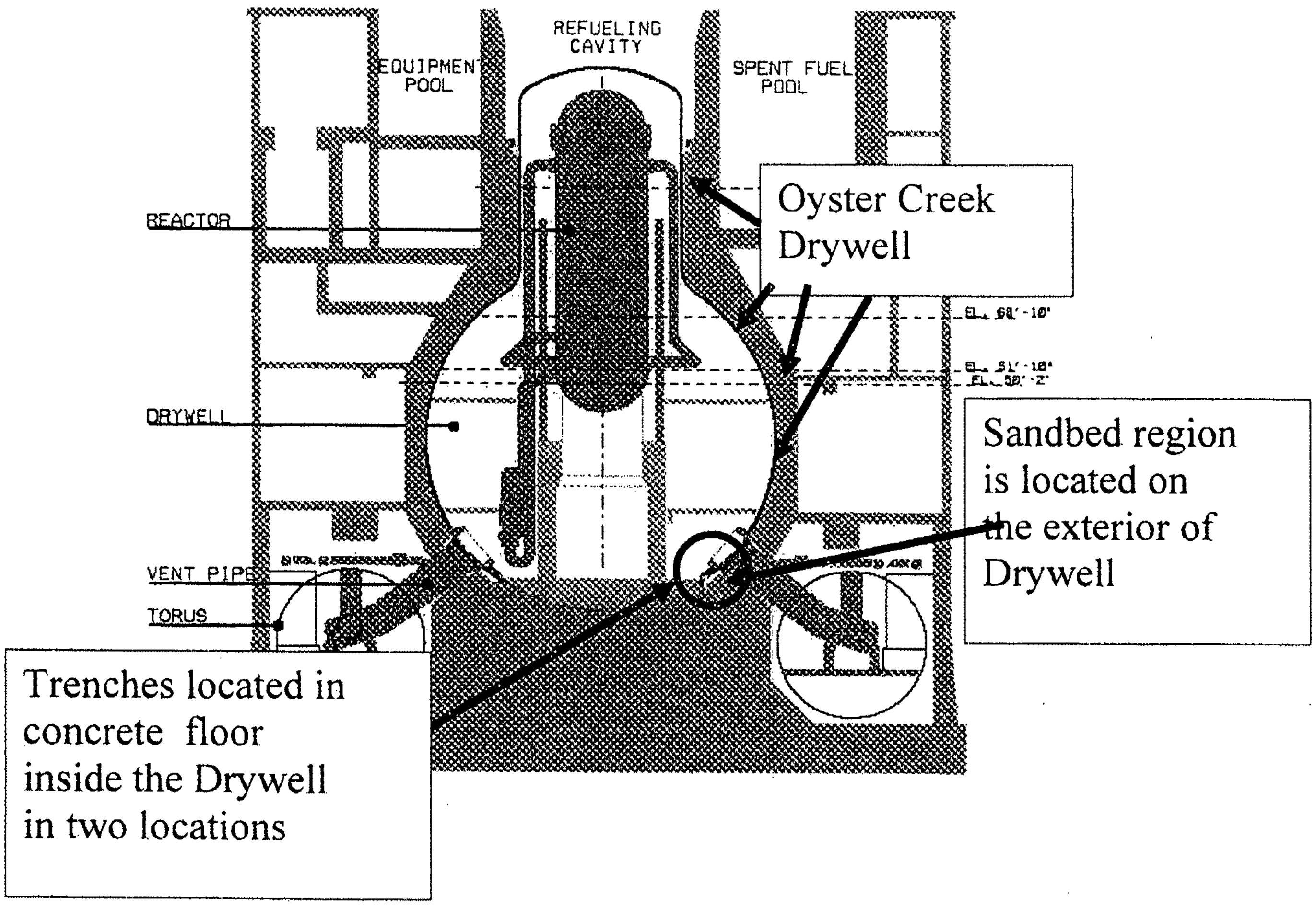



Figure 2-1. Schematic of Oyster Creek Drywell

## 3.0 APPROACH

A data set including UT thickness measurements from 106 points, measured from the outside of the drywell in 1992, then repeated in 2006, was received from Wayne Choromanski [1].

A Tech Eval prepared by Oyster Creek [2] was also received. The Tech Eval includes data in various forms from 1986, 1992, and 2006. It focuses on present thickness with a lesser emphasis on the trends. Most of the evaluation is for data collected for Bays 5 and 17, where the trenches are. The Tech Eval concludes that "the Drywell Vessel in the region below the concrete floor at elevation 10'3" may have been corroding at a rate of .002 to .003 inches per year between 1986 and 2006. UT readings below the concrete floor at Elevation 10'3" confirm that all locations meet the required thickness criteria."

The data were reviewed from numerous perspectives to ascertain systematic conditions (e.g., any bias) between measurements, differences among zones, among bays, and any oddities or obvious outliers. Fits of the data were also developed to test for the most appropriate distribution to use and to determine coefficients that would enable quantitative analysis of the statistics.

Those evaluations of deltas and thicknesses included graphical and numerical checks for the proper distribution to describe the variations in the data and included comparisons and evaluations of means and standard deviations of all values (thicknesses in 1992 and 2006 and the difference between those two thickness measurements), and creation of cumulative distribution functions to check for fit to normal or other distributions.

## 4.0 RESULTS

All 106 data points were included in the spreadsheet assembled and checked by Wayne Choromanski and denoted in this report as Reference 1. This analysis processed those data in an Excel spreadsheet graphically and numerically with results described below.

### 4.1 Apparent Deltas

The original focus in the evaluation was on the deltas (2006 thickness minus 1992 thickness). Those deltas were evaluated as a function of "original" (1992) plate thickness, and the distribution of delta by zone and by bay (Figures 4-1 through 4-4). Figure 4- 2 clearly shows that the mean delta varied by bay and by zone and that the distribution of deltas (Figures 4-3 and 4-4) looked very much like a normal distribution centered at a small negative value, implying a small metal loss. There was no apparent effect of original (1992) plate thickness (Figure 4-1). The variation of delta among bays was significantly larger than the variation among zones, despite the fact that the time of wetness among the different zones would be very dramatic. The lowest zone would be wet the longest, Zone 2 would be wet for a shorter time (as any water rolled down the drywell), and the upper two zones (Zones 3 and 4) would be expected to be wet for the least amount of time. Key data are summarized in Table 4-1.

A cumulative distribution of the deltas was created by ordering the deltas from smallest to largest and applying a look-up table from standard statistical texts to assign a parameter PHI. PHI is related to where in a normal distribution the point lies, based on the point's rank. For example, the point that is in the exact middle of the distribution (F = 0.50000) is at the mean (i.e., PHI = 0; which means 0 standard deviations from the mean). The first (lowest value) point defines the extreme of the data that is available and will be in the lower tail of the distribution (PHI will be a relatively large negative number). Similarly, the largest value will correspond to a relatively large positive PHI. When the data are plotted as PHI vs. delta, the data generate a reasonably straight line. The better the straight line, the better the fit to the normal distribution. The mean of the distribution is where PHI = 0 and the breadth of the distribution (i.e., how large the standard deviation is) can be determined by how small the slope of the curve is (i.e., a horizontal line would have a very large standard deviation). For example, if all of the values were at exactly the same value, that value would obviously be the mean and the standard deviation would be zero (no variation in the data).

The CDF plot for the deltas (Figure 4-5) produced a very nice straight line over much of the population, however, the larger negative deltas were the values that destroyed the quality of the linear fit. The best fit line had an $R^2$ value of 0.83 (a perfect fit has $R^2 = 1.000$); not a bad fit but not a great one. Figure 4-5 also includes an eyeball best fit to the well behaved data.

Physical observations of the coating condition at the 2006 examination indicated that the coating was still in excellent condition. The expected corrosion rate for an intact coating would be zero. That is, the coating provides a barrier between the electrolyte and the metal so that the anodic and cathodic half-reactions that are critical to any corrosion process would be totally eliminated. Actual metal losses of a mil or more are not consistent with a coating that is still in good condition; the condition that was found in 2006. Apparent deltas of 70 mils or more (six such deltas were reported) are totally unreasonable in view of the physical condition of the coating as well as examination of the drywell from the inside. Those large negative deltas, like the positive values of delta (i.e., the drywell was thicker in 2006 than in 1992) indicate that the deltas determined from the difference between the 1992 thickness ($t_{1992}$) and the 2006 thickness ($t_{2006}$) were subject to significant uncertainty and the use of delta only would be misleading.

## 4.2 Thickness Evaluations

Using the difference between separate measurements as discussed in Section 4.1 clearly magnifies the potential error. The 1992 and 2006 thickness measurements were each evaluated as separate populations to determine the appropriate distribution and to assess any systematic differences between the two measurements such that bias and any corrosion effects could be separated. As shown in Figures 4-6 and 4-7, the primary attribute that the thickness analyses determined was that thickness was a strong function of the bay and much less a function of zone.

The cumulative distribution functions for the 1992 and 2006 thickness populations were created as described below.

As was done for the deltas (Figure 4-5), the individual thickness measurements from 1992 and from 2006 were ordered, from smallest to largest. A look-up table was applied to assign a parameter PHI, where PHI is related to where in a normal distribution the point lies, based on the point's rank. For example, the point that is in the exact middle of the distribution (F = 0.50000) is at the mean (i.e., PHI = 0; which means 0 standard deviations from the mean). The first (lowest value) point defines the extreme of the available data and will be in the lower tail of the distribution (PHI will be a relatively large negative number). Similarly, the largest value will correspond to a relatively large positive PHI. When the data are plotted as PHI vs. thickness, the data should generate a straight line. The better the straight line, the better the fit to the normal distribution. The mean of the distribution is where PHI = 0 and the breadth of the distribution (i.e., how large the standard deviation is) can be determined by how horizontal the curve is. For example, if all of the values were at exactly the same value, that value would obviously be the mean and the standard deviation would be zero (no variation in the data).

Figure 4-8 shows that the 2006 thickness data are described well by a normal distribution, with an excellent straight line fit to the data ($R^2 = 0.98$). Figure 4-8 also shows that the 1992 plate thickness data were also described by a normal distribution (linear; $R^2 = 0.98$). The cumulative distribution of the 1992 thickness data also showed that the 1992 measurements were thicker at all values of PHI than those from 2006 (i.e., the drywell apparently lost thickness between 1992 and 2006 as might be expected). At the mean (PHI = 0), that difference was about 20 mils of thinning. At PHI = -3 (3 standard deviations below the mean, approximately the 99$^{th}$ percentile), the thickness difference was about 29 mils (29 mils of thinning). At PHI = 3, approximately the 1$^{st}$ percentile, the difference was about 12 mils. Those observations suggest that the measurements made in 2006 were systematically lower than the those in 1992 by 12 to 20 mils. It can be argued that the ***actual*** thickness differences based upon subtracting the 2006 thickness from the 1992 thickness (and ignoring the error associated with performing the measurements at exactly the same locations in both 1992 and 2006) are actually 12 to 20 mils less than the delta values that are reported.

Table 4-2 summarizes the comparison between the 1992 and 2006 measurements, including the means and standard deviations determined graphically and those same parameters determined for the two populations using the appropriate functions in Excel. The agreement between the graphical analysis and the computational analysis using Excel is excellent.

Note that this analysis does not say whether the 1992 measurements are better than the 2006 measurements or vice versa; only that the difference between the two has a bias in it.

Table 4-1

Mean Deltas by Bay

| | Deltas | | | | |
|---|---|---|---|---|---|
| Bay | Mean | S.D. | n[1] | n'[2] | |
| 1 | -19 | 21.8 | 23 | 23 | |
| 3 | -3 | 6.8 | 9 | 9 | |
| 5 | -34 | 31.1 | 8 | 8 | |
| 7 | -13 | 13.7 | 5 | 7 | |
| 9 | -10 | 9.6 | 10 | 10 | |
| 11 | -14 | 14.7 | 8 | 8 | |
| 13 | -17 | 30.9 | 15 | 19 | |
| 15 | -1 | 15.2 | 11 | 11 | |
| 17 | -13 | 32.0 | 9 | 11 | |
| 19 | -24 | 27.8 | 8 | 10 | |
| | | | | | |
| Population | -15 | 23 | 106 | 116 | |
| | | | | | |
| Total Population | | | $t_{1992}$ | $t_{2006}$ | Delta |
| | Mean | | 865 | 849 | -15 |
| | Std. Dev | | 114 | 112 | 23 |
| | Max | | 1156 | 1160 | 27 |
| | Min | | 618 | 602 | -118 |

[1] Thickness measurements in 1992 and 2006
[2] Thickness measurements in 1992 or 2006

Table 4-2

Comparison of Cumulative Distributions of Thickness (1992 and 2006)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Best fits to CDFs for 1992 and 2006 thicknesses | | | | | | | | | |
| | | | | | | | | | |
| 2006: | $PHI_{2006}$ = | 0.0086 | t | -7.2708 | | | | | |
| 1992: | $PHI_{1992}$ = | 0.0084 | t | -7.2742 | | | | Per Excel (RawData2) | |
| OR | | | | | implying | Mean | Std. Dev. | Mean | Std. Dev. |
| 2006: | $t_{2006}$ = | 116.2791 | $PHI_{2006}$ | 845.4419 | | 845 | 116 | 849 | 112 |
| 1992: | $t_{1992}$ = | 119.0476 | $PHI_{1992}$ | 865.9762 | | 866 | 119 | 865 | 114 |
| | | | | | | | | | |
| | | | | | | | | | |
| PHI | Delta, mils[3] | | | | | | | | |
| -3 | 28.8 | | | | | | | | |
| -2.5 | 27.5 | | | | | | | | |
| -2 | 26.1 | | | | | | | | |
| -1.5 | 24.7 | | | | | | | | |
| -1 | 23.3 | | | | | | | | |
| -0.5 | 21.9 | | | | | | | | |
| 0 | 20.5 | | | | | | | | |
| 0.5 | 19.2 | | | | | | | | |
| 1 | 17.8 | | | | | | | | |
| 1.5 | 16.4 | | | | | | | | |
| 2 | 15.0 | | | | | | | | |
| 2.5 | 13.6 | | | | | | | | |
| 3 | 12.2 | | | | | | | | |
| | | | | | | | | | |

[3]Determined from the difference between best fits for thickness distributions from 2006 and 1992. Note that sign is opposite that for Table 4-1 and Figures 4-1 through 4-4.

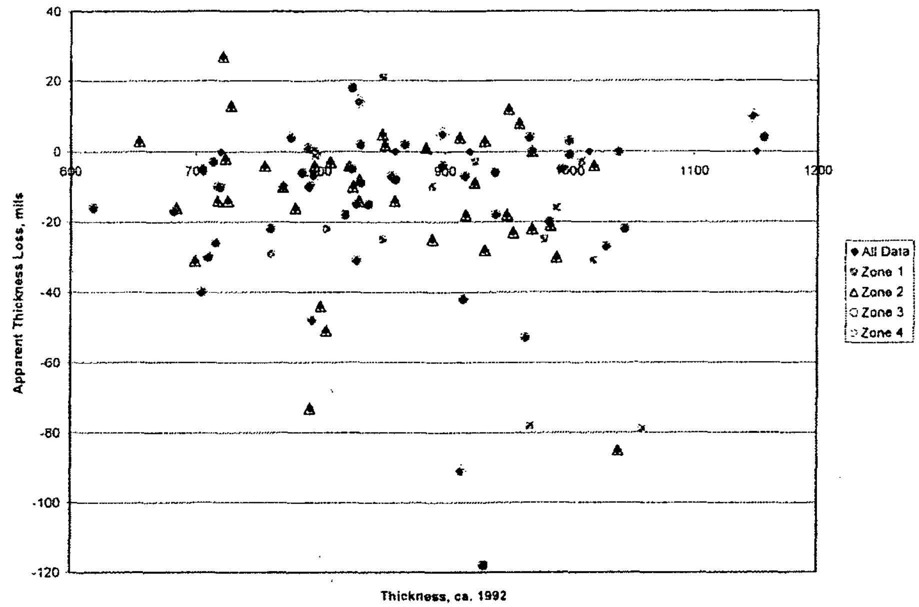



Figure 4-1. Apparent Thickness Change as a Function of Thickness Determined in 1992

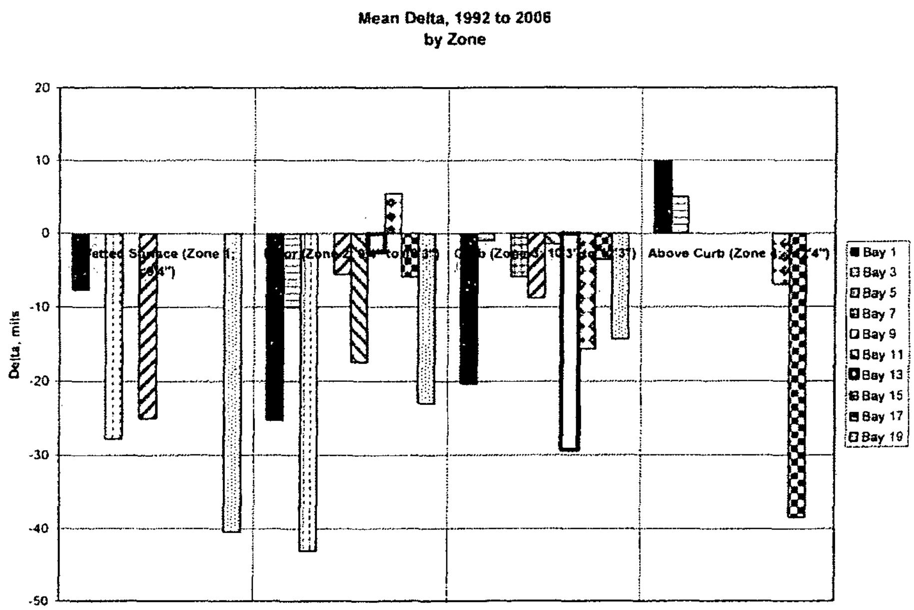



Figure 4-2. Delta by Zone and by Bay

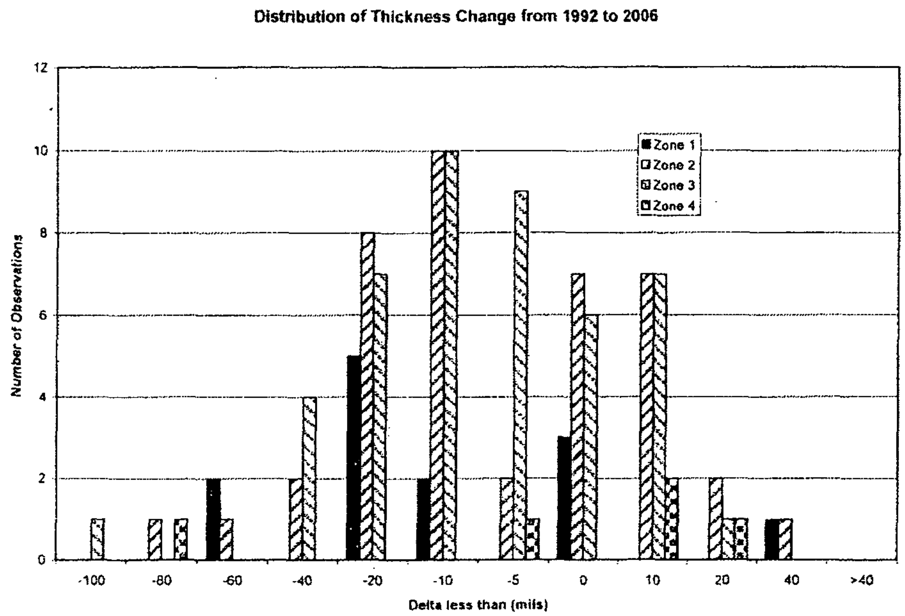



Figure 4-3. Distribution of Delta by Zone

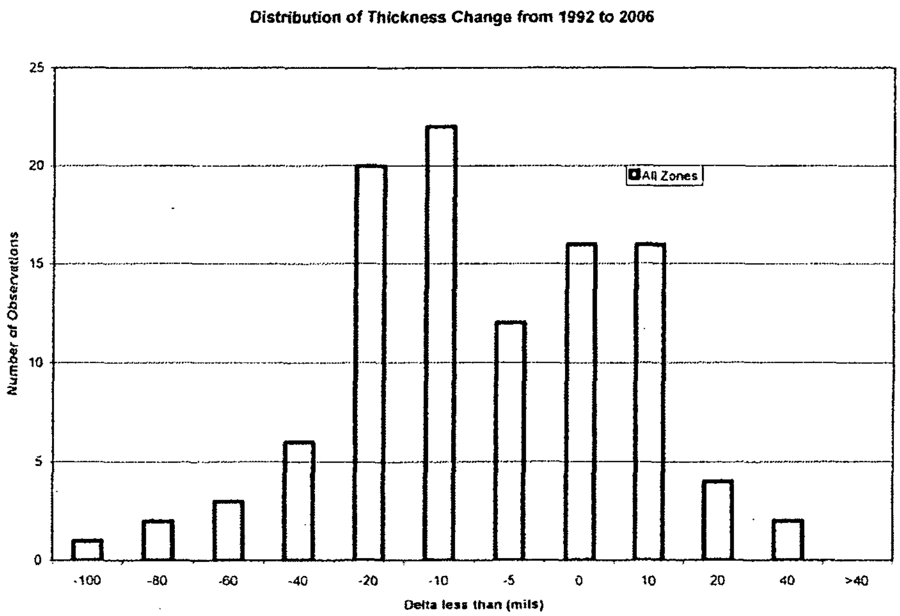



Figure 4-4. Distribution of Delta – All Zones

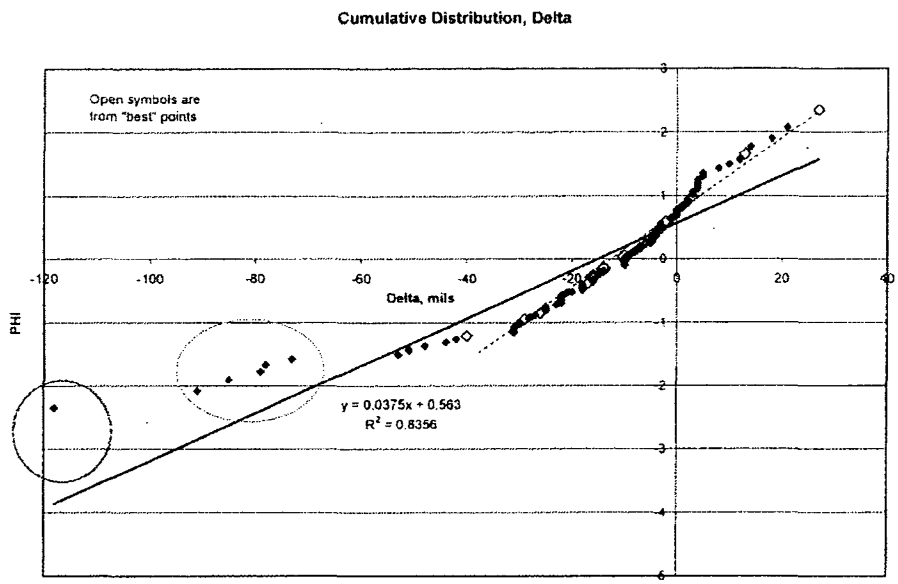



Figure 4-5. Cumulative Distribution, Delta

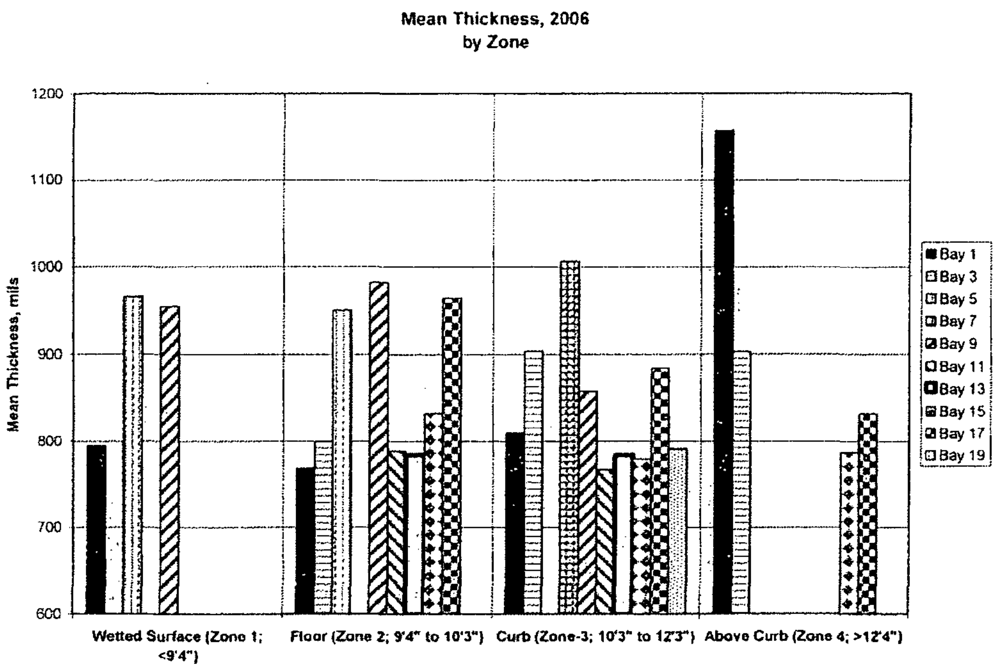



Figure 4-6. Mean Thickness (2006) by Zone and by Bay

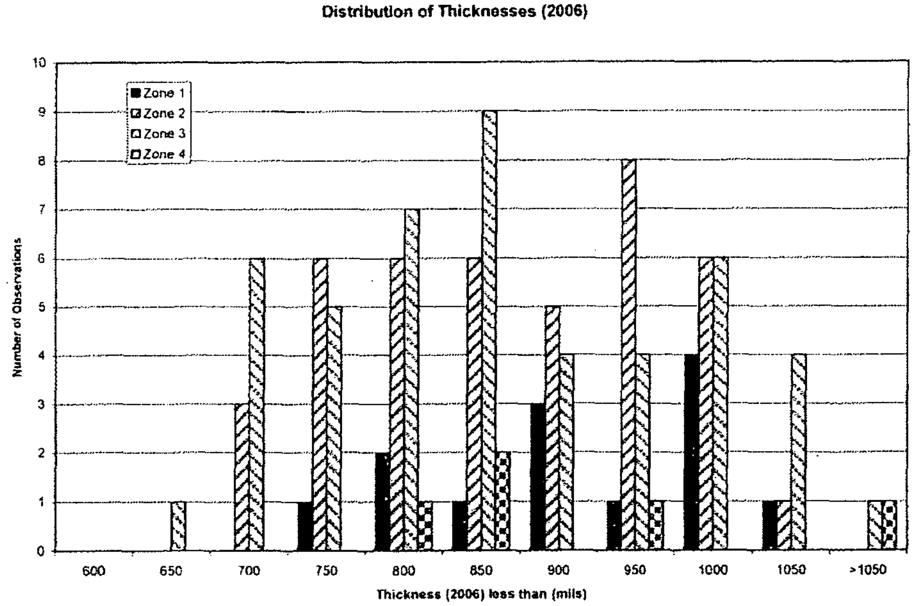



Figure 4-7. Distribution of Thickness (2006) by Zone

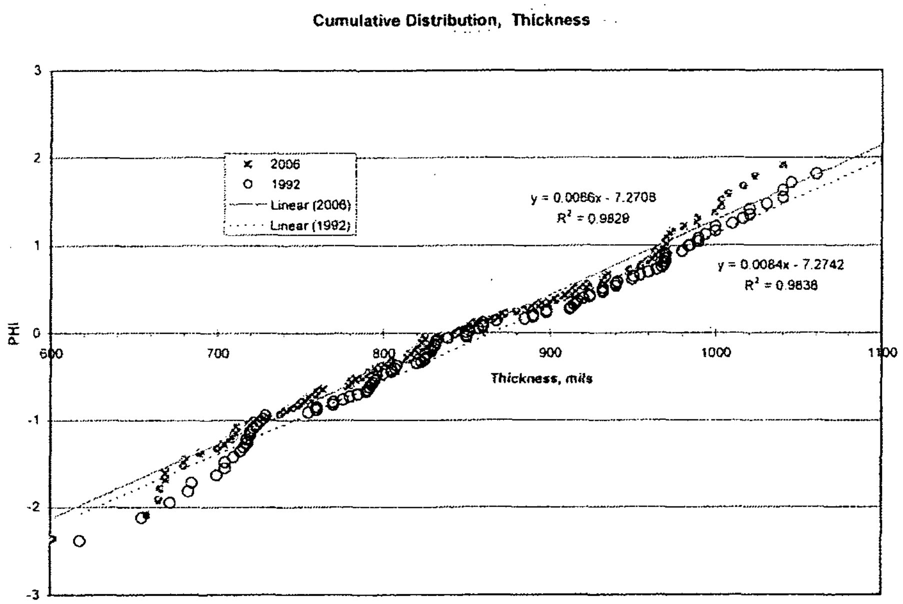



Figure 4-8. Cumulative Distributions, $t_{2006}$ and $t_{1992}$

## 5.0 DISCUSSION

The delta, determined by the difference between separate UT thickness measurements taken at the same locations in 1992 and 2006, will be the sum of several terms as shown below:

Delta = Any Corrosion + bias (technique and operator) ± random error in measurements (both 1992 and 2006).

Random errors in the separate measurements will result from the inherent uncertainty in each UT thickness measurement plus the uncertainty associated with placing the transducer on exactly the same location at both points in time. Standardizing the procedure (e.g., scanning each location over a small, pre-determined area, and always reporting the minimum or average reading) can minimize the latter contribution to error. The site reported that different techniques were used in 1992 (done prior to coating; only a single point reported for each location) and 2006. The 2006 measurements were done through the coating, with software corrections to account for the coating and to adjust for the "air gap" resulting from placement of a flat transducer on a slightly curved (dimpled to provide a smooth and readily discernible location for repeat measurements) surface. Perhaps most significantly, the 2006 measurements scanned the defined areas and reported the minimum thickness. The differences in technique between 2006 would be expected to introduce some amount of bias (e.g., reporting minimum values vs. a single value) and could increase or decrease the random error.

Those separate thickness measurements will magnify the error, especially when two separate measurements at different points in time are intended to define a delta, where the expected delta is actually very near zero. The result is that some fraction, 21% in this case, of the locations appear to become thicker while others become thinner. The use of the difference between the 2006 and 1992 thickness measurements suggests that some locations appear to have become much thinner; clearly in stark contrast to the physical observation of the condition of the coating. In all cases, the delta is the difference between two thickness values that are very close in value. The error in individual measurements is clearly greater than the actual difference between drywell thickness in 1992 vs. that in 2006.

The statistical evaluation discussed in Section 4.1.2 clearly demonstrates that there is a bias in the thickness measurements, where the magnitude of that bias is at least 12 mils and is probably more like 20 mils. Clearly, that bias should be added to all of the 1992 readings, which defines the 2006 thickness data as the reference point (i.e., improved technique vs. 1992). Still, random errors can produce differences between individual measurements that do not correspond to the physical observation of coating condition.

Combining the statistical analysis with the physical observation of coating condition and the maximum corrosion rate that could occur beneath an intact coating provides clear evidence that the actual mean value of the difference between the 2006 and 1992 thickness measurements is zero or a value very near zero and that the six points (possibly twelve points) that indicate large negative deltas are actually outliers that should be ignored. That is, the actual differences in thickness between the 2006 and 1992 measurements have a mean that is essentially zero and a maximum of four mils or less. Those mean and maximum differences are far less than the bias introduced by the different techniques.

The most effective use of these data is to define the 2006 thickness measurements as the baseline as of 2006. Corrosion rate, as defined by physical observation of coating condition and a thorough analysis of the 106 thickness measurements done in both 1992 and 2006 confirms that the apparent corrosion over that 14 year period is essentially nil. The latter determination (i.e., corrosion or corrosion rate defined by the difference in the thickness measurements at each of the 106 locations) is subject to systematic and random errors that make the use of the differences less useful. Those latter measurements should be used with caution. Future determinations of corrosion of the drywell must be sure to combine physical observation of coating condition and supplement (but not replace) those observations with the thickness differences.

## 6.0 CONCLUSIONS

A statistically based review was performed on Oyster Creek drywell thickness data from 1992 and 2006. That review showed that the variation in individual thickness values varied significantly by bay and to a lesser extent by zone (i.e., height above or below the drywell floor).

Differences between the 1992 and 2006 UT thickness measurements, taken at the same 106 locations at both times showed that the vast majority of the difference data (deltas) were distributed around zero. More than 20% of the difference measurements indicated that the drywell became thicker over time; a few measurements suggested that there were large decreases in thickness over the 14 year period.

The several differences that suggested that there were very large thickness losses were in sharp contrast to the physical observation of the coating, which was in good condition. Metal losses beneath an intact coating would be non-existent or extremely small; clearly not losses of 70 mils or more.

Evaluation of the thicknesses in 1992 and 2006 showed that the thickness populations at both times were described well by a normal distribution. The statistical evaluation clearly demonstrates that there is a bias in the thickness measurements, where the magnitude of that bias is at least 12 mils and is probably more like 20 mils. Clearly, that bias should be added to all of the 1992 readings, which defines the 2006 thickness data as the reference point (i.e., improved technique vs. 1992). Still, random errors can produce differences between individual measurements that do not correspond to the physical observation of coating condition.

Combining the statistical analysis with the physical observation of coating condition and the maximum corrosion rate that could occur beneath an intact coating provides clear evidence that the actual mean value of the difference between the 2006 and 1992 thickness measurements is zero or a value very near zero and that the six points (possibly twelve points) that indicate large negative deltas are actually outliers that should be ignored. That is, the actual differences in thickness between the 2006 and 1992 measurements has a mean that is essentially zero and a maximum of four mils or less. Those mean and maximum differences are far less than the bias introduced by the different techniques.

The most effective use of these data is to define the 2006 thickness measurements as the baseline as of 2006. Corrosion rate, as defined by physical observation of coating condition and a thorough analysis of the 106 thickness measurements done in both 1992 and 2006 confirms that the apparent corrosion over that 14 year period is essentially nil. The latter determination (i.e., corrosion or corrosion rate defined by the difference in the thickness measurements at each of the 106 locations) is subject to systematic and random errors that make the use of the differences less useful. Those latter measurements should be used with caution. Future determinations of corrosion of the drywell must be sure to combine physical observation of coating condition and supplement (but not replace) those observations with the thickness differences.

## 7.0 REFERENCES

1. "Data submittal 2006 vs. 92.xls", e-mail from Wayne Choromanski (Exelon) to George Licina, 11-3-2006.

2. Tech Eval A2152754 E09 (transmitted to SI by Wayne Choromanski. 11-1-2006).