RAS 14223

U.S. NUCLEAR REGULATORY COMMISSION
In the Matter of AMERGEN ENERGY CO., LLC
Docket No. 50-0219-LR Official Exhibit No. 16
OFFERED by: Applicant/Licensee Intervenor NRC Staff Other
IDENTIFIED on 9/20/07 Witness/Panel N/A
Action Taken: ADMITTED REJECTED WITHDRAWN
Reporter/Clerk NV

APPLICANT'S EXH. 16

Exelon Nuclear

CC-AA-309-1001
Revision 2

Design Analysis (Major Revision)		**Last Page No.** [6] 1 of ~~184~~ 183	
Analysis No.: [1] C-1302-187-5320-024	**Revision:** [2] 2	PT 3/28/07	
Title: [3] O.C. Drywell Ext. UT Evaluation in Sandbed			
EC/ECR No.: [4] 06-01078	**Revision:** [5] 0		
Station(s): [7] Oyster Creek		**Component(s):** [14]	
Unit No.: [8] 1			
Discipline: [9] Mechanical			
Descrip. Code/Keyword: [10]			
Safety/QA Class: [11] Q			
System Code: [12] 187			
Structure: [13] Drywell			

CONTROLLED DOCUMENT REFERENCES [15]

Document No.:	From/To	Document No.:	From/To
GE Report Index 9-3	From		
GE Report Index 9-4	From		
GE Letter Report PC-0391407	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]

See the Summary of Change Sheet, which is attached.

Preparer: [20]	Peter Tamburro	P A Tam	3/26/07
	Print Name	Sign Name	Date

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

Reviewer: [22]	Julian ABRAHAM (CONTRACTOR)	Julian Abraham	3-28-07
	F.H. RAY	F.H. Ray	5/17/07
	Print Name	Sign Name	Date

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

Calculation was reviewed for adequacy of methodology, new data entry accuracy, and spot checking of mathematical computations. A comparison with previous revision was made.

Based on my review and successful resolution of technical comments, I find the calculation acceptable.

(For External Analyses Only)

External Approver: [24]	N/A		
	Print Name	Sign Name	Date
Exelon Reviewer: [25]	N/A		
	Print Name	Sign Name	Date

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

Exelon Approver: [27]	F.H. RAY	F. Henry Ray	5/18/07
	Print Name	Sign Name	Date

DOCKETED
USNRC

October 1, 2007 (10:45pm)

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Template=SECY-028

SECY-02

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TITLE O.C. Drywell Ext. UT Evaluation in Sandbed

REV	SUMMARY OF CHANGE	APPROVAL	DATE
2	A complete revision to incorporate 2006 data of the same inspection locations. In addition the calculation section for each bay now includes a spatial evaluation of the data. Also the calculation section for each bay now includes an additional evaluation with respect to the amount of material that is less than 0.736" and its location with respect to the original calculated stress locations. Revision bars are not shown since revision 2 affects most pages of Revision 1.	Pete Tamburro J Abramovici Howie Ray	3/28/07 3-29-07 5/15/07

N0036 (1/99)

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Section **Page**

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 (1992) 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. These 1992 inspections began with visual inspections to identify the thinnest areas in each bay. UT measurements were then performed on the thinnest points within each area.

In October 2006 the majority of these areas were UT inspected a second time. The locations were found using the data sheets from the 1992 inspection.

In addition, revision 2 of this calculation develops representative areas and thicknesses for each bay.

This calculation is not intended to develop corrosion rates based on comparison of the 1992 and 2006 UT data. This is due to uncertainties and inconsistencies between the 1992 and 2006 external UT readings. Reference 3.8 provides an assessment of corrosion rates in the sandbed from 1992 to 2006 utilizing regularly monitored locations from inside the drywell. Reference 3.8 concludes that there were no observable corrosion rates in the sandbed between 1992 and 2006. Reference 3.8 also performs a "worst case" analysis of the external data reviewed in this calculation and concludes that even when assuming the worst apparent material loss (which is not credible), none of these locations would corrode to less the minimum require thickness prior to 2008, which is the next schedule inspection of these areas.

2.0 SUMMARY OF RESULTS:

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

This was performed by evaluating the UT measurements for each bay against acceptance criteria for general buckling, local buckling, and primary membrane plus bending stresses.

All UT measurements for bays 3, 5, 7, and 9 are all greater than the uniform acceptance criteria and therefore acceptable (see table 2-1).

All UT measurements for bays 11, 15, and 17 are all greater than the uniform acceptance criteria, except for one measurement in each bay. Further evaluation of these three areas show that they meet the local criteria and are therefore acceptable (see table 2-1).

All UT measurements for bays 1, 13 and 19 are evaluated using uniform and local criteria and found to be acceptable. The results are acceptable (see table 2-1).

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	2	5 of 183
Originator	**Date**	**Reviewed by**		**Date**
Peter Tamburro	3/21/07	Julien Abramovici		

TABLE (2-1) SUMMARY OF 1992 AND 2006 UT EVALUATIONS

Bay	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1	0.736"	0.802"	0.636" Per Sec. 6.2	0.696" over a 36" by 36" Area	0.490"	0.665" (Area 3)	Yes
3	0.736"	0.865"	0.636" Per Sec. 6.2	NA – All readings were greater than 0.736"	0.490"	0.764" (Area 8)	Yes
5	0.736"	0.960"	0.636" Per Sec. 6.2	NA – All readings were greater than 0.736"	0.490"	0.880" (Area 5)	Yes
7	0.736"	0.995"	0.636" Per Sec. 6.2	NA – All readings were greater than 0.736"	0.490"	0.920" (Area 1)	Yes
9	0.736"	0.905"	0.636" Per Sec. 6.2	NA – All readings were greater than 0.736"	0.490"	0.781" (Area 8)	Yes
11	0.736"	0.783"	0.636" Per Sec. 6.2	0.747" over 2 ½" diameter area	0.490"	0.700" (Area 1)	Yes
13	0.736"	0.786"	0.636" Per Sec. 6.2	0.658" over a 12" by 12" Area	0.490"	0.602" (Area 7)	Yes
15	0.736"	0.788"	0.636" Per Sec. 6.2	0.711" over a 12" by 12" Area	0.490"	0.711" (Area 1)	Yes
17	0.736"	0.892"	0.636" Per Sec. 6.2	0.663" over a 12" by 12" Area	0.490"	0.663" (Area 2)	Yes
19	0.736"	0.801"	0.636" Per Sec. 6.2	0.720" over a 36" by 36" Area	0.490"	0.712" (Area 11)	Yes

Notes: 1) This value is the average of all Individual UT readings.
2) This value is the average of recorded thicknesses in a local area not greater than 36" by 36".
3) This value is the thinnest of all individual UT readings in that Bay.

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.

3.8 Calculation C-1302-187-E310-041, Rev. 0 Statistical Analysis of Drywell Vessel Sandbed Thickness Data 1992, 1994, 1996, and 2006.

3.9 TDR 1108 "Summary Report of Corrective Action Taken From Operating Cycle 12 through 14R.

3.10 ASME Section VIII, 1962 Edition.

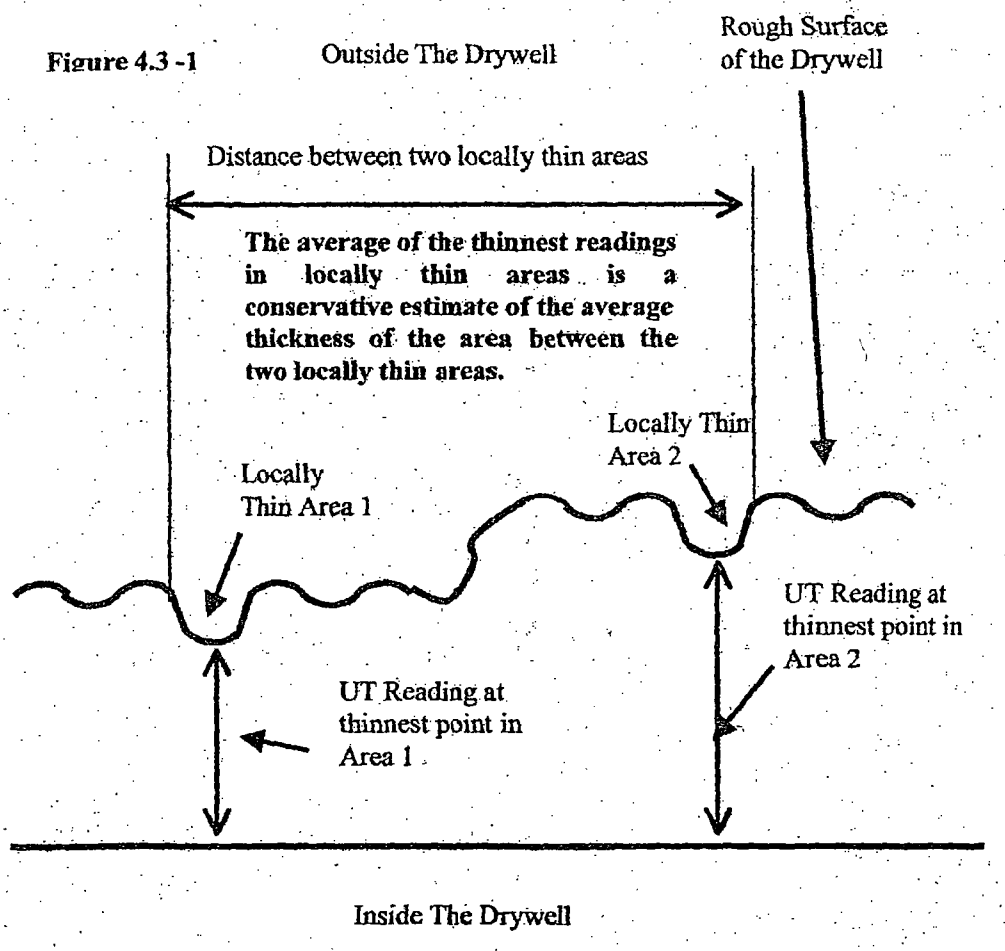
4.0 ASSUMPTIONS AND BASIC DATA:

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.

4.3 The average of a series of thinnest UT readings within an area results in a conservative estimate of the average thickness of the area. This concept is illustrated in figure 4.3-1

Figure 4.3 -1


Outside The Drywell
Rough Surface of the Drywell
Distance between two locally thin areas
The average of the thinnest readings in locally thin areas is a conservative estimate of the average thickness of the area between the two locally thin areas.
Locally Thin Area 2
Locally Thin Area 1
UT Reading at thinnest point in Area 2
UT Reading at thinnest point in Area 1
Inside The Drywell

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 1992 at the two thinnest 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)

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

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

5.6 The 1992 UT data is provided in appendix D.

5.7 The 2006 UT data is provided in Appendix E.

5.8 In 2006 Inspectors located the majority of the same areas by using the 1992 NDE Inspection Data Sheets. Since many of the inspected locations were ground down in 1992 to develop a smooth surface, the bulk of the locations could be found by observing small flat convex areas in contrast to surrounding the surfaces that were rough. The data is provided in Appendix E.

These readings were not intended for corrosion rate trending due to uncertainties and inconsistencies between the 1992 and 2006 UT readings. These uncertainties include:

a) The roughness of the inspected surfaces due to the previously corroded surface of the shell in the sandbed regions

b) The different UT technologies between 1992 and 2006

c) UT equipment instrument uncertainties and

d) The poor repeatability in attempting to inspect the exact same unmarked locations over time

Never the less a conservative evaluation was performed in which the worst case difference between 2006 and 1992 values were evaluated to ensure that the next scheduled inspection is appropriate (reference 3.8).

6.0 METHODS OF ANALYSIS:

Acceptance Criteria
The requirements of section 6.1 and 6.3 shall be met or the requirements of section 6.2 and 6.3 shall be met.

6.1 Sandbed General Uniform Wall Criteria:

Criteria: The Drywell Vessel in the Sandbed (between elevations 8' 11½" and 12' 3") shall have an average thickness greater than the uniform general thickness of 0.736" or meet the requirements of section 6.2.

This acceptance criteria is based upon GE Reports 9-3 and 9-4 (Ref. 3.2 & 3.3) as well as other GE studies (Ref. 3.5). The GE reports used a projected uniform thickness of 0.736 inches in the sandbed area. 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.

Individual readings less than 0.736" may be acceptable as long as the average thicknesses for surrounding area is greater than 0.736" and there are no individual UT readings less than 0.490 inches. Areas up to 36" by 36" may be evaluated to the uniform criteria by averaging thinnest readings within the area.

Therefore, if all the UT measurements for thickness in one bay are greater than 0.736 inches the bay is evaluated to be acceptable. Also if the average thickness of adjoining readings (within an area as large as 36" by 36") is greater than 0.736" then that area is acceptable.

Also "Evaluation Thicknesses" calculated per section 6.4 may compared to the uniform acceptance criteria of 0.736".

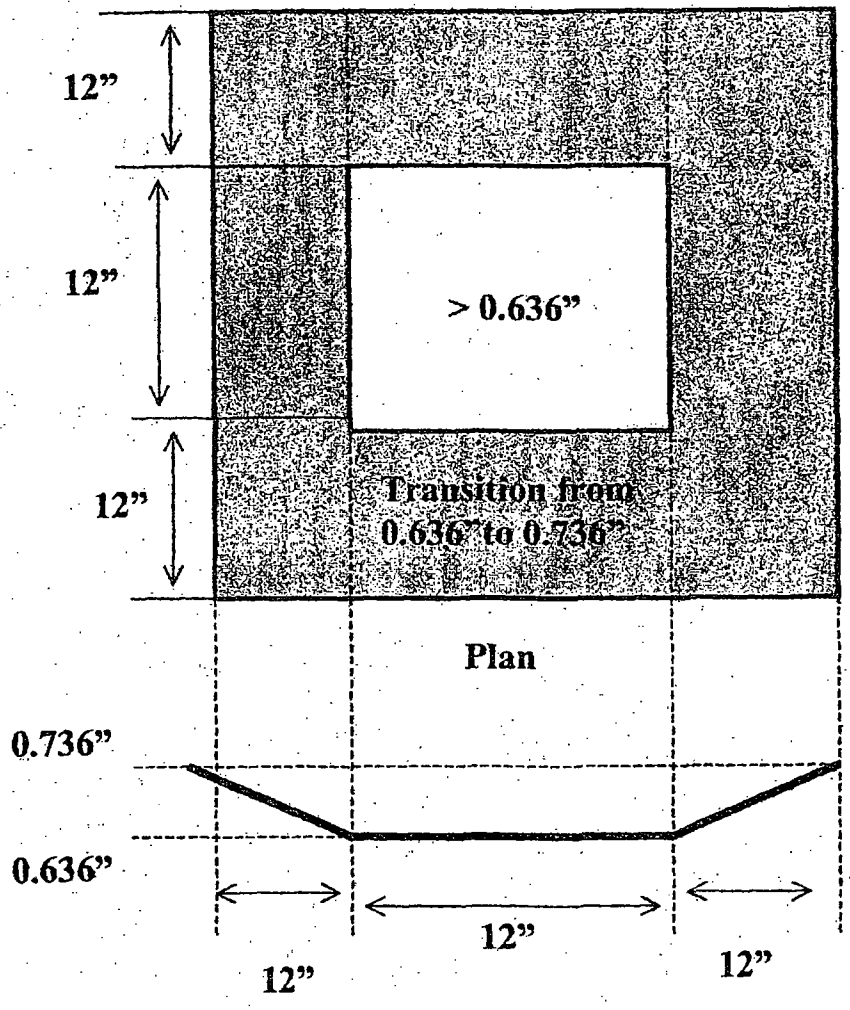
Where the above evaluation methods cannot meet this acceptance criteria, a more detailed evaluation for local buckling shall be performed per section 6.2.

6.2 Local Wall Criteria For Buckling:

Criteria: An evaluated area for local buckling shall not be larger than 36" by 36" wide. The center of the area shall be no larger than 12" by 12" and shall be on average 0.636" thick or greater. The surrounding 36" by 36" area centered on 12" by 12" area shall be on average thicker than the transition from 0.636" to 0.736".

This criteria is schematically shown below.

Figure 6.2-1



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 thickness. The methodology used in these studies is provided in reference 3.5 with excerpts 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, $[\sigma_{ap}]$, developed and saved from this static analysis. A buckling pass is then run to solve for the lowest eigenvalue or load factor, λ, 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.

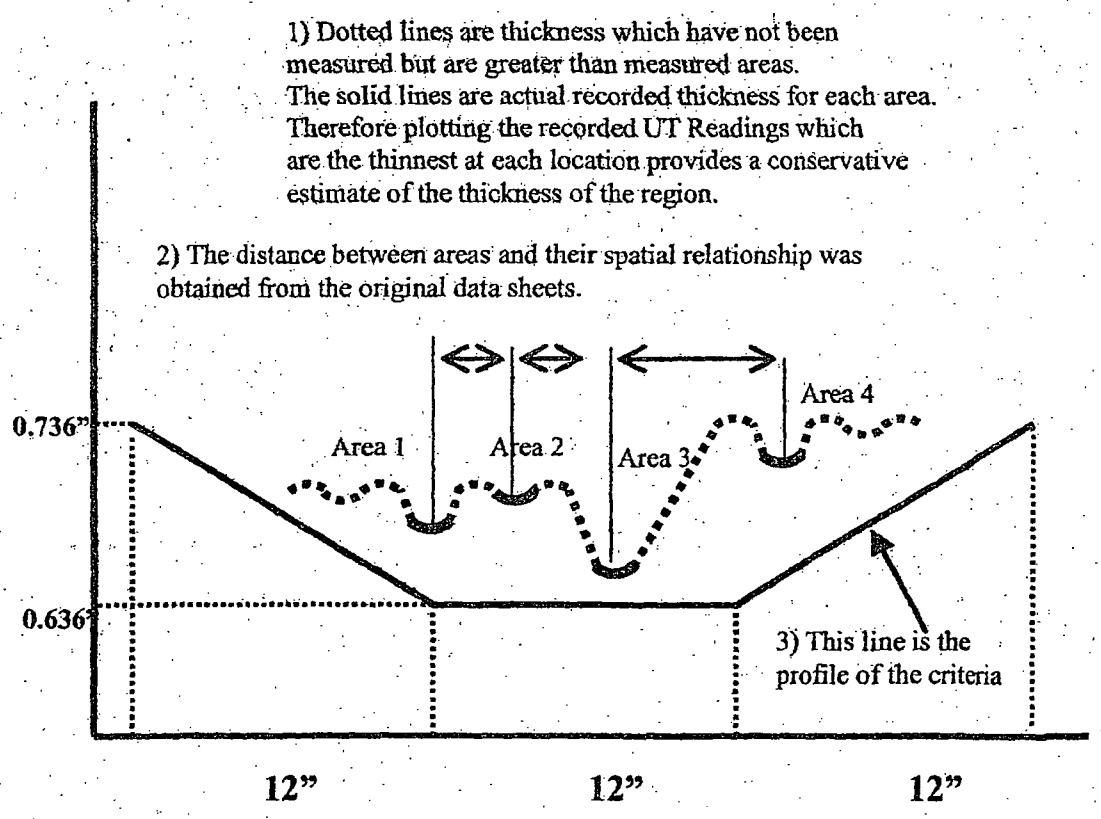
In addition, a second buckling analysis was performed for a wall thickness reduction of 0.636 inches over the one square foot area. The results of this case reduced the load factor and theoretical buckling stress by 3.9% in Reference 3.5. The center of the thinned area was located close to the maximum displacement point in the buckling analysis with uniform thickness 0.736" as per Reference 3.5. 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. The total loss in volume, compared to the same area with a thickness of 0.736", is 72 cubic inches.

For this calculation only the second case, which is more conservative, is to be used as acceptance criteria.

Actual individual thicknesses readings within the 12" by 12" area may be less than 0.636" as long as the individual readings are greater than 0.490" (section 6.3) and the average thickness over the entire 12" by 12" area is greater than 0.636". The same rational is applicable to the transition region outside the 12" by 12" area.

The actual UT readings and their spatial relationship will be compared to the acceptance criteria by plotting the profile of the areas and the recorded thicknesses overlaid on the criteria. This concept is shown on figure 6.2-2. Profiles will be developed in two directions, one in the vertical direction and the second in the horizontal direction.

Figure 6.2 -2



6.2.1 Correction for the Location of the Locally Thin Area.

The above criteria based on a 36" by 36" area was developed from sensitivity studies (reference 3.5) using the original ANSYS model which modeled the Drywell Vessel. The sensitivity studies placed the 36" by 36" grid on the area of the model that had the highest buckling stresses. This area is located between the centerlines of the vent lines. Areas below the vent lines had less compressive stresses. Therefore locally thin areas located under a vent lines will have more margin than the same locally thin areas located between the centerline of the vent lines.

This is shown in figure 3-11 and 3-13 of the original GE study (reference 3.4). These figures show the calculated compressive stresses from the original finite element modeling of the Drywell Vessel for the bounding case. In particular, figure 3-13 shows that the circumferential stresses in the bounding case vary from approximately 4300 to 5400 psi under the vent line to approximately 6500 psi at the centerline between the vent lines). Therefore it is concluded that there is at least 20% additional margin in areas that are below the centerlines of the vent line. These figures are attached in Appendix G.

6.2.2 Cumulative Effect of Locally Thin Area To Buckling

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

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 wavelengths 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 100 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 for the first case 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 case 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. The total loss in volume, compared to the same area with a thickness of 0.736", is 72 cubic inches.

6.3 Very Local Wall Criteria – Primary Membrane Plus Bending

Criteria: An individual UT reading shall be greater than 0.490".

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:

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

This acceptance criteria for 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 is that shell failures 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. Therefore, the requirements for primary membrane plus bending stresses, specified by the above code sections are not required for very local wall thickness as long as all measured thickness are greater than 0.479 inches evaluation presented in the calculation. In summary 0.479 inches can be considered the uniform general criteria for primary membrane plus bending stresses and there are no proximity requirements as long as all UT readings are greater than 0.479".

Therefore the Drywell Vessel in the sandbed vessel could be uniformly 0.479" thick and still withstand the design pressure of 44 psig and meet code stress allowable.

Revision 0 of the calculation associated this acceptance criteria with a value of 0.490" and not 0.479". Also this acceptance criteria was mistakenly attributed to primary membrane plus bending stresses (pressure) and local buckling criteria, and was limited to a 2 ½" diameter area. However review of the basis for the criteria (as described above) shows that this criteria only applies to primary membrane plus bending stresses and not buckling. In addition as documented above, the 0.479" value is a uniform thickness requirement value for primary membrane plus bending stresses. Therefore the 2 ½" diameter area restriction and proximity restrictions to other locally thin areas (greater than 0.479") is not applicable to this criteria.

However for purposes of maintaining historical consistency and to ensure additional conservatism 0.490" will remain as the value for this as acceptance criteria in this calculation.

6.4 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. This evaluation arrives a meaningful value for the general sandbed shell thickness for use in the assessment to the uniform and local buckling acceptance criteria. This meaningful value is referred to as the "Evaluation Thickness". It is computed by accounting for the depth measurements taken around the areas with the thinnest centers in 1992 and considering the roughness of the shell surface. The pit depth measurements were performed over a 1 inch band around points that were less than 0.736 inch. Therefore that resulting Evaluation Thickness is an estimate of the average thickness of the 2 inch diameter area around the individual thinnest reading.

6.4.1 Estimates the Surface Roughness

The factor that estimates the surface roughness is first discussed. 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.

6.4.2 Estimate of Area Surrounding the Thinnest UT Reading

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 UT probe and is slightly deeper than originally found. The depth of these areas was measured within a 1" band 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 result in general shell thicknesses near the indications over a 2 ½" diameter area (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 it to the uniform and local buckling acceptance criteria. This thickness is referred to as the "Evaluation Thickness" and can be attributed to an approximate 2" diameter area around the UT reading and is computed as follows:

T (evaluation) = UT (measurement) + AVG (micrometer) - Trough

where:

T (evaluation) = General shell thickness used for the evaluation

UT (measurement) = thickness measurement at the area (location)

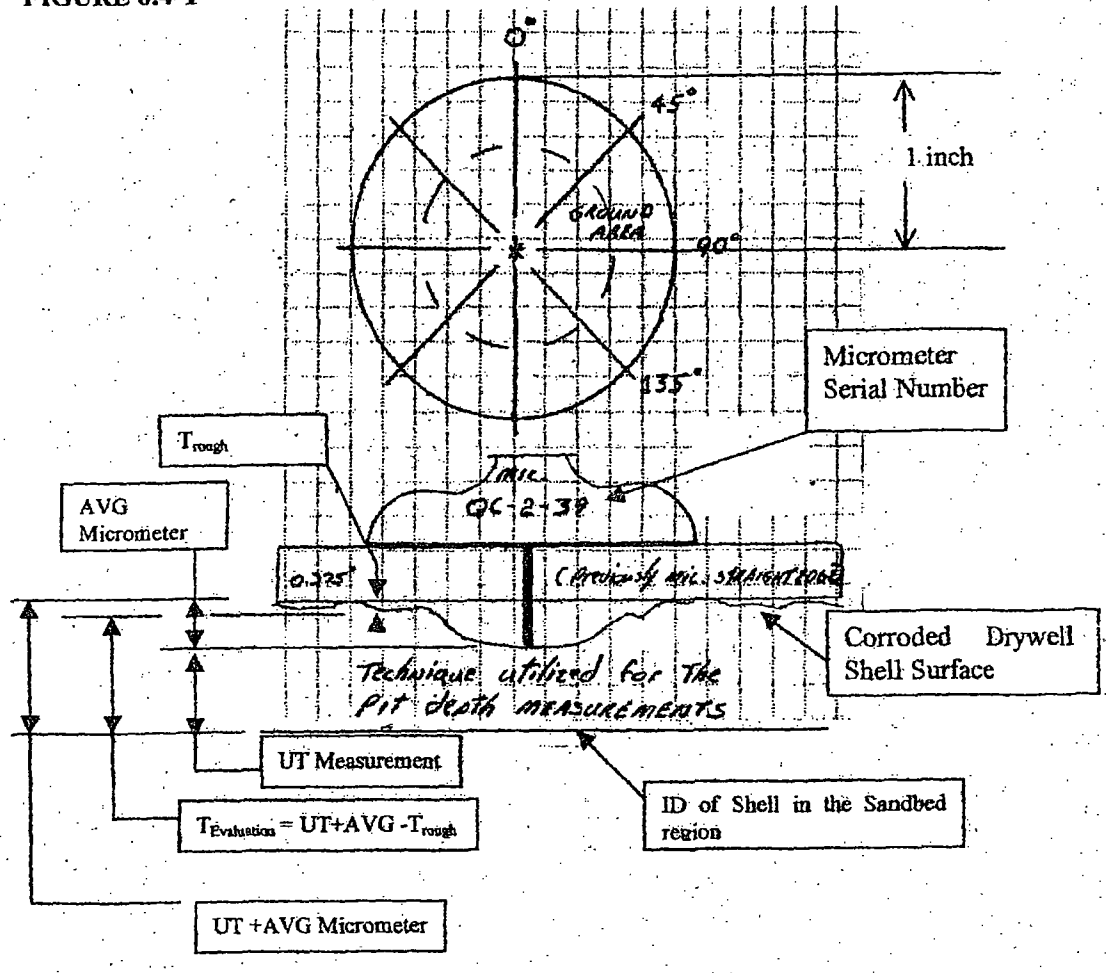
AVG (micrometer) = average depth of the area relative to its immediate surroundings

Trough = 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. If not, the area must meet the criteria in section 6.2.

The procedure was originally performed on the 1992 UT inspection date and repeated on the 2006 data. Both sets of results are documented.

FIGURE 6.4-1


0°
45°
90°
135°
1 inch
GROUND AREA
Micrometer Serial Number
T_{rough}
AVG Micrometer
0.225
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

7.0 CALCULATIONS:

7.1 EVALUATION OF BAY #1 SUMMARY

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 in 1992. The 2006 inspections confirmed this observation (references 3.6). This inspection focused on the thinnest areas of the drywell, even if it was very local. 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 1-1. (Figure 1-1 is not to scale). The graphical presentation in Figure 1-1 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. Figure 1-2 plots areas that are thinner than 0.736" in 2006. Figure 1-2 is to scale with respect to the distances between the readings.

7.1.1 Local Readings Less Than The Uniform Criteria

Table 1-1 below provides individual UT readings for 1992 and 2006. These readings are the thinnest single readings within each locally thin area. All readings are confined to areas less than 2 ½" inches in diameter. Shaded readings are less than the uniform criteria of 0.736 inches and must be further evaluated. These areas and their location are shown on figure 1-2. The figure presents the areas with readings less than 0.736 inches as squares and areas with readings over 0.736 inches as triangles.

Areas 14 and 15 were selected to confirm that no corrosion had taken place in the area above the bathtub ring. Table 1-1 also provides the results of the 2006 inspection.

Table 1-1Bay # 1 thinnest UT Data

Area No.	1992 UT Measurement (inches)	2006 UT Measurement (inches)
1	0.720	0.710
2	0.710	0.690
3	0.705	0.663
4	0.760	0.738
5	0.710	0.680
6	0.760	0.721
7	0.760	0.660

8	0.805	0.783
9	0.805	0.754
10	0.839	0.824
11	[illegible]	[illegible]
12	[illegible]	[illegible]
13	0.792	[illegible]
14	1.147	1.157
15	1.156	1.160
16	0.796	0.795
17	0.860	0.846
18	0.917	0.899
19	0.890	0.865
20	0.965	0.912
21	[illegible]	[illegible]
22	0.852	0.854
23	0.850	0.828
Average	**0.822**	**0.801**

7.1.2 Bay #1 Very Local Wall Thickness Evaluation (Pressure Only)

The table shows that all readings are greater than the criteria of 0.490". The thinnest reading was in area 3, was 0.665 inches in 2006.

7.1.3 Bay 1 Local Wall Thickness Evaluation (Local Buckling)

The values in Table 1-1 are the thinnest individual readings found in the areas. For purposes of this calculation all these areas will be considered to be 2 ½" in diameter. Eight areas (1, 2, 3, 5, 7, 11, 12, and 21) shown in Table 1-1 have individual measurements below 0.736 inches in 1992. Therefore the depth measurements were performed on these areas in 1992 (Table 1-2). At each location, micrometer readings were taken at the 0, 45, 90, and 135 degree orientation. The following table provides a summary of the depths in each azimuth.

Table 1-2 Bay 1 AVG Micrometer Calculations

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"

Example Of Calculation in Table 1-2

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

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

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

The following table provides (per section 6.4) the "Evaluation Thickness" at the locally thin areas. Shaded areas are less than the uniform acceptance criteria of 0.736" and must be evaluated further.

Table 1-3 Summary Of Measurements Below 0.736"

1	0.720"	0.710"	0.217"	0.200"	0.737"		7.1.3.3
2	0.716"	0.690	0.143"	0.200"			7.1.3.3
3	0.705"	0.665"	0.347"	0.200"	0.852"	0.812	7.1.3.1
5	0.710"	0.680"	0.313"	0.200"	0.823"	0.793"	7.1.3.1
6	0.760"						7.1.3.3
7	0.700"	0.669"	0.266"	0.200"	0.766"		7.1.3.3
11	0.714"	0.711"	0.212"	0.200"	0.726"		7.1.3.1
12	0.724"	0.722	0.301"	0.200"	0.825"	0.823	7.1.3.1
13	0.792"						7.1.3.3
21	0.726"	0.712	0.211"	0.200"	0.737"		7.1.3.3

Example of Calculation in Table 1-3

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

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

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

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

Areas 6 and 13 were not characterized in 1992 since the individual thinnest readings within the areas were greater than 0.736". However in 2006 these reading were less than 0.736". Therefore the thinnest individual readings are evaluated per section 6.2. This is conservative since no credit is taken for the surrounding thicker material around the thinnest reading (see assumption 4.3).

7.1.3.1 Areas 3, 5, and 12

Table 1-3 show that the resulting "Evaluation Thickness" of areas 3, 5 and 12 are greater than 0.736 inches and are therefore acceptable.

7.1.3.2 Evaluation of Area 13

Refer to figure 1-6. Area 13 has a single reading of 0.719". This location is next to areas 4 (0.738"), 5 (0.680"), 9 (0.754"), and 19 (0.856"). The "Evaluation Thickness" of area 5 is 0.793" and therefore this location is acceptable. These five areas are bounded by a 23" by 16" area. Since five single points were determined by the inspectors to be the thinnest within this area, the average of these individual readings is a conservative estimate of the average thickness of the 16" by 23" area (see assumption 4.3). The average of these five readings is 0.751", which is greater than 0.736".

7.1.3.3 Evaluation of Areas 1, 2, 6, 7, 11, and 21

Area 2, which has an individual reading of 0.690", was combined with neighboring areas 7 (0.669"), 11 (0.711") and 21 (0.712") (see figure 1-3). These four areas can be captured in a 14" by 18" area that has an average thickness of 0.696". The average thickness value for areas 2, 7, 11, and 21 were then located in relationship to areas 1, and 6 (see figure 1-3). Figure 1-4 and 1-5 show the profile of the 36" by 36" area with the thickness of areas 1, and 6 and the average thickness of areas 2, 7,11 and 21 overlaid with a curve depicting the acceptance criteria.

Figure 1-4 shows the profile along the horizontal axis and figure 1-5 show the profile along the vertical axis. The figures show that the average thicknesses are greater than the criteria.

Please note that Figure 1-4 does show that the two locally thin areas come close to the edges of the 36" by 36" acceptance criteria envelope. However since these areas are significant smaller than the analyzed area and since the two areas are actually located at an azimuth of the drywell that sees less stress (7.1.3.4) the approach to the envelope is judged to be inconsequential.

7.1.3.4 Combined Effect of The 10 Areas on Buckling

There are several conservative factors associated with the size and the location of the locally thin areas which cannot be quantified but are judged to be substantial in demonstrating that the measured thickness are adequate. These are described below.

7.1.3.4.1 Refer to figure 1-7. The locally thin area for this bay that is less than 0.736 inches is located directly under the vent line.

The local buckling criteria (section 6.2) is based on sensitivity studies that placed a 36" by 36" locally thin grid on the area of the finite element model that had the highest buckling stresses. This area is located between the centerlines of the vent lines (+66" to –66 as shown in figure 1-2). Areas below the vents lines had less compressive stresses (-36" to +36"). Therefore locally thin areas located under a vent lines will have more margin than the same locally thin areas located between the centerline of the vent lines. Review of the original GE study (see appendix F) shows that stresses under the vent line are at least 20% less then the stresses between the centerline of the vent lines. Therefore the necessary wall thickness to maintain the required safety factor for portions of the vessel under the vent lines is substantially less (by at least 20%) than the calculated required uniform thickness of 0.736".

7.1.3.4.2 A second factor is the cumulative size of the ten locally thin areas, which is significantly much smaller than the analyzed 36" by 36" area (see the figure in section 6.2). The total volume of this 36" by 36" area when compared to the volume of a similar 36" by 36" area with a uniform thickness of 0.736" correspond to a reduced volume of 72.0 cubic inches.

The cumulative volume of all ten locally thin areas is about 1.7 cubic inches (see the table below).

Area	Thinnest reading inside the area (inches) (Column 2)	Equivalent volume loss of 2 ½ inches diameter area with thickness equal to thinnest readings (Column 2) when compared to a uniform thickness of 0.736 inches (0.736 – Column 2)* 3.142*(2.5/2)**2
1	0.710	0.128
2	0.690	0.226
3	0.665	0.349
5	0.680	0.275
6	0.731	0.025
7	0.669	0.329

Area	Thinnest reading inside the area (inches) (Column 2)	Equivalent volume loss of 2 ½ inches diameter area with thickness equal to thinnest readings (Column 2) when compared to a uniform thickness of 0.736 inches (0.736 – Column 2)* 3.142*(2.5/2)**2
11	0.711	0.123
12	0.722	0.069
13	0.719	0.083
21	0.712	0.118
	Total	1.723

Therefore the comparison of the "as found" volume reduction, which is about 1.723 cubic inches, to the "analyzed" volume reduction of 72 cubic inches leads to the conclusion that the effect on the buckling load factor is negligible.

In addition since the majority of the vessel in this bay is thicker than 0.736", the thicker areas will reinforce the locally thin areas. For example approximately 7210 square inches of surface area in this bay (of a total of 9072 square inches) is 800 mils or thicker (refer to figure 13-7). When compared to same surface area with a thickness of 0.736" there is a total increase in volume of at least 460 cubic inches. (e .g 460 = (0.8-0.736)* 7210). This additional volume will reinforce the locally thin areas.

7.1.4 Bay #1 General Wall Thickness Criteria (Buckling)

Outside the "Bathtub Ring"

Refer to figure 1-1

Taking the average of the UT measured thicknesses of areas 6, 7, 8, 9, 16, 17, 18, 19, 22 and 23 gives a average thickness of 0.824 inches in 1992 and 0.802 inches 2006 for the shell below the bathtub ring. Based on this a conservative mean thickness of 0.802 inches, is estimated to represent the evaluation thickness for this bay outside the bounds of the bathtub ring. Therefore 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.

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".

In the "Bathtub Ring"

Areas 1, 2, 3, 4, 5, 10, 11, 12, 13, 20, and 21 are confined to the bathtub ring as shown in Figure 1-1 and 1-2. To determine the general shell thickness in the bathtub ring area of this bay the evaluation thicknesses for each of the areas 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:

An average value of the evaluation thicknesses presented in Table 1-3 for this band is as follows;

Area	Evaluation Thickness (1992)	Evaluation Thickness (2006)
1	0.737"	0.727"
2	0.659"	0.633"
3	0.852"	0.812"
4*	NA	0.738"*
5	0.823"	0.793"
10*	NA	0.824"*
11	0.726"	0.723"
12	0.825"	0.823"
13*	NA	0.719"*
20*	NA	0.912"*
21	0.737"	0.714"
	Average = 0.766"	Average = 0.765"

* Note for area 4, 10, 13 an 20 the actual 2006 UT measurement were used since these areas were not characterized in 1992.

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.

7.1.5 Conclusion

Figure 1-7 illustrates representative areas and thicknesses in this bay as follows:

Area B – This is a 23" wide and 16" high area, which is at least 0.751" thick. This thickness is based on the thickness of the Bathtub Ring (refer to section 7.1.3.2).

Area C - This is a 36" by 36" area which is at least 0.696 inches thick. This thickness is based on the evaluation in section 7.1.3.3.

Area D- The remaining areas of the Bay are 0.800 inches thick or greater. This thickness is based on the evaluation in section 7.1.4.

Area E - This is a 11" wide by 18 " high area which and is at least 0.765 inches thick. This thickness is based on the thickness of the Bathtub ring (refer to section 7.1.4).

Therefore this bay meets the acceptance criteria based on the following:

1) All individual readings are greater than 0.490 inches.

2) Except for Area C, the entire bay has thickness greater than 0.736 inches.

3) Area C (which is limited to an area of 36" by 36") meets the acceptance criteria in section 6.2.

Figure 1-1

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".

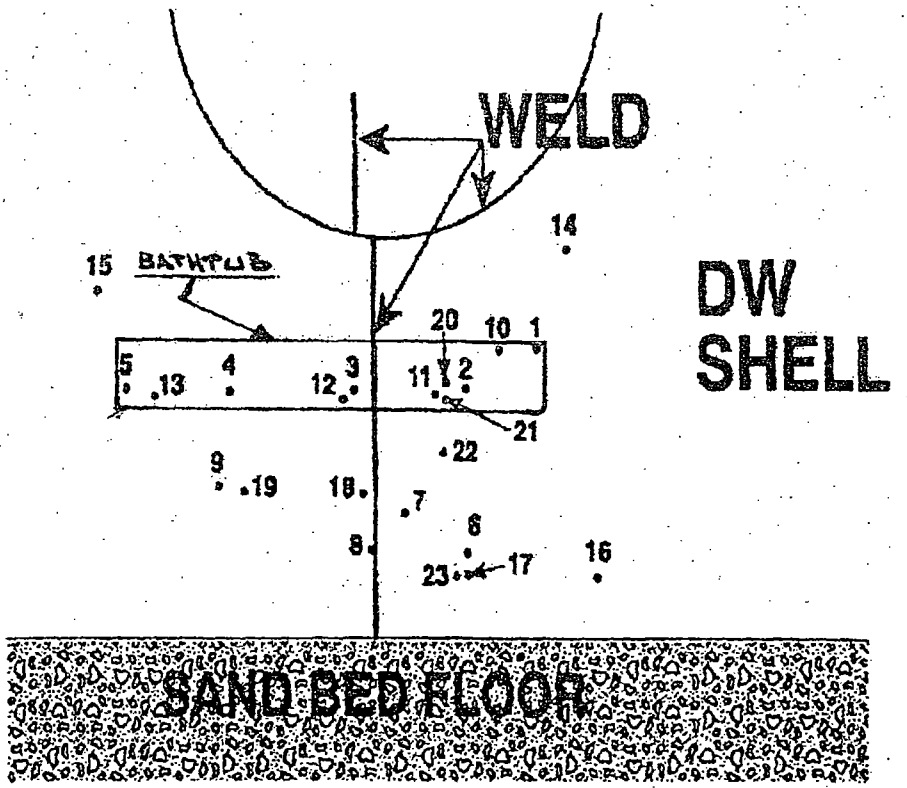


Figure 1-2

Bay 1 2006
Spatial Relationship Of Locally Thin Areas

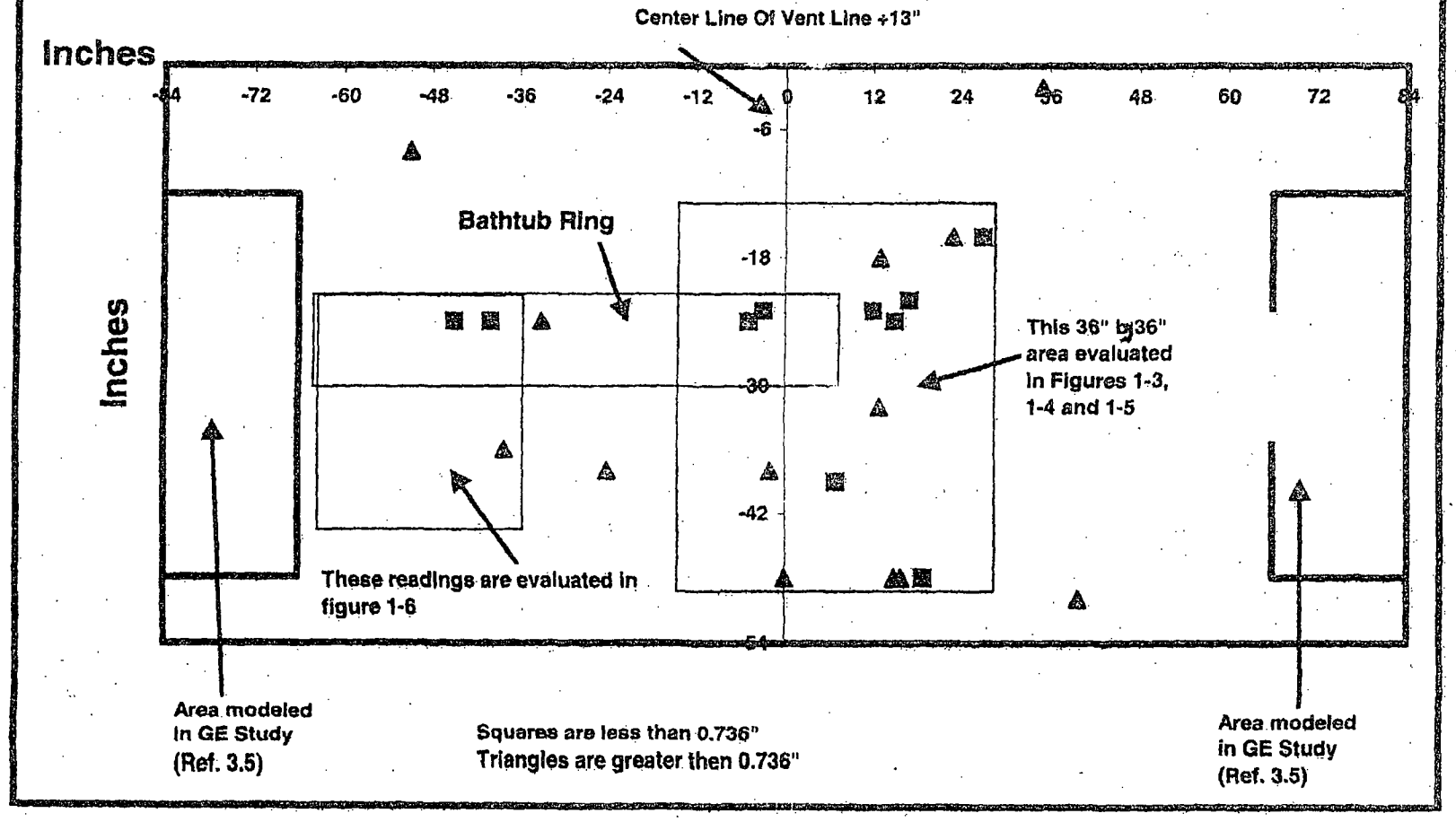


Figure 1-3

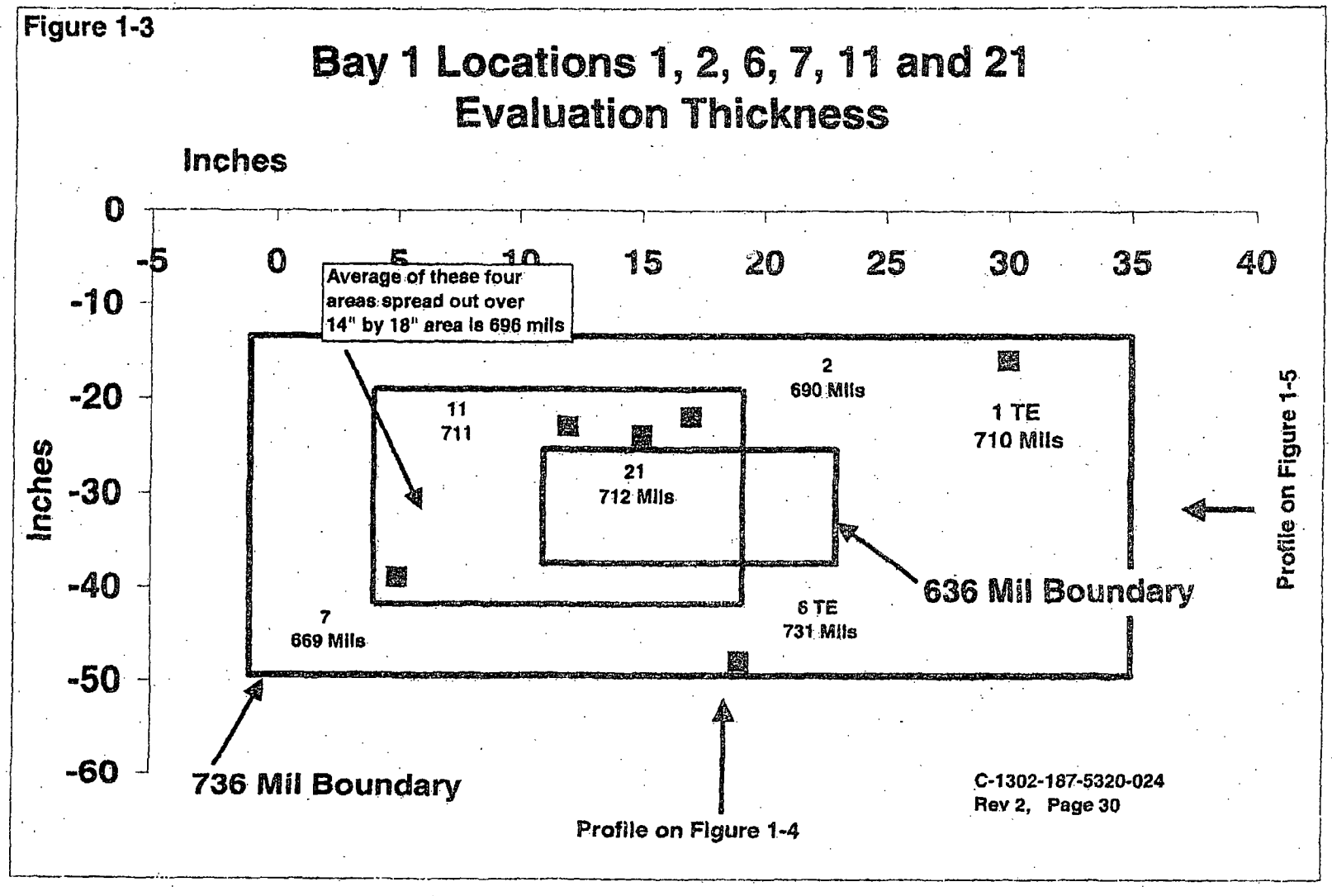


Figure 1-4

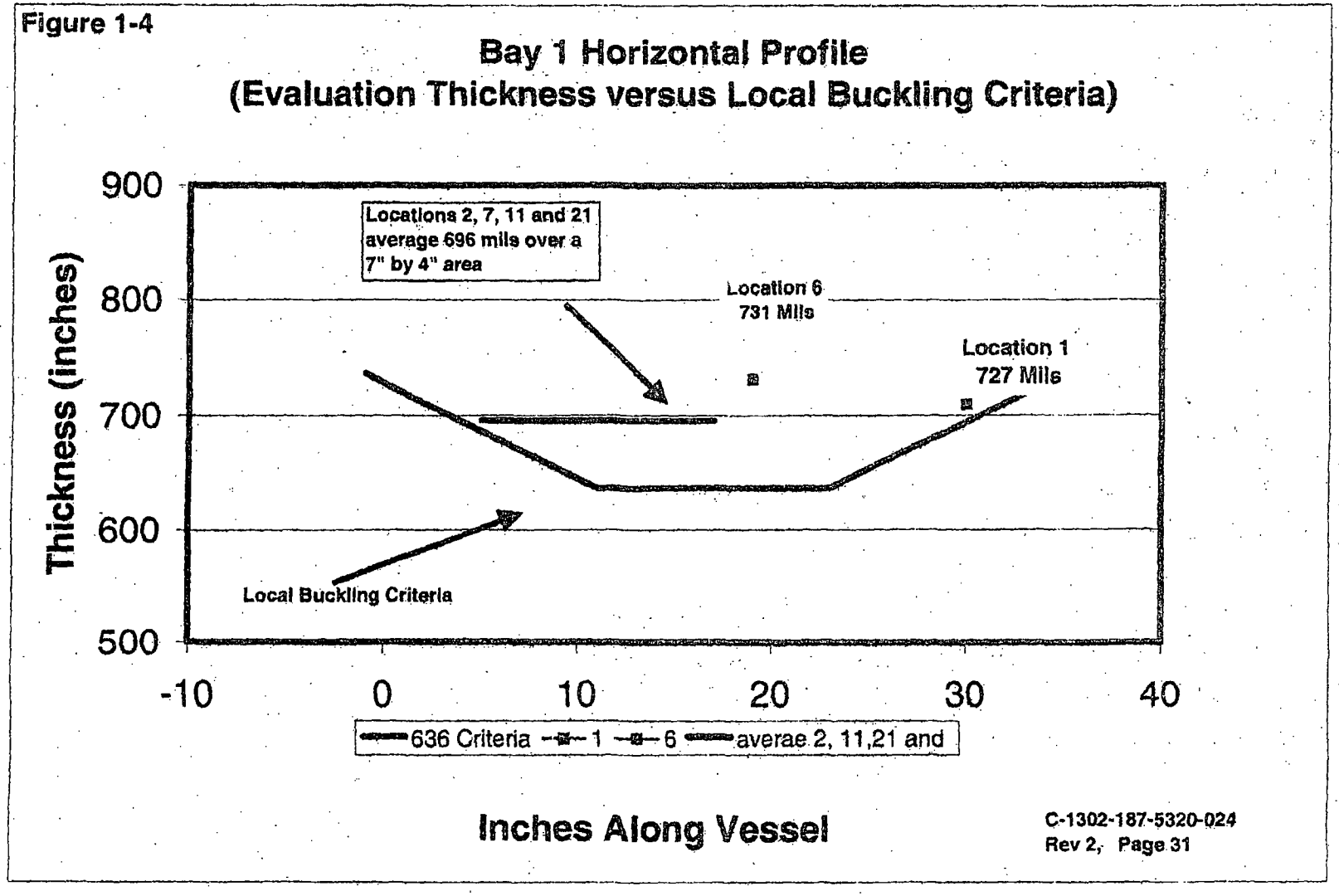


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Figure 1-5

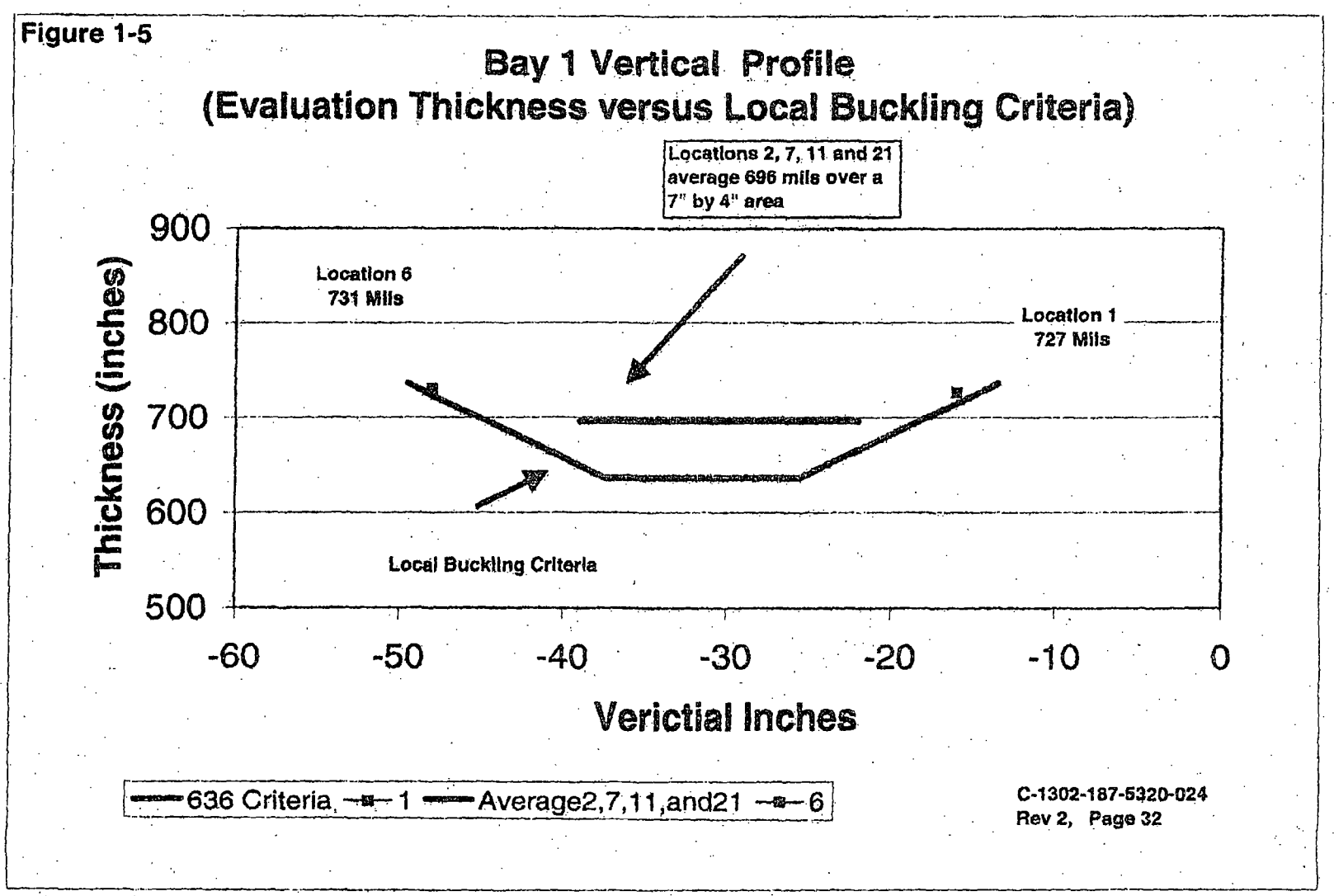

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Figure 1-6

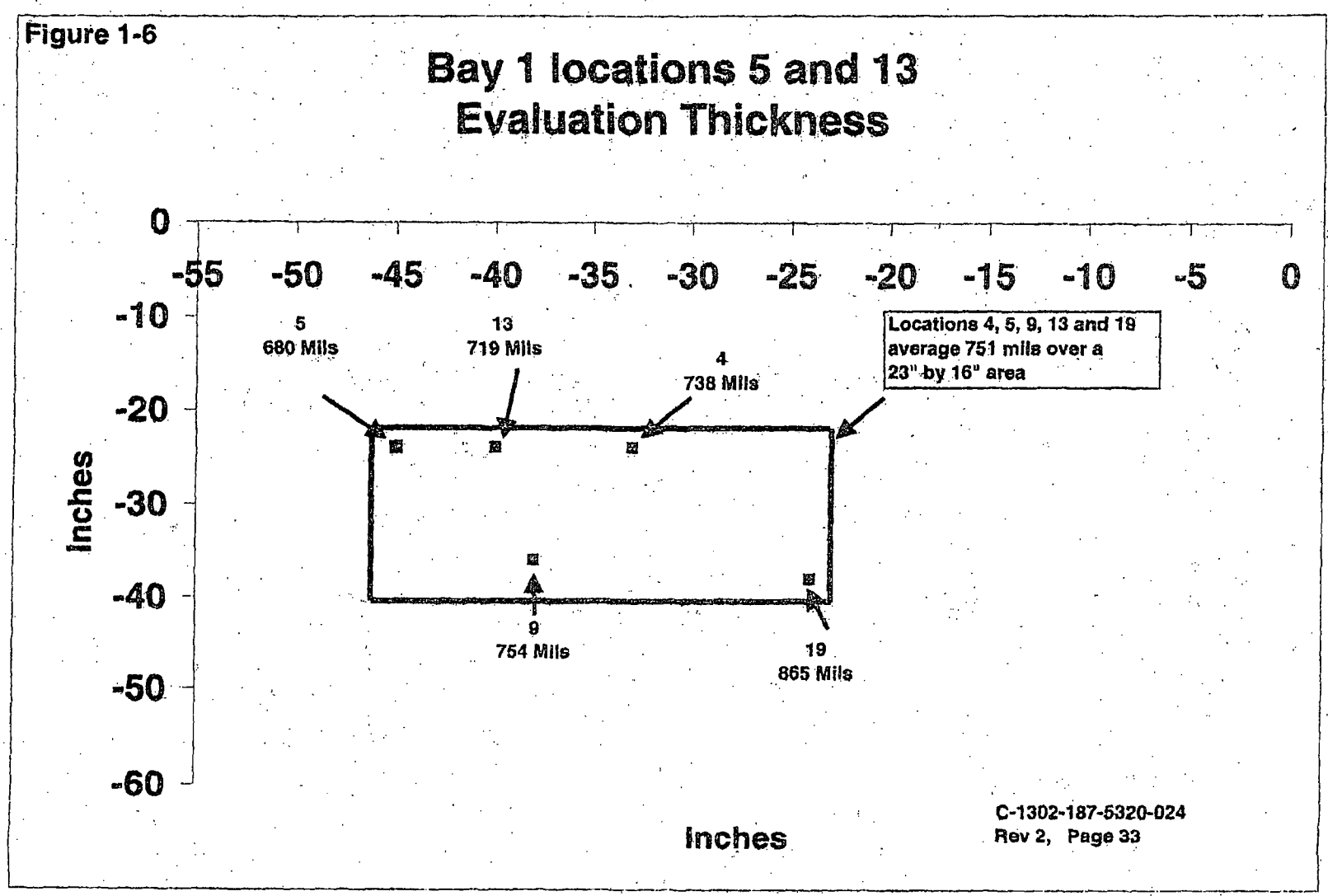

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Figure 1-7

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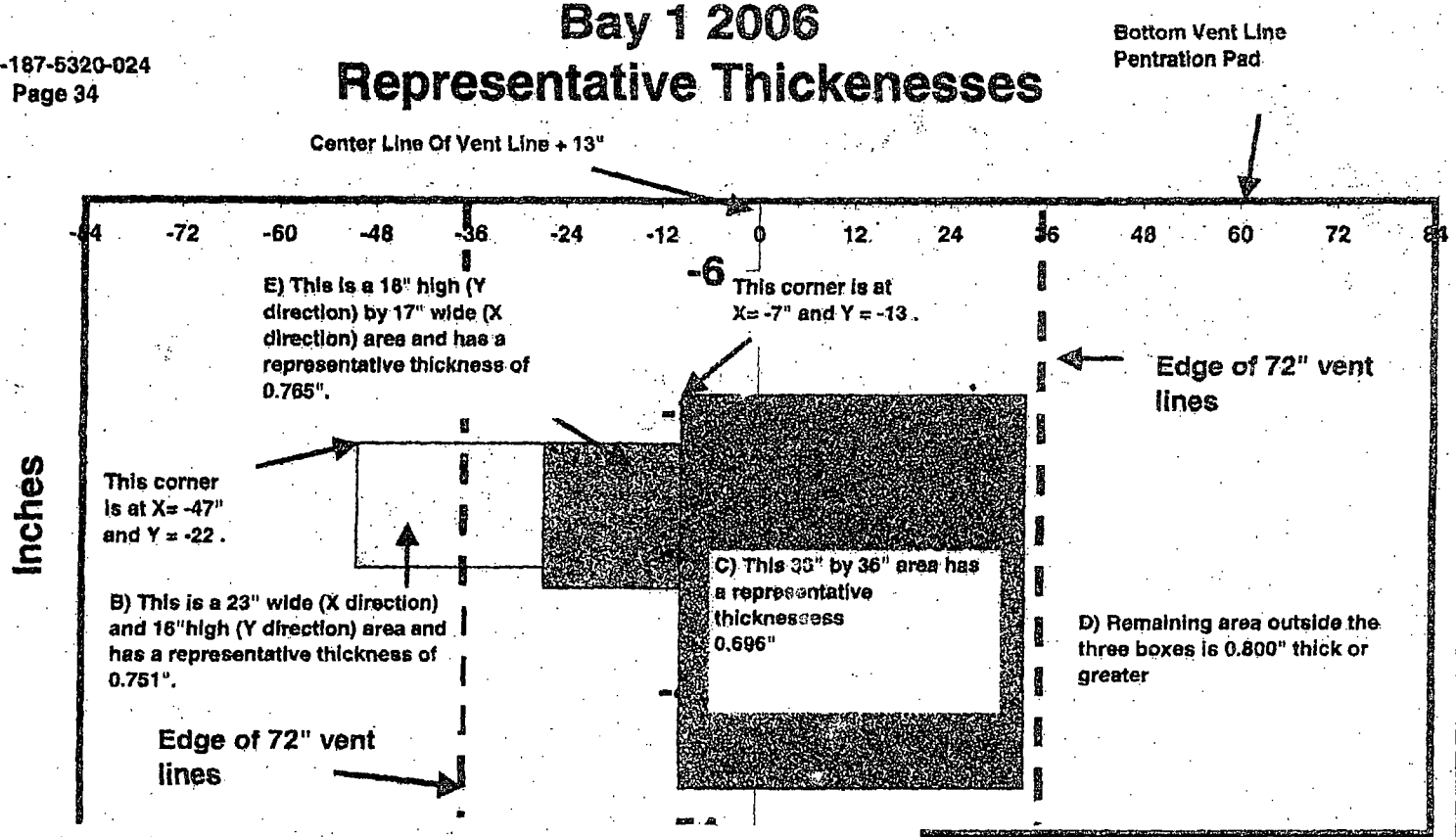
Bay 1 2006
Representative Thickenesses



All X and Y dimensions are referenced from 13 inches to the right of centerline of the vent line (X direction) and the bottom of the Penetration Reinforcement Pad (Y dimension). Reference NDE Data sheets 92-072-12 page 1 of 2 and 1R21LR-022 page 2 of 2.

7.3 UT EVALUATION BAY #3 SUMMARY

The outside surface of this bay is rough; similar to bay one, full of dimples comparable to the outside surface of golf ball (references 3.6). This observation was 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.

7.3.1 Local Readings Less Than The Uniform Criteria

Eight areas were selected to represent the thinnest areas based on the visual observations of the shell surface (Table 3-1 and Fig. 3-1). These areas are a deliberate attempt to produce a minimum measurement. Table 3-1 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. Therefore, the uniform criteria is met throughout the bay and it is concluded that the bay is acceptable.

These areas and their location are shown on figure 3-2.

Table 3-1 Bay # 3 Thinnest UT Data

[illegible]	[illegible] Measurement (inches)	[illegible] Measurement (inches)
1	0.795	0.795
2	1.000	0.999
3	0.857	0.850
4	0.898	0.903
5	0.823	0.819
6	0.968	0.972
7	0.826	0.816
8	0.780	0.764
Average	**0.8685**	**0.865**

7.3.2 Bay #3 Very Local Wall Thickness Evaluation (Pressure Only)
All individual readings were greater than the acceptance criteria of 0.490". The thinnest reading was 0.764" in area 8 recorded in 2006.

7.3.3 Bay 3 Local Wall Thickness Evaluation (Local Buckling)
The results indicate that all of the areas have thickness greater than the 0.736 inches. Therefore the uniform criteria is met throughout the bay and the use of the local wall thickness criteria for buckling is not required.

7.3.4 Bay 3 General Wall Thickness Criteria (Buckling)
The UT measurements presented in Table 3-1 equal an average of 0.868 inches in 1992 and 0.865" in 1992. 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.

7.3.5 Conclusion

It is concluded that Bay 3 is acceptable since all individual UT readings in 1992 and 2006 were greater than the uniform acceptance criteria.

Figure 3-2 illustrates the representative thicknesses in this bay, which is 0.865 inches or greater (refer to section 7.3.4).

BAY #3 DATA

Figure 3-1

NOTES:

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

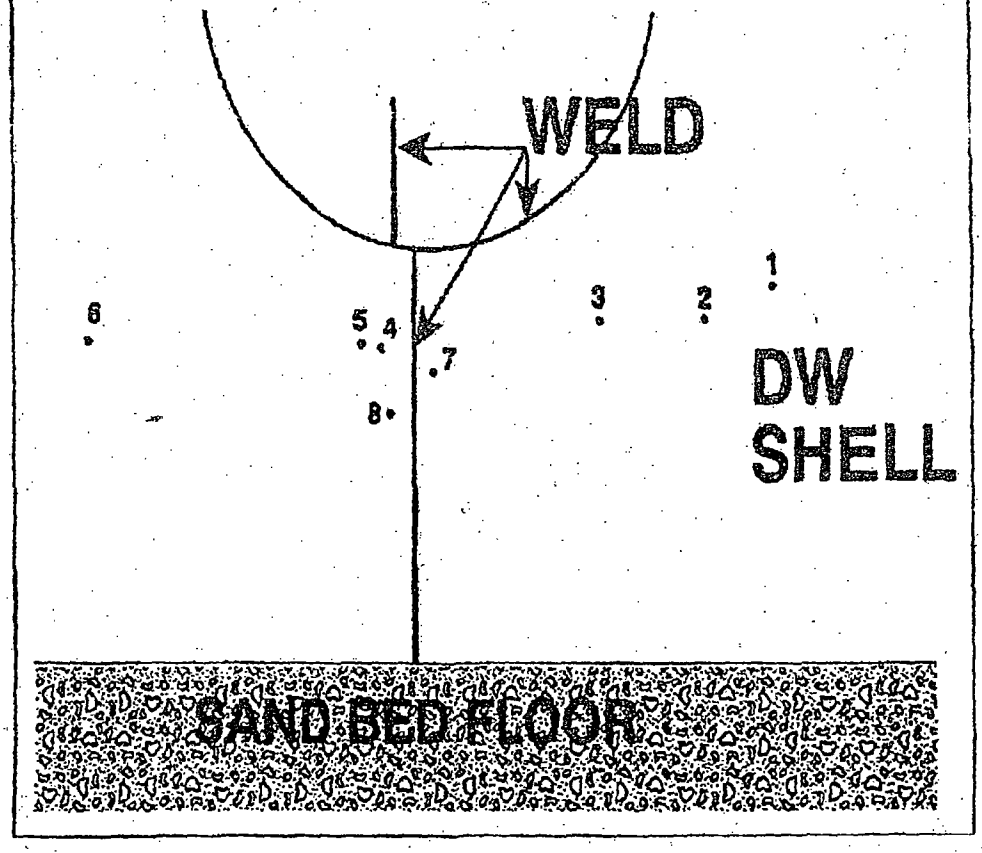
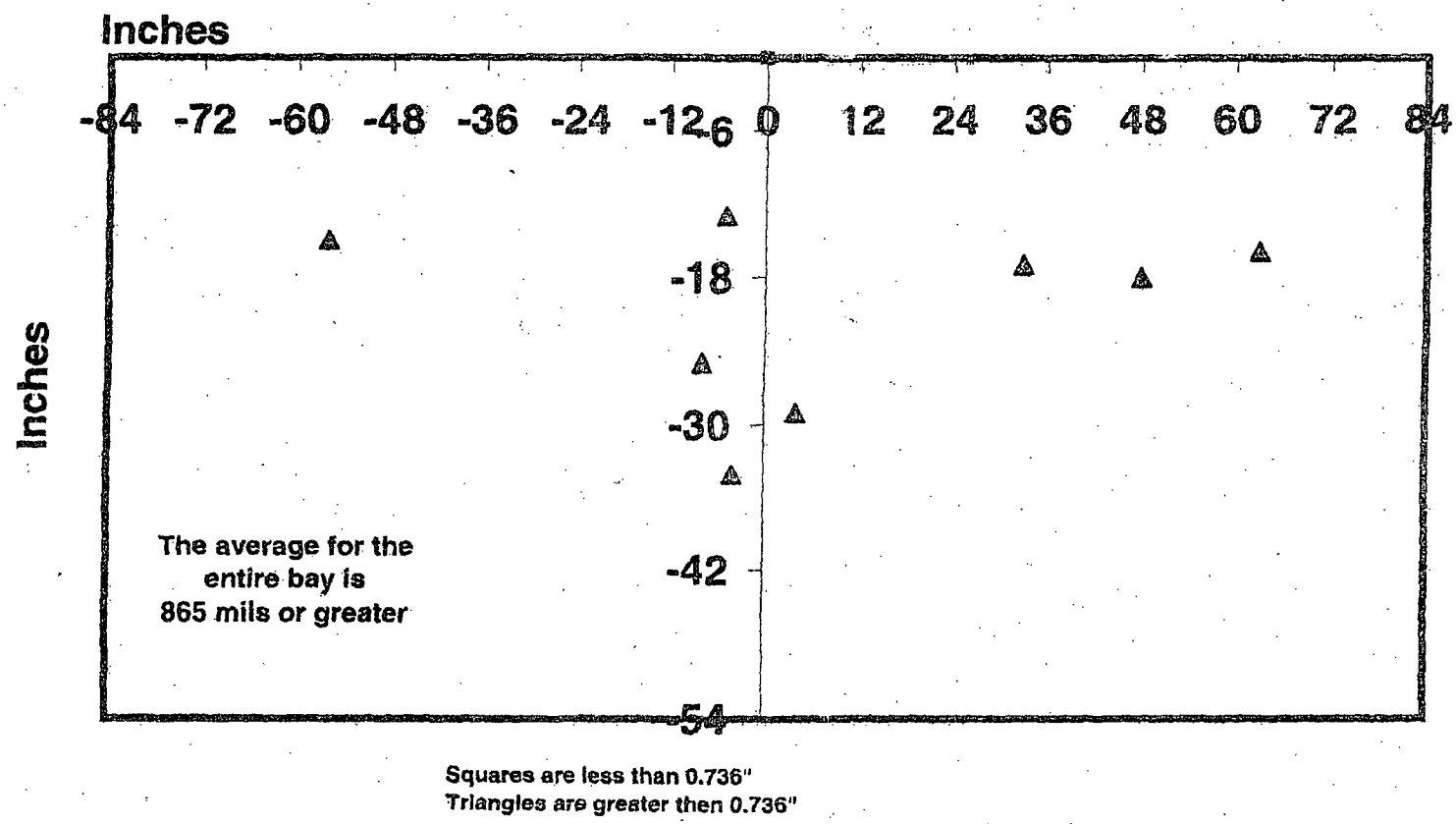


FIGURE (3)

Figure 3-2

Bay 3 2006
Spatial Relationship Of Locally Thin Areas



Squares are less than 0.736"
Triangles are greater then 0.736"

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7.5 UT EVALUATION BAY 5 SUMMARY

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 (references 3.6). 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 areas were selected to represent the thinnest areas based on the visual observations of the shell surface (see Fig. 5-1). These areas are a deliberate attempt to produce a minimum measurement. Table 5-1 shows these thickness values. The results indicate that all of the areas have thickness greater than the 0.736 inches.

7.5.1 Local Readings Less Than The Uniform Criteria

The individual thinnest UT measurements for locally thin areas are presented in Table 5-1. All 1992 and 2006 reading were greater than 0736 inches. Therefore, the uniform criteria is met throughout the bay and it is concluded that the bay is acceptable.

These areas and their location are shown on figure 5-2

Table 5-1 Bay # 5 Thinnest UT Data

Location	1992 UT Measurements (inches)	2006 UT Measurements (inches)
1	0.970	0.948
2	1.040	0.955
3	1.020	0.989
4	0.910	0.948
5	0.890	0.880
6	1.060	0.981
7	0.990	0.974
8	1.010	1.007
Average	**0.986**	**0.960**

7.5.2 Bay #5 Very Local Wall Thickness Evaluation (Pressure Only)

All individual readings were greater than the acceptance criteria of 0.490". The thinnest reading was 0.880" in area 5 recorded 2006.

7.5.3 Bay 5 Local Wall Thickness Evaluation (Local Buckling)

The results indicate that all of the areas have thickness greater than the 0.736 inches. Therefore the uniform criteria is met throughout the bay and the use of the local wall thickness criteria for buckling is not required.

7.5.4 Bay #5 General Wall Thickness Criteria (Buckling)

The UT measurements presented in Table 5-1 equal an average of 0.986 inches in 1992 and 0.960" in 2006. 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.

7.5.5 Conclusion

It is concluded that Bay 5 is acceptable since all individual UT readings in 1992 and 2006 were greater than the uniform acceptance criteria.

Figure 5-2 illustrates the representative thicknesses in this bay, which is 0.960 inches or greater (refer to section 7.5.4).

Figure 5-1

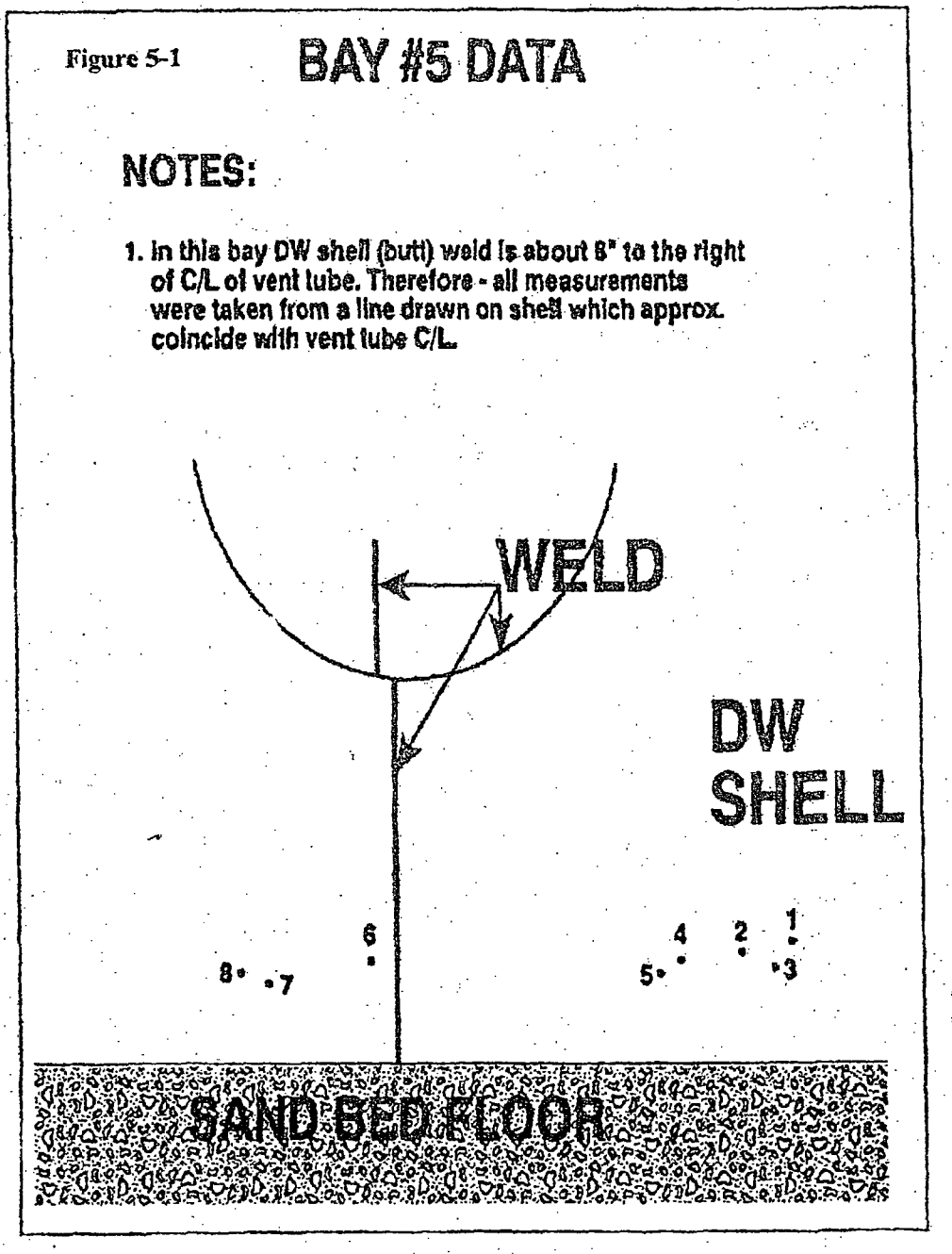
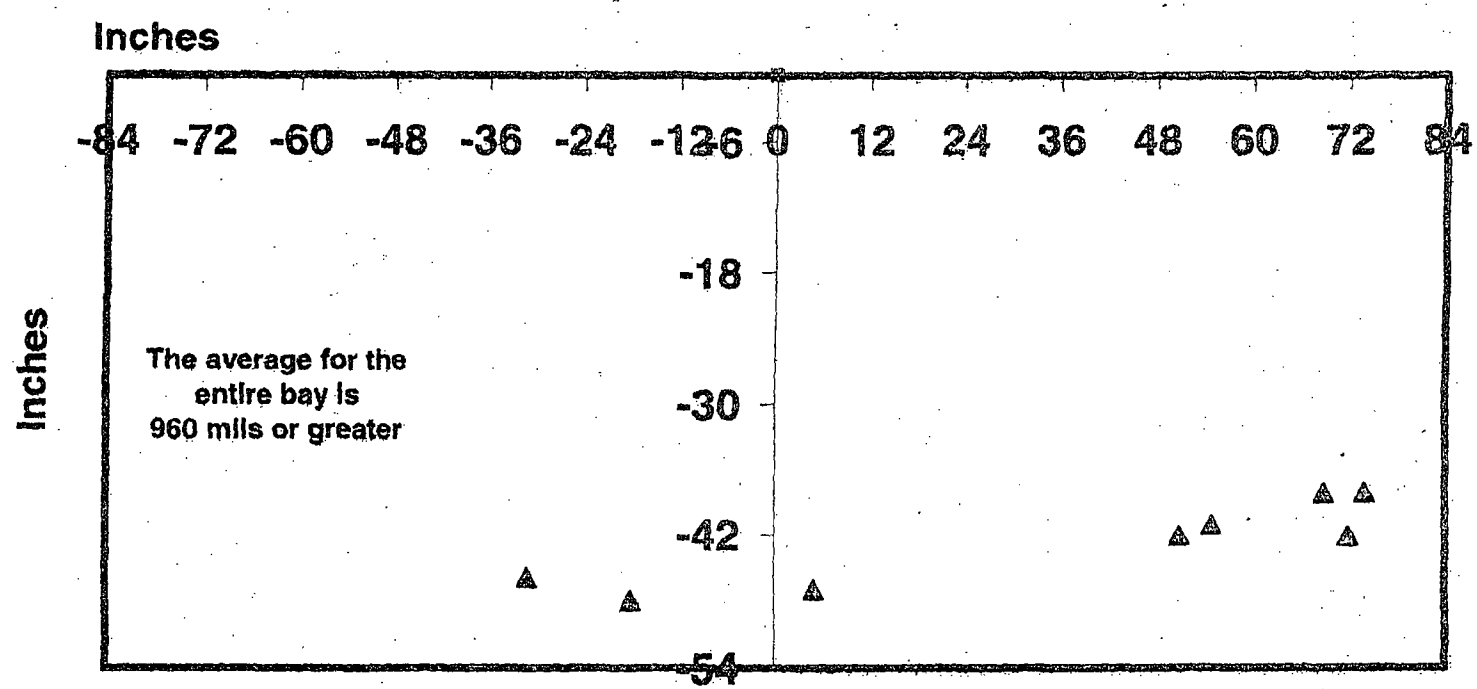


FIGURE (5)

Figure 5-2

Bay 5 2006
Spatial Relationship Of Locally Thin Areas



Squares are less than 0.736"
Triangles are greater then 0.736"

7.7 UT EVALUATION BAY 7 SUMMARY

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 (references 3.6). 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 areas were selected to represent the thinnest areas based on the visual observations of the shell surface (Fig. 7-1). These areas are a deliberate attempt to produce a minimum measurement. Table 7-1 presents thee values.

7.7.1 Bay #7 Local Readings Less Than The Uniform Criteria

The individual thinnest UT measurements for locally thin areas are presented in Table 7-1. All 1992 and 2006 readings are greater than 0.736 inches. Therefore, the uniform criteria is met throughout the bay and it is concluded that the bay is acceptable.

These areas and their location are shown on figure 7-2.

Table 7-1 Bay # 7 Thinnest UT Data

Location	1992 UT Measurement (inches)	2006 UT Measurement (inches)
1	0.920	NA
2	1.016	NA
3	0.954	0.956*
4	1.040	NA
5	1.030	1*
6	1.045	1.02*
7	1.000	1.002*
Average	**1.000**	**0.995**

* - These were the thinnest documented readings on the 2006 data sheet.

7.7.2 Bay #7 Very Local Wall Thickness Evaluation (Pressure Only)

All individual readings were greater than the acceptance criteria of 0.490". The thinnest reading was in area 1, was 0.920 inches in 1992.

7.7.3 Bay 7 Local Wall Thickness Evaluation (Local Buckling)

The results indicate that all of the areas have thickness greater than the 0.736 inches. Therefore the uniform criteria is met throughout the bay and the use of the local wall thickness criteria for buckling is not required.

7.7.4 Bay #7 General Wall Thickness Criteria (Buckling)

The UT measurements presented in Table 5-1 equal an average of 1.000 inches in 1992 and 0.995" in 2006. 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.

7.7.5 Conclusion

It is concluded that Bay 7 is acceptable since all individual UT readings in 1992 and 2006 were greater than the uniform acceptance criteria.

Figure 7-2 illustrates the representative thicknesses in this bay, which is 0.995 inches or greater (refer to section 7.5.4).

Figure 7-1

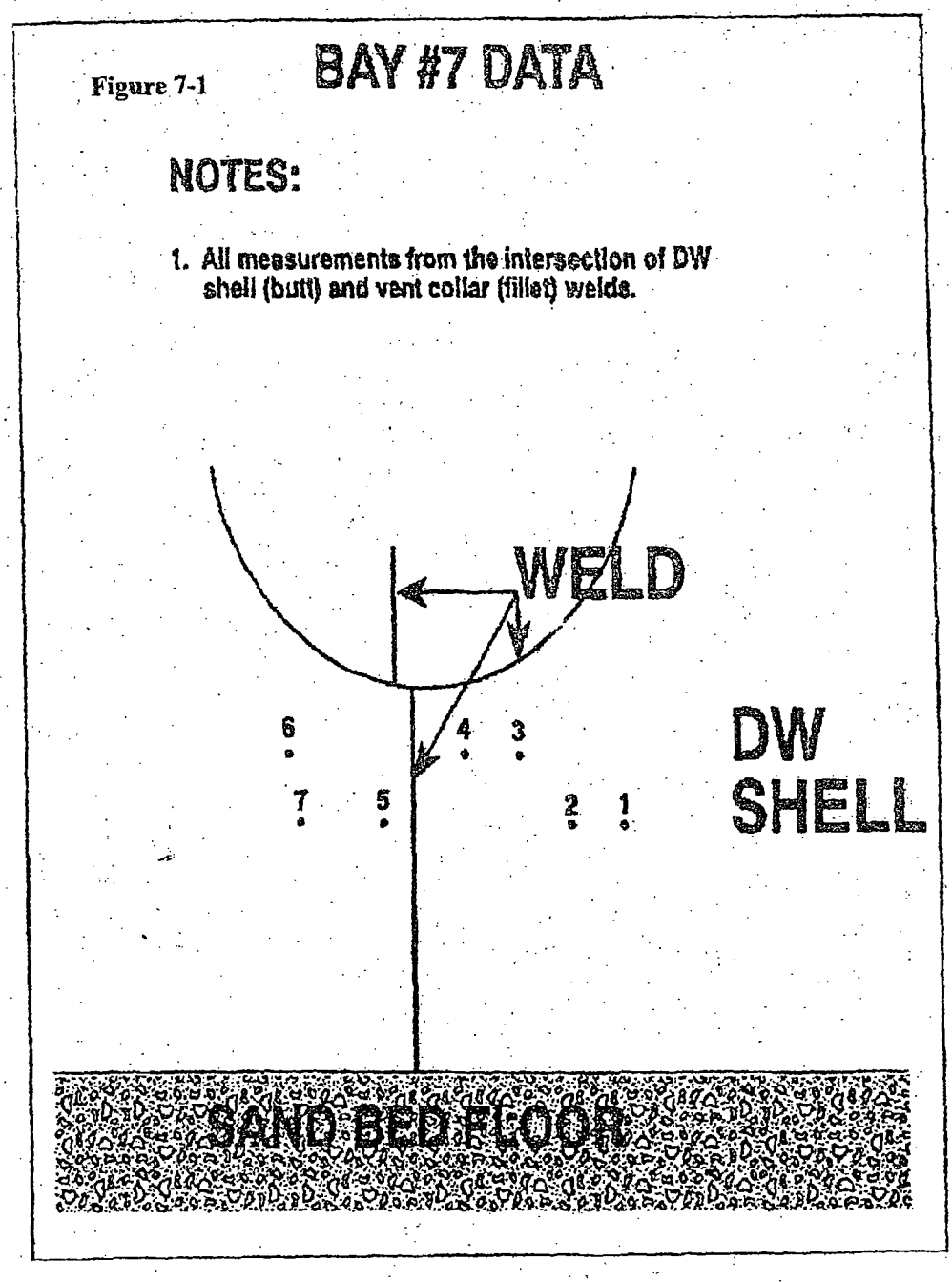
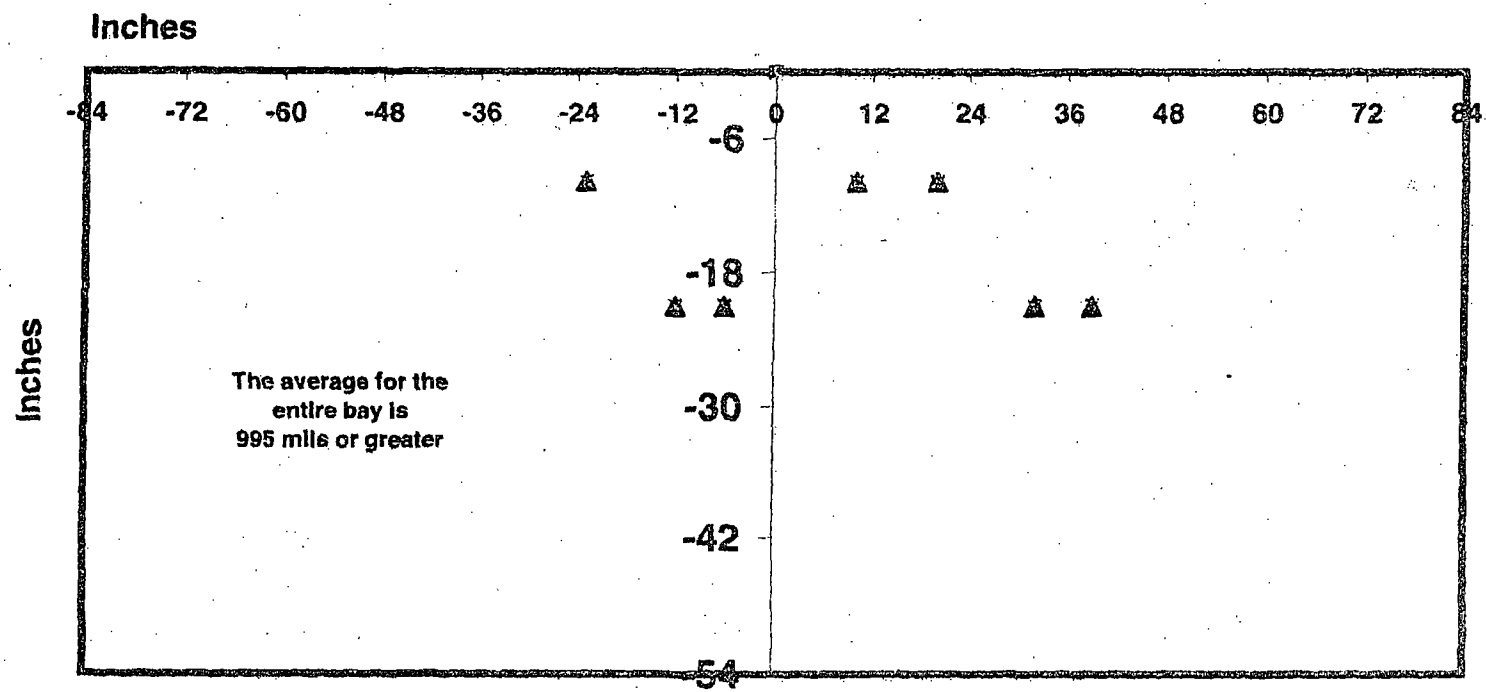


FIGURE (7)

Figure 7-2

Bay 7 2006
Spatial Relationship Of Locally Thin Areas



Squares are less than 0.736"
Triangles are greater then 0.736"

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7.9 UT EVALUATION BAY #9 SUMMARY

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 (references 3.6). 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 areas were selected to represent the thinnest areas based on the visual observations of the shell surface (Fig. 9-1). These areas are a deliberate attempt to produce a minimum measurement. Table 9-1 shows readings taken to measure the thinnest thicknesses of the drywell shell.

7.9.1 Bay #9 Local Readings Less Than The Uniform Criteria

The individual thinnest UT measurements are presented in Table 9-1. All 1992 and 2006 readings are greater than 0.736 inches. Therefore, the uniform criteria is met throughout the bay and it is concluded that the bay is acceptable.

These areas and their location are shown on figure 9-2.

Table 9-1 Bay # 9 Thinnest UT Data

Location	1992 UT Measurements (inches)	2006 UT Measurements (inches)
1	0.960	0.968
2	0.940	0.934
3	0.994	0.989
4	1.020	1.016
5	0.985	0.964
6	0.820	0.802
7	0.825	0.820
8	0.791	0.781
9	0.832	0.823
10	0.980	0.955
Average	**0.915**	**0.905**

7.9.2 Bay #7 Very Local Wall Thickness Evaluation (Pressure Only)

All individual readings were greater than the acceptance criteria of 0.490". The thinnest reading was in area 8, was 0.781 inches in 2006.

7.9.3 Bay 7 Local Wall Thickness Evaluation (Local Buckling)

The results indicate that all of the areas have thickness greater than the 0.736 inches. Therefore the uniform criteria is met throughout the bay and the use of the local wall thickness criteria for buckling is not required.

7.9.4 Bay #7 General Wall Thickness Criteria (Buckling)

The UT measurements presented in Table 9-1 equal an average of 0.915 inches in 1992 and 0.905" in 2006. 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.

7.9.5 Conclusion

It is concluded that Bay 9 is acceptable since all individual UT readings in 1992 and 2006 were greater than the uniform acceptance criteria.

Figure 9-2 illustrates the representative thicknesses in this bay, which is 0.905 inches or greater (refer to section 7.9.4).

Figure 9-1

BAY #9 DATA

NOTES:

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

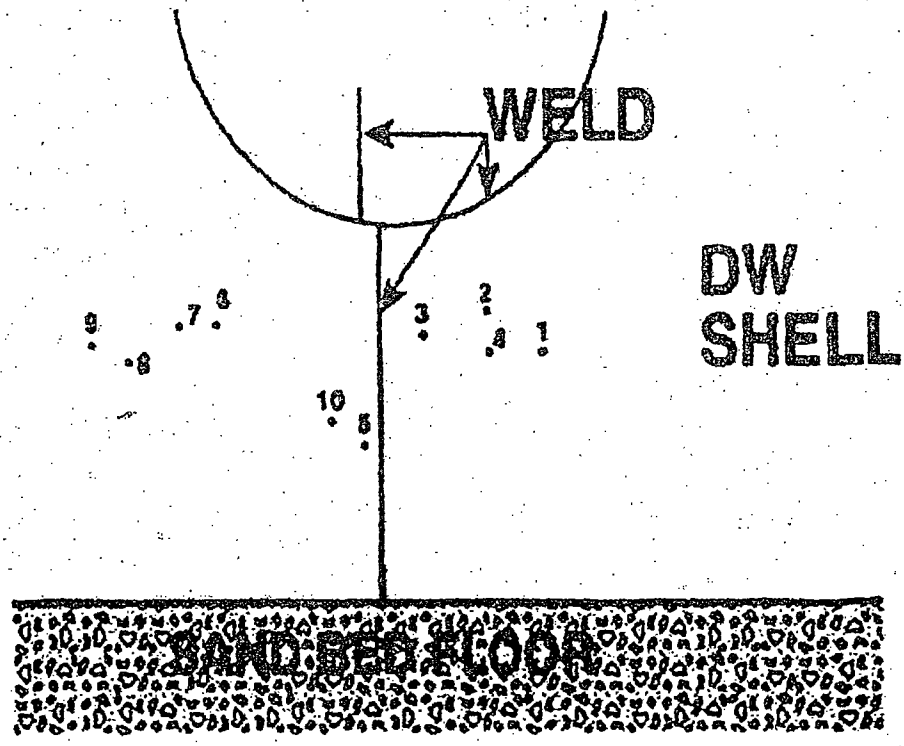
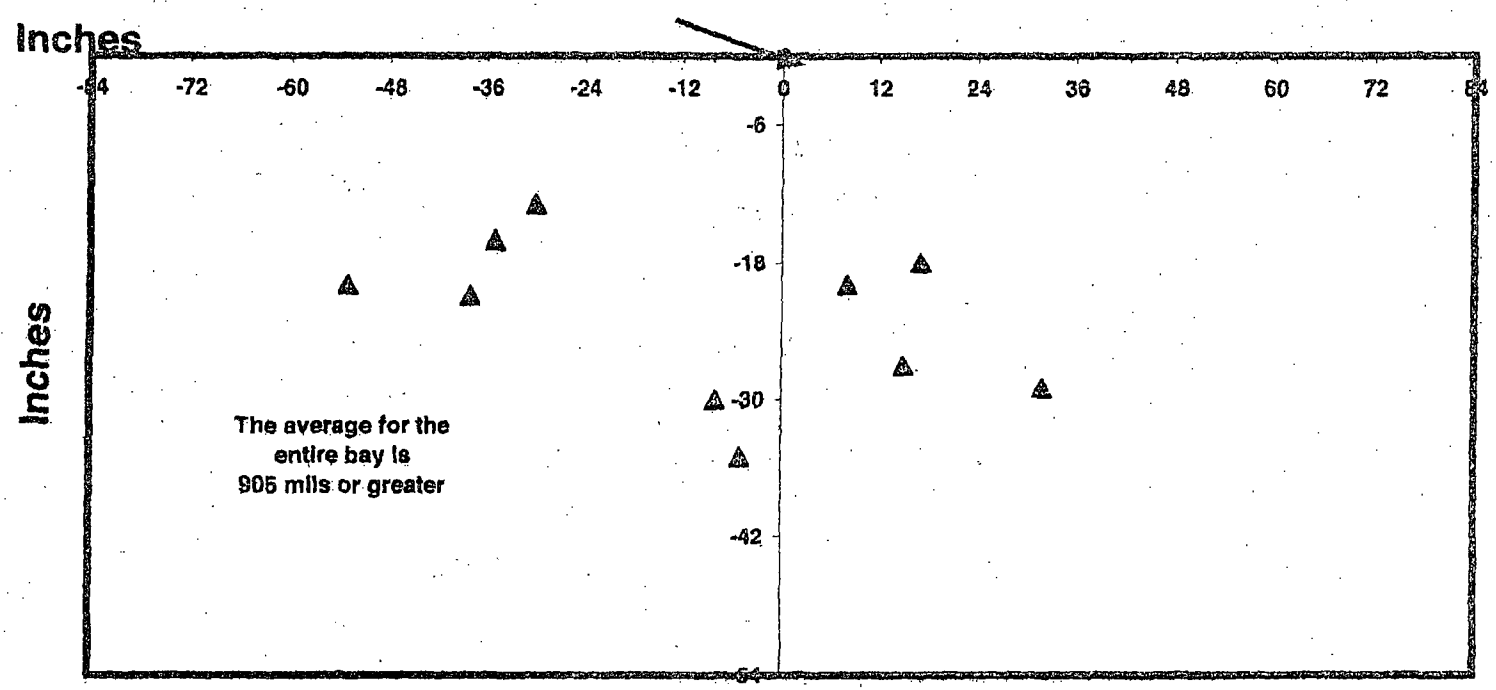


FIGURE (9)

Figure 9-2

Bay 9 2006
Spatial Relationship Of Locally Thin Areas



Squares are less than 0.736"
Triangles are greater then 0.736"

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7.11 UT EVALUATION BAY #11 SUMMARY

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 11-1, located at about 10 to 12 inches below the vent pipe reinforcement plate.

7.11.1 Bay #11 Local Readings Less Than The Uniform Criteria

Eight areas were selected to represent the thinnest local areas based on the visual observations of the shell surface (Fig. 11-1). These areas are a deliberate attempt to produce a minimum measurement (references 3.6). Table 11-1 shows readings taken to measure the thicknesses of the drywell shell. Area 1 as shown in Table 11-1, has a reading less than 0.736 inches. Inspector observations indicate that this area 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 11-2.

These areas and their location are shown on figure 11-2. The figure presents the areas with readings less than 0.736 inches as squares and areas with readings over 0.736 inches as triangles.

Table 11-1 Bay # 11 Thinnest UT Data

Location	1992 Measurement (inches)	2006 Measurement (inches)
1	0.705	0.700
2	0.770	0.760
3	0.832	0.830
4	0.755	0.751
5	0.831	0.823
6	0.800	0.756
7	0.831	0.817
8	0.815	0.825
Average	**0.792**	**0.783**

7.11.2 Bay #11Very Local Wall Thickness Evaluation (Pressure Only)

All individual readings were greater than the acceptance criteria of 0.490". The thinnest reading was in area 1, was 0.700 inches in 2006.

7.11.3 Bay 11 Local Wall Thickness Evaluation (Local Buckling)

One area (area 1) shown in Table 11-1 had a individual measurement below 0.736 inches in 1992 and in 2006. Therefore the depth measurements were performed in 1992 (Table 11-2). The calculated "Evaluation Thickness" for both the 1992 and 2006 are greater than 0.736" and therefore meet the acceptance criteria.

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

Table 11-2 Summary of Measurements Below 0.736 Inches

1	0.705"	0.770"	0.246"	0.200"	0.751"	0.746"	Acceptable

7.11.4 Bay #11 General Wall Thickness Criteria (Buckling)

The UT measurements presented in Table 11-1 equal an average of 0.792 inches in 1992 and 0.783" in 2006. 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.

7.11.5 Conclusion

It is concluded that Bay 11 is acceptable since all but one individual UT readings in 1992 and 2006 were greater than the uniform acceptance criteria. The calculated "Evaluation thickness" of the one remaining area is greater than then 0.763" criteria

Figure 11-2 illustrates the representative thicknesses in this bay, which is 0.783 inches or greater (refer to section 7.11.4).

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Originator	Date	Reviewed by		Date
Peter Tamburro	3/21/07	Julien Abramovici		

Figure 11-1

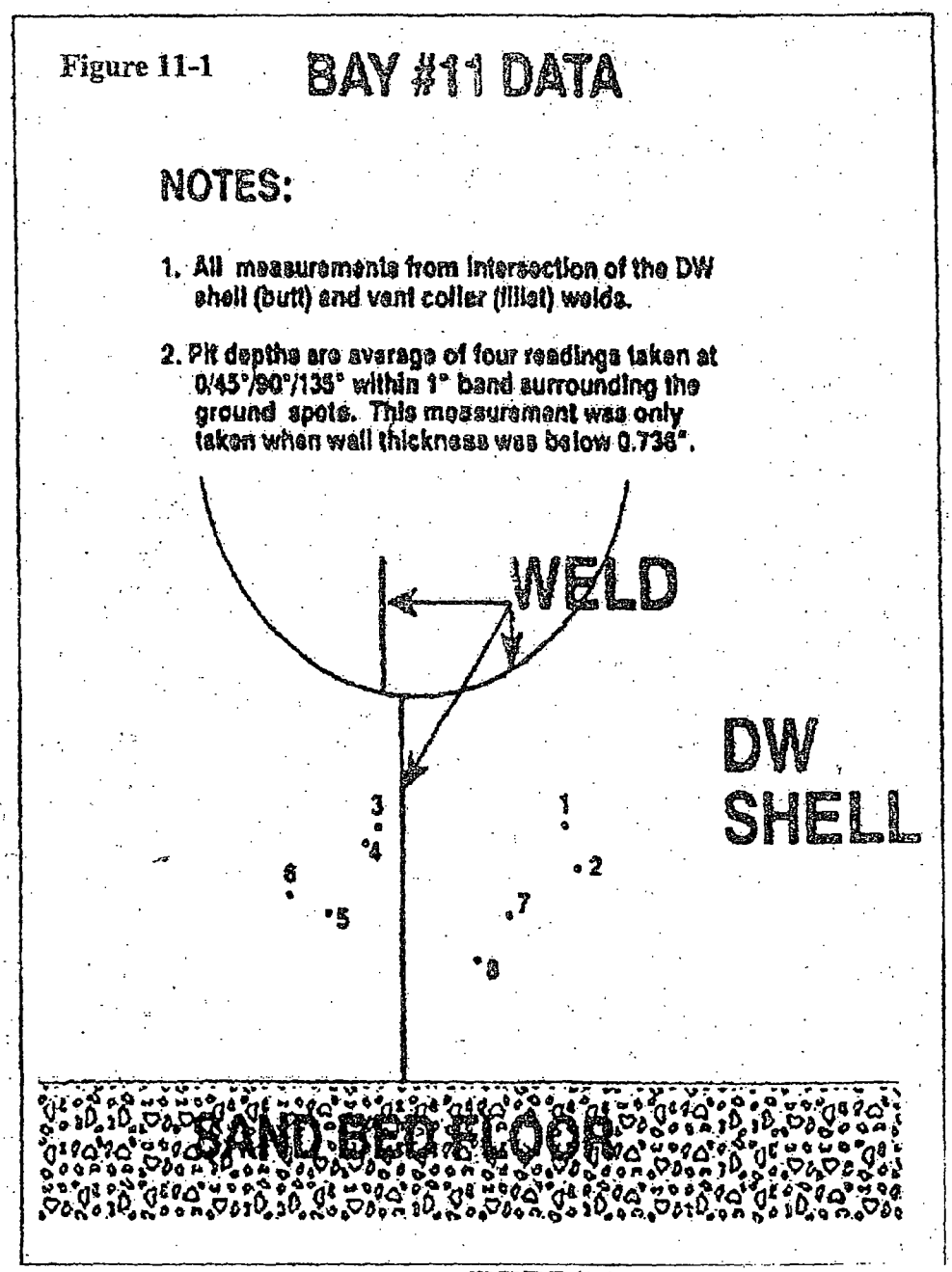
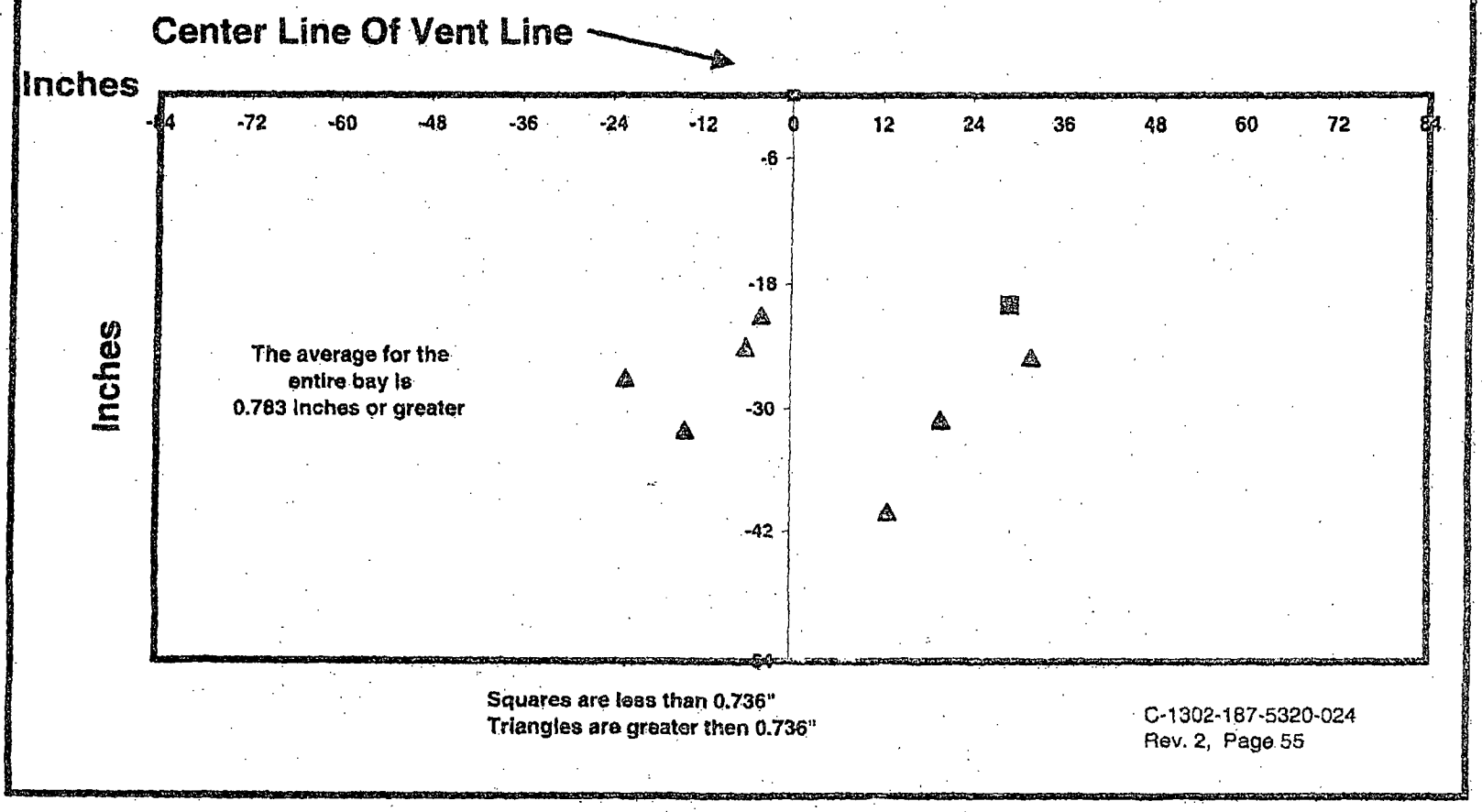


FIGURE (11)

Figure 11-2

Bay 11 2006
Spatial Relationship Of Locally Thin Areas



7.13 EVALUATION OF BAY #13 SUMMARY

The outside surface of this bay is rough and full of dimples similar to bay 1. This observation was made by the inspector who located the thinnest areas thereby biasing the remaining wall measurements to the conservative side (references 3.6). This inspection focused on the thinnest areas, even if very local. 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. Outside the bathtub ring the shell appears to be fairly uniform in thickness where no abrupt changes in thickness are present.

7.13.1 Local Readings Less Than The Uniform Criteria

The table below provides individual UT readings for 1992 and 2006. These readings are the thinnest single reading within each locally thin area. All readings are confined to areas less than 2 ½" inches in diameter. Shaded readings are less than the uniform criteria of 0.736 inches and must be evaluated. The 1992 individual UT readings for areas 6, 10, 11, 14, and 19 were less than the corresponding 2006 values. For all other area the 2006 value were less than the 1992 values. These areas and their location are shown on figure 13-2. The figure presents the areas with readings less than 0.736 inches as squares and areas with readings over 0.736 inches as triangles.

Table 13-1 Bay # 13 Thinnest UT Data

Location No.	1992 UT Measurement Thickness (inches)	2006 UT Measurement Thickness (inches)
1/1A	0.672/0.690*	NA
2/2A	0.72/0.903*	NA
3	0.941	0.923
4	0.915	0.873
5/5A	0.748/0.815*	0.709
6/6A	0.655/0.697*	0.638
7/7A	0.618/0.752*	0.602
8/8A	0.718/0.801*	0.704
9	0.924	0.915
10/10A	0.928/0.810*	0.741
11/11A	0.685/0.854*	0.639
12	0.885	0.886
13	0.932	0.814
14	0.868	0.87

15/15A	[illegible]	[illegible]
16	0.829	0.814
17	0.807	NA
18	0.825	NA
19	0.912	0.916
20	1.170	NA
Average	**0.810**	**0.786**

* In 1992 two UT measurements were performed on these locations. The first was the thinnest reading within the location and the second was intended to provide a value for thickness of the immediate area surrounding the thinnest point.

7.13.2 Bay #1, Very Local Wall Thickness Evaluation (Pressure Only)
The table shows that all readings are greater than the criteria of 0.490". The thinnest reading was in area 7, was 0.602 inches in 2006.

7.13.3 Bay 13 Local Wall Thickness Evaluation (Local Buckling)

Nine areas shown in Table 13-1 have individual measurements below 0.736 inches in 1992. Six areas shown in Table 13-1 have individual measurements below 0.736 inches in 2006. Figure 13-2 shows the areas of these areas.

Inspector observations indicate that these areas were not more than 1 to 2 inches in diameter. The individual thickness values in Table 13-1 are the thinnest individual readings found in these areas. For purposes of this calculation all these areas will be considered to be 2 ½" in diameter.

In 1992 for areas 1, 2, 5, 6, 7, 8, 10, 11, and 15 the measured thinnest UT reading was less than 0.736". Therefore micrometer depth measurements were performed on these areas to better characterize the thickness of surrounding area. At each location, micrometer readings were taken at the 0, 45, 90, and 135 degree orientation. The following table provides a summary of the depths in each azimuth.

Table 13-2 Bay 13 AVG Micrometer Calculations

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"

Table 13-3 provides (per section 6.4) the "Evaluation Thickness" at the locally thin areas. Based on the 2006 data, areas 6, 8, 10 and 15 are greater than the uniform acceptance criteria of 0.736" and are therefore acceptable. Areas 1 and 2 were not found in 2006. However the 1992 "Evaluation Thicknesses" for these two areas are significantly larger than 0.736".

Shaded areas (5, 7, and 11) have resulting evaluation thicknesses less than the uniform acceptance criteria of 0.736" and must be evaluated in further detail. The 2006 "Evaluation Thicknesses" of all three areas are less than the 1992 values. Therefore only the 2006 "Evaluation Thicknesses" will be addressed in the remainder of this section.

Table 13-3 Summary of Measurements Below 0.736 Inches

1	0.672"	NA	0.351"	0.200"	0.823"	NA	7.13.3
2	0.722"	NA	0.360"	0.200"	0.882"	NA	7.13.3
5	0.718"	0.708	0.217"	0.200"	0.735"	0.725	7.13.3.1
6	0.655"	0.658	0.301"	0.200"	0.756"	0.759	7.13.3
7	0.618"	0.602	0.255"	0.200"	0.673"	0.657	7.13.3.2
8	0.718"	0.704	0.278"	0.200"	0.796"	0.782	7.13.3.2
10	0.728"	0.741	0.211"	0.200"	0.739"	0.752	7.13.3
11	0.685"	0.699	0.256"	0.200"	0.741"	0.725	7.13.3.2
15	0.683"	0.666	0.273"	0.200"	0.756"	0.739	7.13.3

7.13.3.1 Evaluation of Area 5

Refer to figure 13-6. Area 5 has a single reading of 0.708" in 2006. This area is next to areas 10 (0.741") and 14 (0.870"). These three areas are bounded by a 8" by 12" area. Since these single points were determined by the inspectors to be the thinnest within this area, the average of these three thicknesses is a conservative estimate of the average thickness of the area (see assumption 4.3).

The average of these three reading is 0.773", which is greater than 0.736". Therefore area 5 meets the 0.736" uniform criteria.

7.13.3.2 Evaluation of Areas 7, 8, and 11

Areas 7, 8 and 11 were evaluated together in a single 12" by 12" area (see figure 13-2 and 13-3) and compared to the local buckling criteria established in section 6.2.

Area 7 has a single reading of 0.602" that is less than 0.636" (the thickness criteria for the 12" by 12" area). This area was combined with areas 8 (0.704") and 11 (0.669"). These three areas are bounded by a 12" by 12" area. Since these single points were determined by the inspectors to be the thinnest within this area, the average of these three thicknesses is a conservative estimate of the average thickness of the 12" by 12" area (see assumption 4.3). The average of these three readings is 0.658", which is greater than local buckling criteria of 0.636". Therefore areas 7, 8 and 11 meet the local buckling criteria. Figure 13-4 and 13-5 show the profile of the 36" by 36" area with average of 7, 8 and 11 minimum thickness overlaid on the curve depicting the acceptance criteria.

Figure 13-4 shows the profile along the horizontal axis and figure 13-5 shows the profile along the vertical axis.

7.13.3.3 Combined Effect of Locally Thin Areas on Buckling

There are several conservative factors associated with the size and the location of the locally thin areas which cannot be quantified but are judged to be substantial in demonstrating that the measured thickness are adequate. These are described below.

7.13.3.3.1 Refer to figure 13-7. The locally thin area for this bay that is less than 0.737 inches is located directly under the vent line.

The local buckling criteria (section 6.2) is based on sensitivity studies that placed a 36" by 36" locally thin grid on the area of the finite element model that had the highest buckling stresses. This area is located between the centerlines of the vent lines (+66" to –66 as shown in figure 13-2). Areas below the vents lines had less compressive stresses (-36" to +36"). Therefore locally thin areas located under a vent lines will have more margin than the same locally thin areas located between the centerline of the vent lines. Review of the original GE study (see appendix F) shows that stresses under the vent line are at least 20% less then the stresses between the centerline of the vent line. Therefore the necessary wall thickness to maintain the required safety factor for portions of the vessel under the vent lines is substantially less (by at least 20%) than the calculated required uniform thickness of 0.736".

7.13.3.3.2 A second factor is the cumulative size of the nine locally thin areas, which is significantly much smaller than the analyzed 36" by 36" area (see the figure in section 6.2). The total volume of this 36" by 36" area when compared to the volume of a similar 36" by 36" area with a uniform thickness of 0.736" correspond to a reduced volume of 72.0 cubic inches.

The cumulative volume of all nine (in 1992) locally thin areas is less than 2.086 cubic inches (see the table below).

Table 13-4

Area	Thinnest reading inside the area (inches) (Column 2)	Equivalent volume loss of 2 ½ inches diameter area with thickness equal to thinnest readings (Column 2) when compared to a uniform thickness of 0.736 inches 0.736 – Column 2)* 3.142*(2.5/2)**2
1	0.672	0.314
2	0.722	0.069
5	0.718	0.088
6	0.655	0.398
7	0.618	0.579
8	0.718	0.088
10	0.728	0.039
11	0.685	0.250
15	0.683	0.260
	Total -	2.086

Therefore the comparison of the "as found" volume reduction which is less than 2.086 cubic inches to the "analyzed" volume reduction of 72 cubic inches leads to the conclusion that the effect on the buckling load factor is negligible.

In addition since the majority of the vessel in this bay is thicker than 0.736", the thicker areas will reinforce the locally thin areas. For example approximately 7730 square inches of surface area in this bay (of a total of 9072 square inches) is 800 mils or thicker (refer to figure 13-7). When compared to same surface area with a thickness of 0.736" there is a total increase in volume of at least 495 cubic inches. (e .g 495 = (0.8-0.736)* 7730). This additional volume will reinforce the locally thin areas.

7.13.4 Bay #13 General Wall Thickness Criteria (Buckling)

Outside the "Bathtub Ring"

Refer to figure 13-1 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.

Taking the average of the UT measured thicknesses of areas 3, 4, 9, 12, 13, 16, 17, 18, and 19 gives a average thickness of 0.824 inches in 1992 and 0.802 inches 2006 for the shell below the bathtub ring. Therefore 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.

In the "Bathtub Ring"

Areas 5, 6, 7, 8, 10, 11, 14, and 15 are confined to the bathtub ring as shown in Figure 13-1 and 13-2. To determine the general shell thickness in the bathtub ring area of this bay the evaluation thicknesses for each of the areas defined above are averaged together.

An average value of the evaluation thicknesses presented in this band is as follows.

Table 13-5

Area	1992 Evaluation Thickness	2006 Evaluation Thickness
5	0.735"	0.725"
6	0.756"	0.759"
7	0.673"	0.657"
8	0.796"	0.782"
10	0.739"	0.752"
11	0.741"	0.725"
14	0.868"	0.870"
15	0.756"	0.739"
	Average = 0.758"	Average = 0.751"

The table shows an average evaluation thickness of greater than 0.758 inches in 1992 and greater than 0.751 inches in 2006 for the bathtub ring. These results are based on UT readings and average micrometer readings for only the thinnest area. UT readings and micrometer readings were generally not taken for the remainder of the shell, which were greater than 0.736 inches. In reality, the remainder of the shell is much thicker than the above results.

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.

7.13.5 Conclusion

Figure 13-7 illustrates representative areas and thicknesses in this bay as follows:

Area B – This is a 18" high by 60 inches wide area, which is at least 0.751" thick. This thickness is based on the thickness of the Bathtub ring (refer to section 7.13.4).

Area C - This is a 12" by 12" area (within area B) is at least 0.658 inches thick. This thickness is based on the evaluation in section 7.13.3.2.

Area D- The remaining areas of the Bay is 0.800 inches thick or greater. This thickness is based on the evaluation in section 7.13.4.

Therefore this bay meets the acceptance criteria based on the following:

1) All individual readings are greater than 0.490 inches.

2) Except for Area C, the entire bay has thickness greater than 0.736 inches.

3) Area C (which is limited to an area of 12" by 12") meets the acceptance criteria in section 6.2.

Figure 13-1

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. 1A 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".

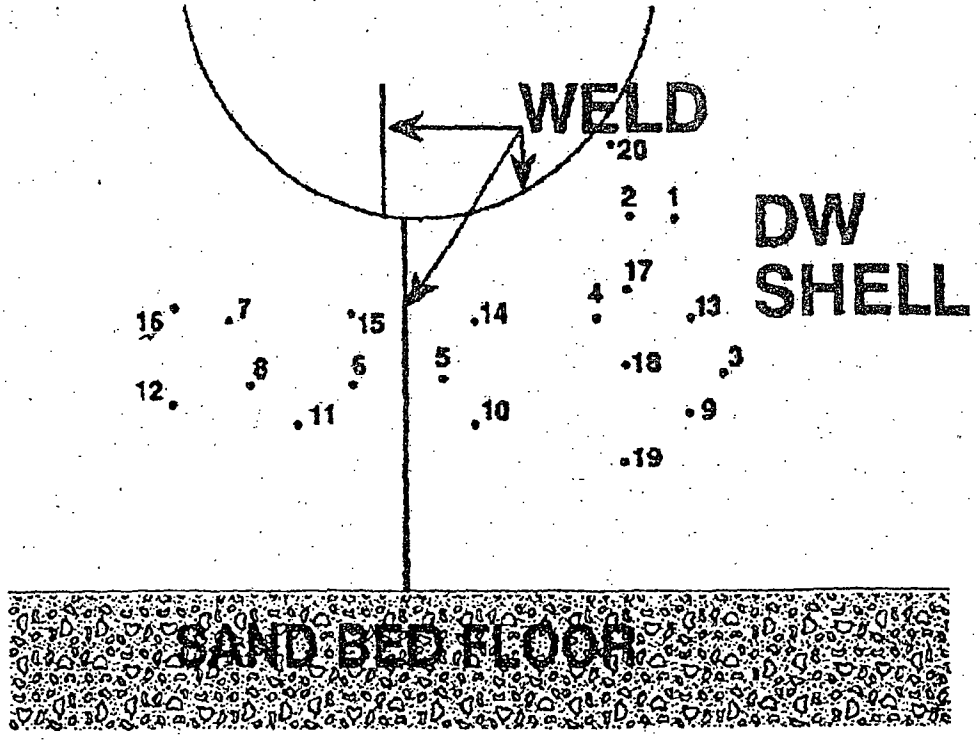


Figure 13 -2

Bay 13 - 2006
Spatial Relationship Of Locally Thin Areas

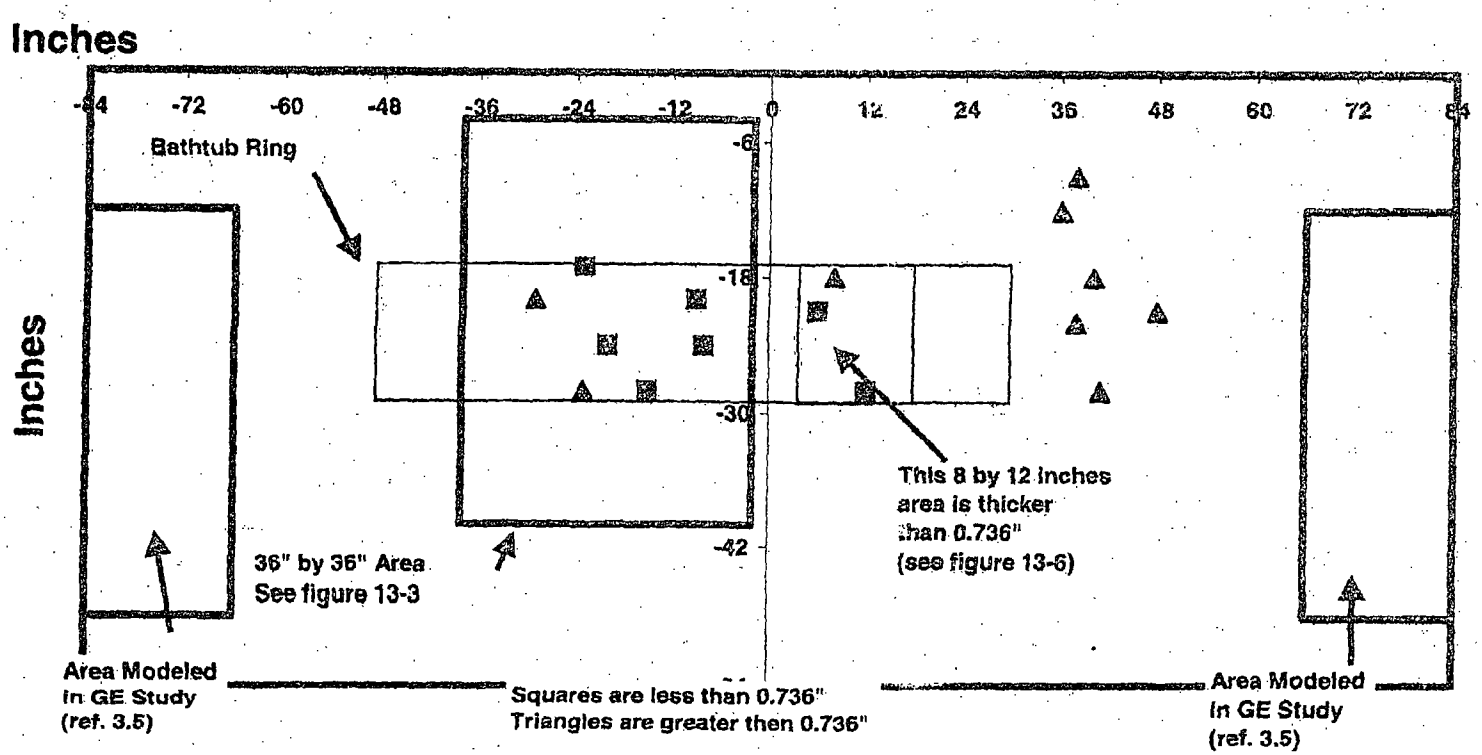


Figure 13 -3

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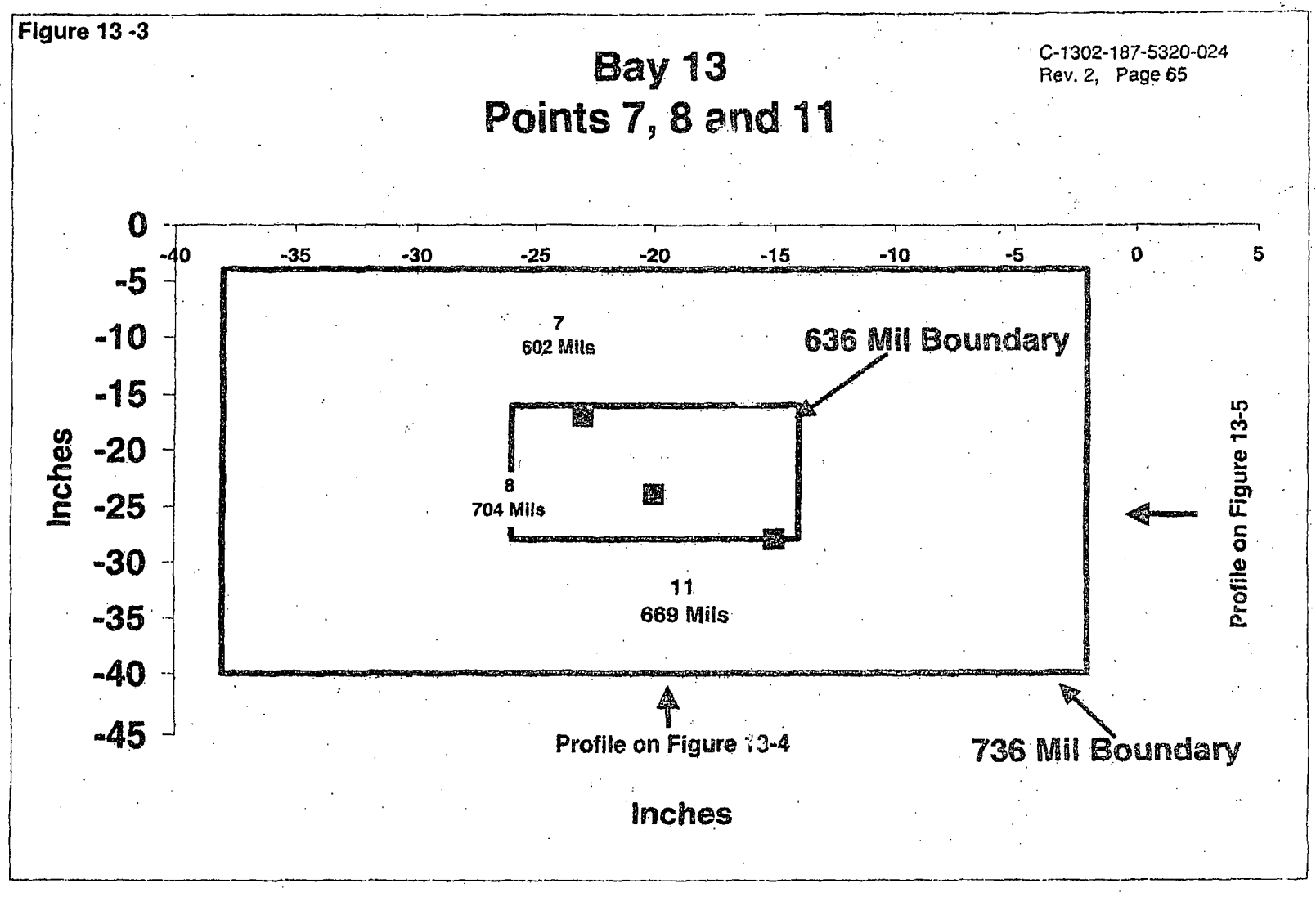


Figure 13 -4

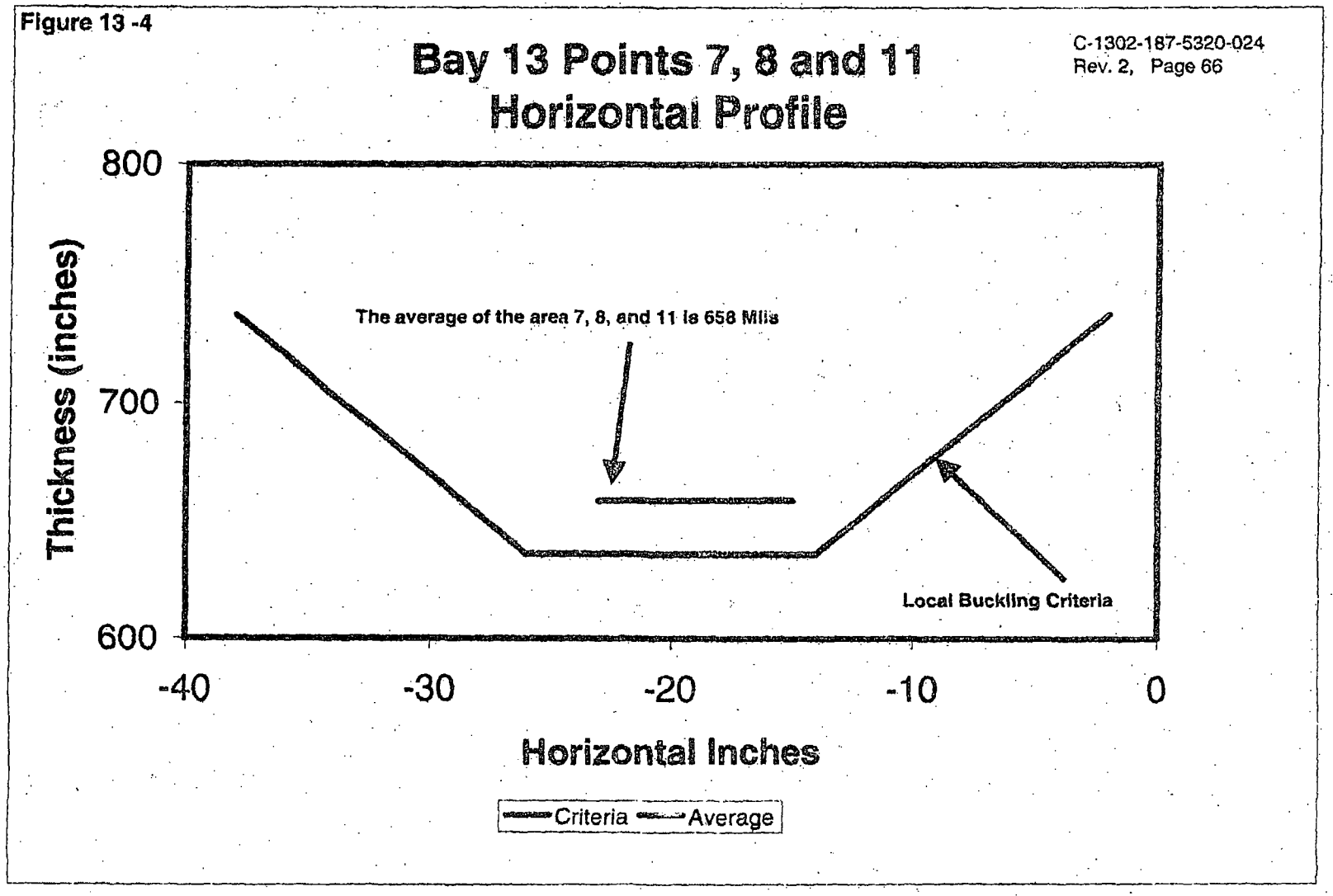


Figure 13 -5

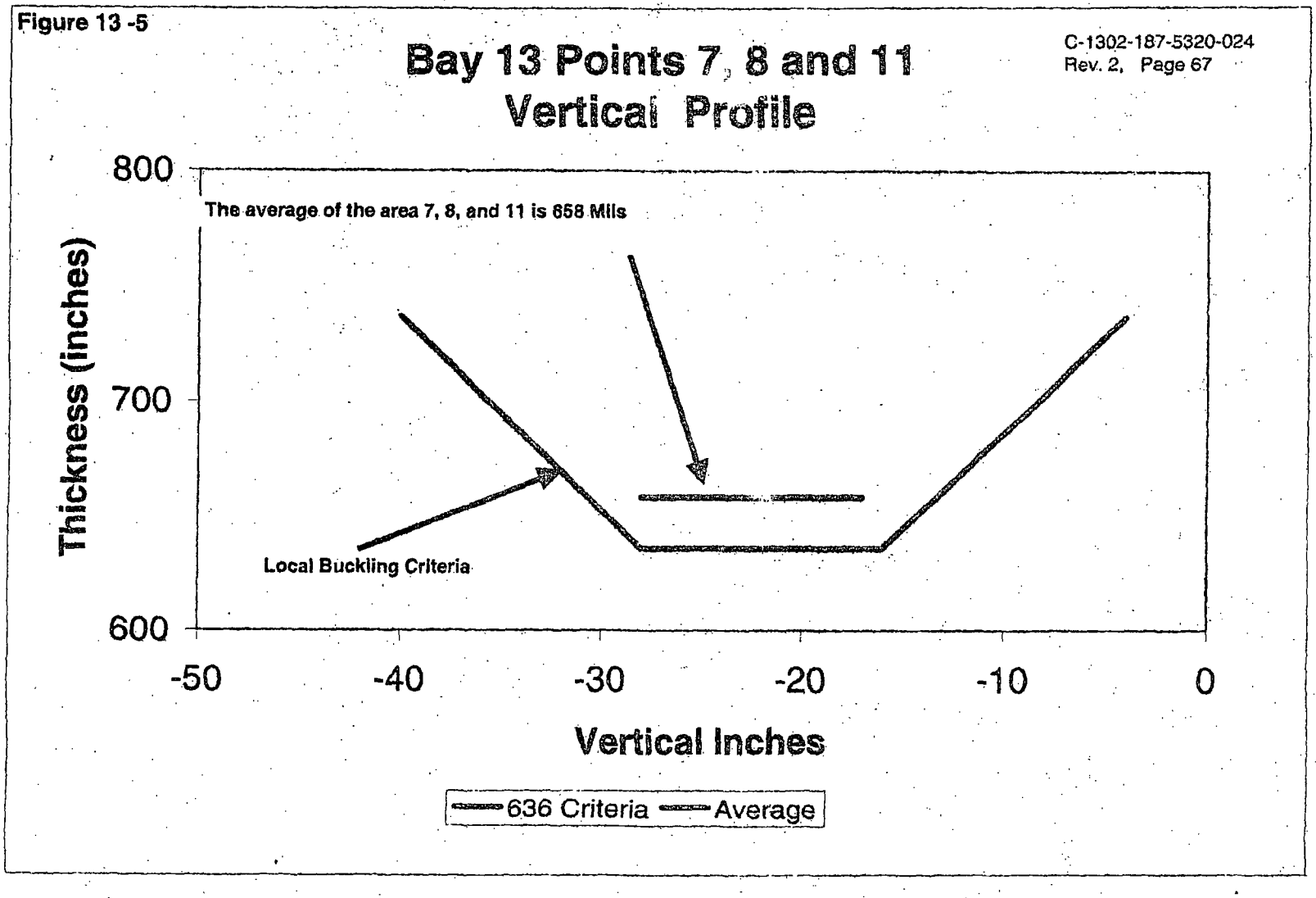


Figure 13-6

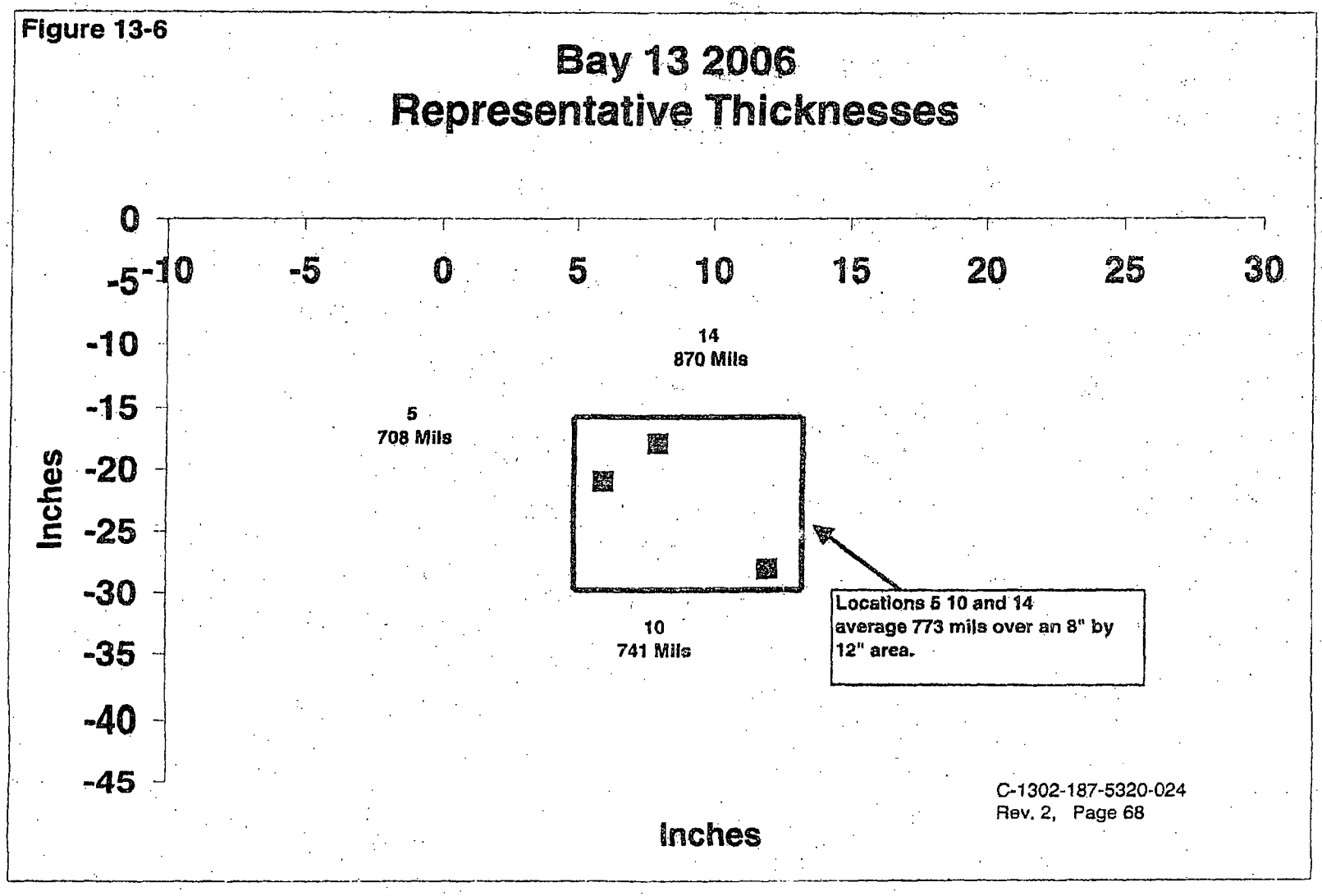
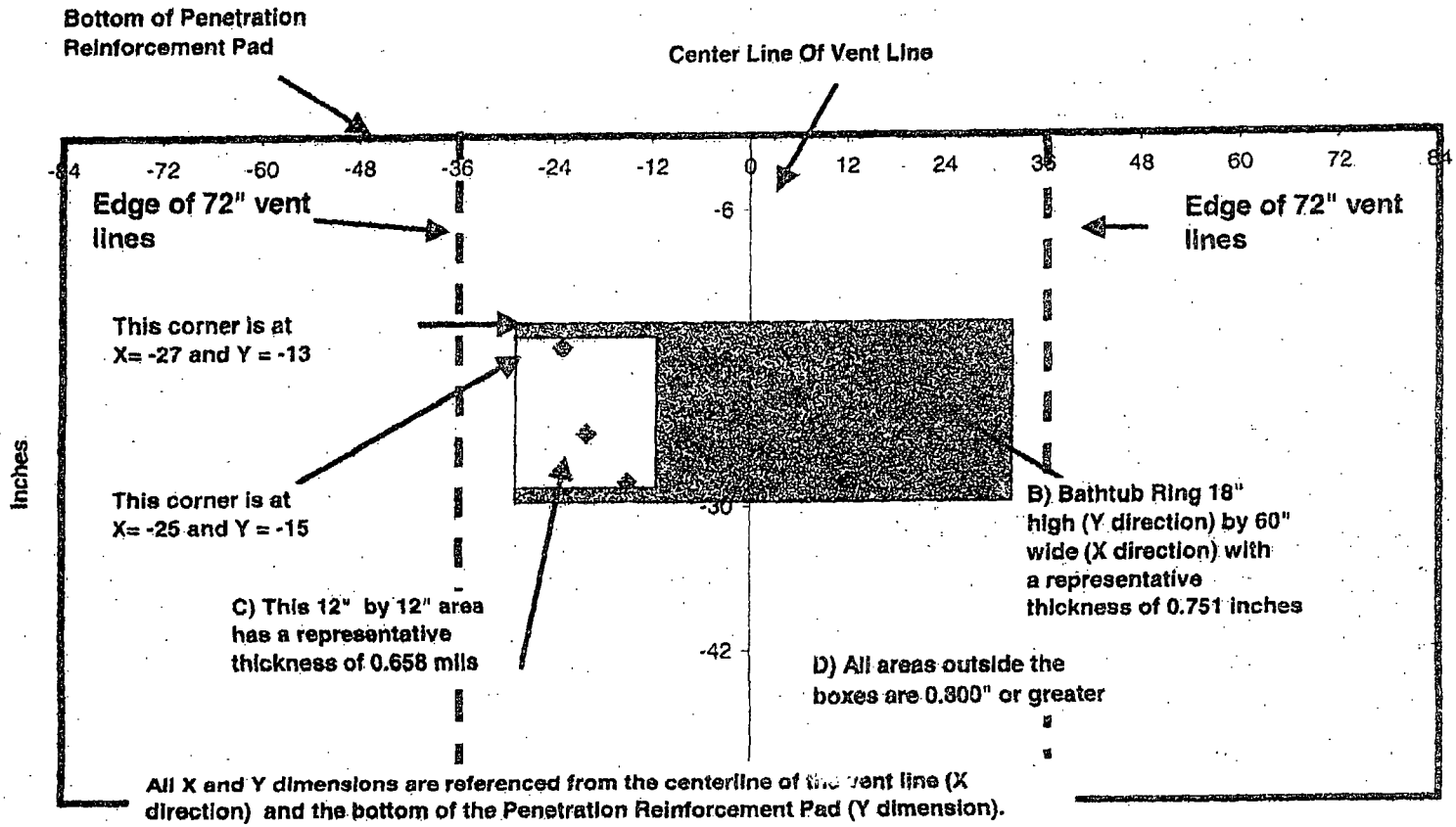


Figure 13-7

Bay 13 - 2006
Locally Thin Areas



7.15 UT EVALUATION BAY 15 SUMMARY

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 bathtub ring seen in the other bays, was not very prominent in this bay (references 3.6). 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.

7.15.1 Bay #15 Local Readings Less Than The Uniform Criteria

Eleven areas were selected to represent the thinnest areas based on the visual observations of the shell surface (Fig. 15-1). These areas are a deliberate attempt to produce a minimum measurement. Table 15-1 shows readings taken to measure the thinnest thicknesses of the drywell shell. The results indicate that all of the areas have thickness greater than the 0.736 inches, except one area in 1992 and another area in 2006. Inspector observations indicate that these areas were 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 azimuths around the spot and the average is shown in Table 15-1.

These areas and their location are shown on figure 15-2. The figure presents the areas with readings less than 0.736 inches as squares and areas with readings over 0.736 inches as triangles.

Table 15-1 Bay # 15 Thinnest UT Data

[illegible]	[illegible]	[illegible]
1	0.786	[illegible]
2	0.829	0.777
3	0.932	0.935
4	0.795	0.791
5	0.850	0.817
6	0.794	0.715
7	0.808	0.805
8	0.770	0.760
9	[illegible]	[illegible]
10	0.860	0.837
11	0.825	0.798
Average	**0.816**	**0.788**

7.15.2 Bay #15 Very Local Wall Thickness Evaluation (Pressure Only)

All individual readings were greater than the acceptance criteria of 0.490". The thinnest reading was in area 1, was 0.711 inches in 2006.

7.15.3 Bay 15 Local Wall Thickness Evaluation (Local Buckling)

Table 15-2 Summary of Measurements Below 0.736 Inches

9	0.722"	0.720	0.337"	0.200"	0.859"	0.857"	7.15.3.1
1	0.786"						7.15.3.2

7.15.3.1 Evaluation of Area 9

The calculated "Evaluation Thickness" of area 9 in 1992 and 2006 are greater than 0.736". Therefore this area meets the acceptance criteria.

7.15.3.2 Evaluation of Area 1

The individual thinnest reading for area 1 in 1992 was greater than 0.736". Therefore this area was not characterized with a micrometer and depth measurements are not available. This area cannot be evaluated using the "Evaluation Thickness". However the 2006 reading was less than 0.736". Therefore area 1 was evaluated against the local buckling criteria per section 6.2.

Area 1 has a single reading of 0.711" in 2006. This single point was determined by the inspectors to be the thinnest within this area. Figure 15-3 plots area 1 and all other recorded areas close by. Figure 15-3 overlays a 36" by 36" area on these locally thin areas. The center 12" by 12" of the area is overlaid on top of area 1.

Figure 13-4 and 13-5 shows the profile of the 36" by 36" area with the area thickness overlaid on the curve depicting the acceptance criteria. Figure 13-4 shows the profile along the horizontal axis and figure 13-5 shows the profile along the vertical axis. These figures show that the local buckling criteria is met.

7.15.3.3 Combined Effect of Locally Thin Areas on Buckling

There are several conservative factors associated with the size and the location of the locally thin areas which cannot be quantified but are judged to be substantial in demonstrating that the measured thickness are adequate. These are described below.

7.15.3.3.1 Refer to figure 15-7. The locally thin area for this bay that is less than 0.736 inches is located under the vent line.

The local buckling criteria (section 6.2) is based on sensitivity studies that placed a 36" by 36" locally thin grid on the area of the finite element model that had the highest buckling stresses. This area is located between the centerlines of the vent lines (+66" to –66 as shown in figure 15-2). Areas below the vents lines had less compressive stresses. Therefore locally thin areas located under a vent lines will have more margin than the same locally thin areas located between the centerline of the vent lines. Review of the original GE study shows that stresses under the vent line are at least 20% less then the stresses between the centerline of the vent lines. Therefore the necessary wall thickness to maintain the required safety factor for portions of the vessel under the vent lines is substantially less (by at least 20%) than the calculated required uniform thickness of 0.736".

7.15.3.3.2 A second factor is the cumulative size of the locally thin areas, which are significantly much smaller than the analyzed 36" by 36" area (see the figure in section 6.2). The total volume of this 36" by 36" area when compared to the volume of a similar 36" by 36" area with a uniform thickness of 0.736" correspond to a reduced volume of 72.0 cubic inches.

The cumulative volume of two locally thin areas is 0.219 cubic inches (see the table below).

Table 15-3

Area	Thinnest reading inside the area (inches) (Column 2)	Equivalent volume loss of 2 ½ inches diameter area with thickness equal to thinnest readings (Column 2) when compared to a uniform thickness of 0.736 inches (0.736 – Column 2)* 3.142*(2.5/2)**2
1	0.711	0.133
9	0.72	0.085
	Total	0.219

Therefore the comparison of the "as found" volume reduction which is less than 0.219 cubic inches to the "analyzed" volume reduction of 72 cubic inches leads to the conclusion that the effect on the buckling load factor is negligible.

In addition since the majority of the vessel in this bay is thicker than 0.736", the thicker areas will reinforce the locally thin areas. For example approximately 8925 square inches of surface area in this bay (of a total of 9072 square inches) is 788 mils or thicker (refer to figure 15-7). When compared to same surface area with a thickness of 0.736" there is a total increase in volume of at least 464 cubic inches. (e .g 464 = (0.788-0.736)* 8925). This additional volume will reinforce the locally thin areas.

7.15.4 Bay #15 General Wall Thickness Criteria (Buckling)

The UT measurements presented in Table 15-1 equal an average of 0.815 inches in 1992 and 0.788" in 2006. 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.

7.15.5 Conclusion

Figure 15-7 illustrates representative areas and thicknesses in this bay as follows:

Area A - This is a 12" high by 12 inches wide area, which is at least 0.711" thick. This thickness is based on section 7.15.3.2).

Area D- The remaining area of the Bay is 0.788 inches thick or greater. This thickness is based on the evaluation in section 7.15.4.

Therefore this bay meets the acceptance criteria based on the following:

1) All individual readings are greater than 0.490 inches.

2) Except for Area A, the entire bay has thickness greater than 0.736 inches.

3) Area A (which is limited to an area of 12" by 12") meets the acceptance criteria in section 6.2.

Figure 15-1

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".

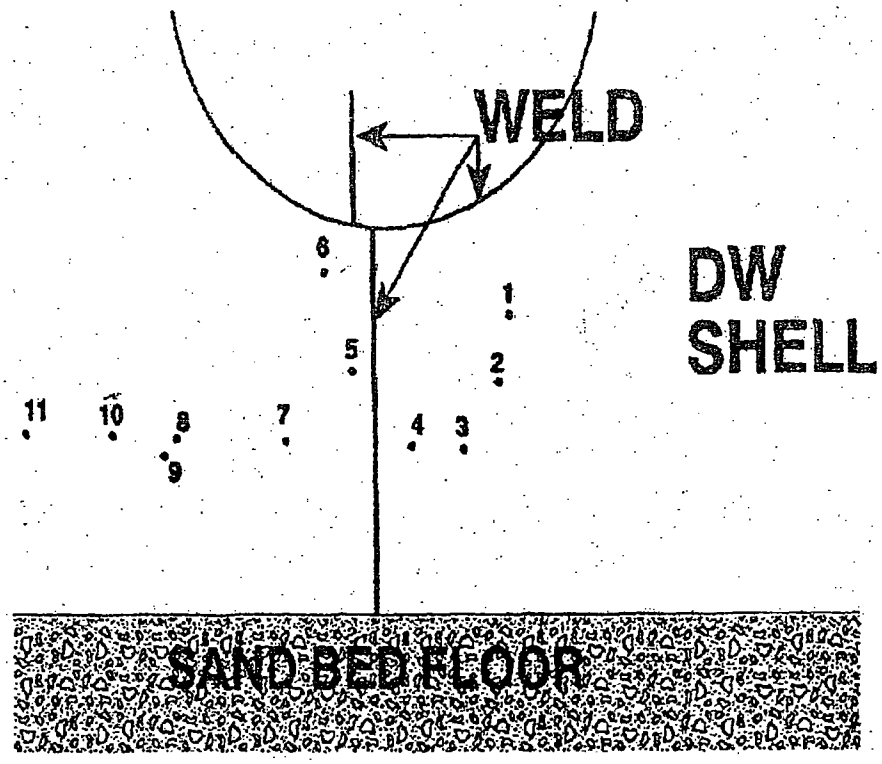


FIGURE (15)

Figure 15-2

Bay 15 2006
Spatial Relationship Of Locally Thin Areas

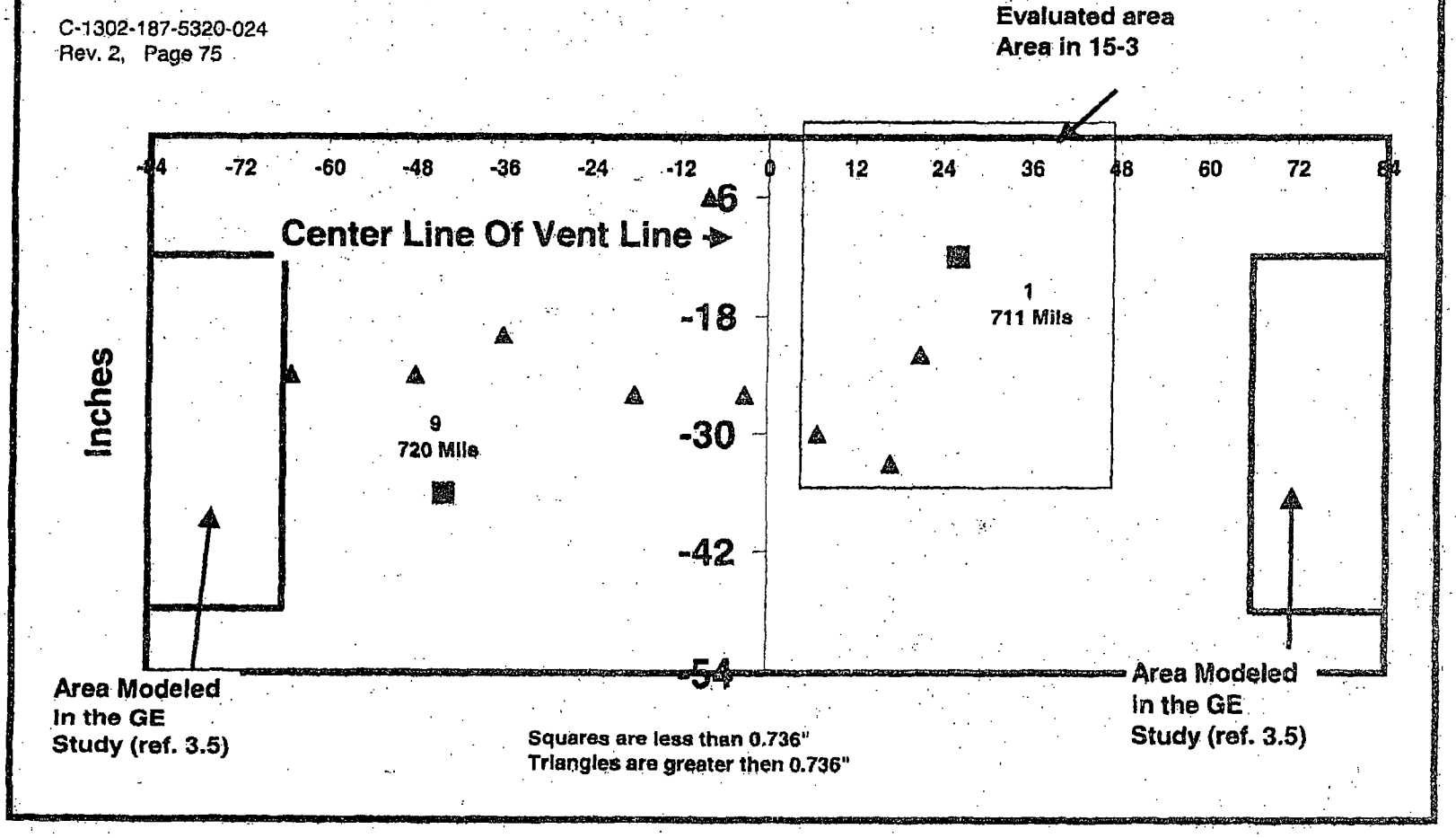


Figure 15-3

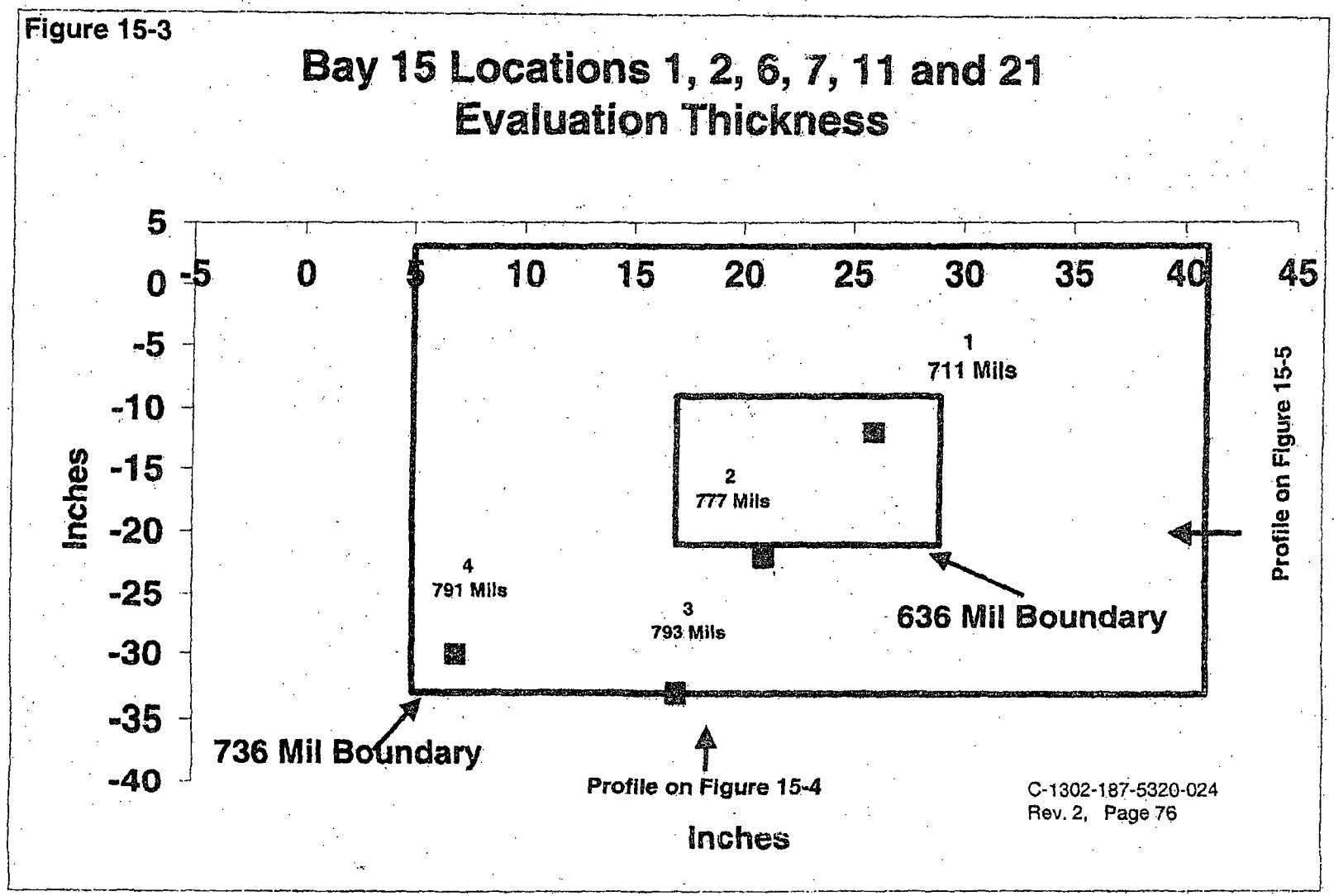


Figure 15-4

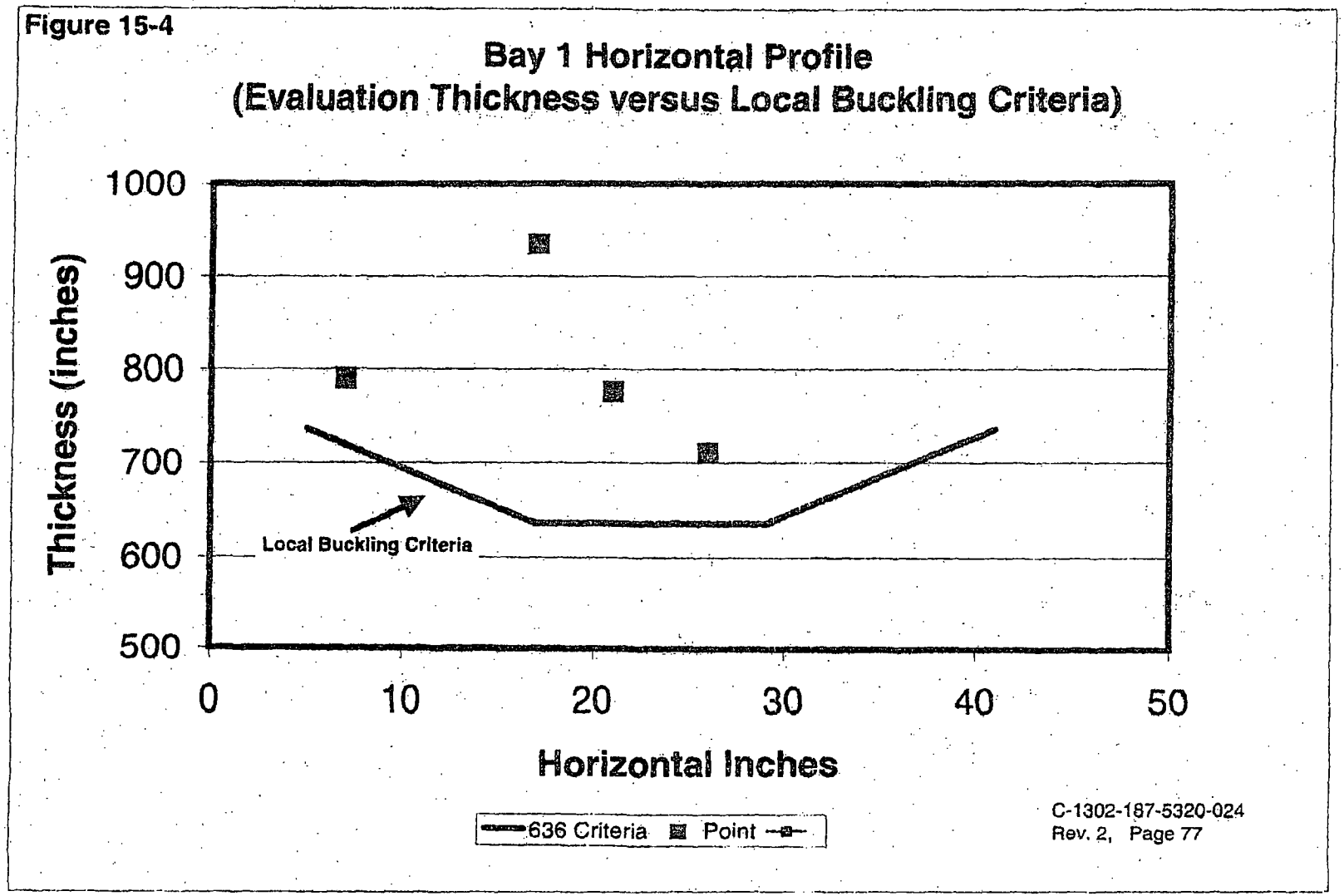


Figure 15-5

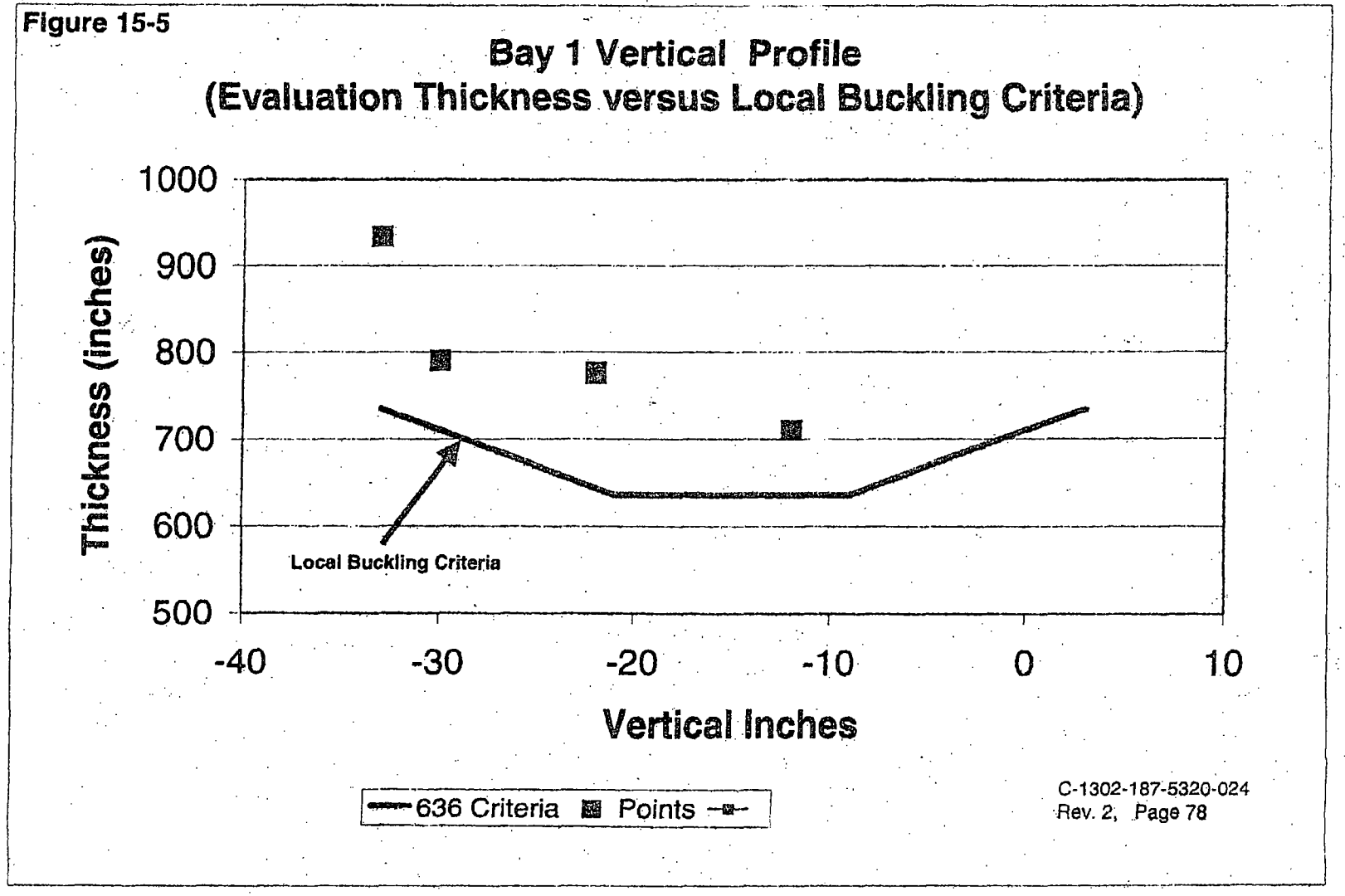


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Figure 15-6

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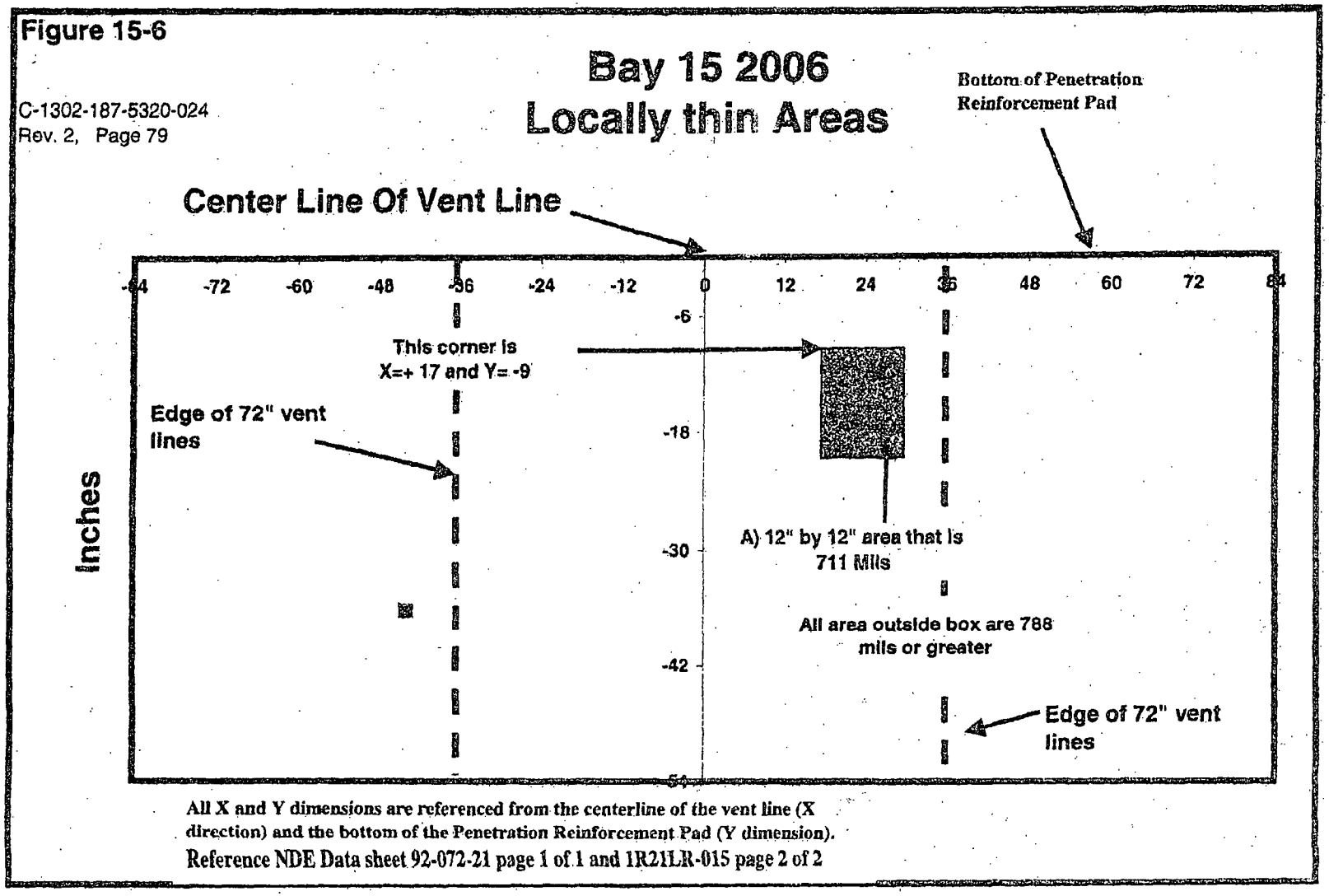

All X and Y dimensions are referenced from the centerline of the vent line (X direction) and the bottom of the Penetration Reinforcement Pad (Y dimension).

Reference NDE Data sheet 92-072-21 page 1 of 1 and 1R21LR-015 page 2 of 2

7.17.1 UT EVALUATION BAY #17 SUMMARY

The outside surface of this bay is rough, similar to bay 1, full of uniform dimples comparable to the outside surface of golf ball (references 3.6). 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.

7.17.1 Bay #17 Local Readings Less Than The Uniform Criteria

Eleven areas were selected to represent the thinnest areas based on the visual observations of the shell surface (Fig. 17-1). These areas are a deliberate attempt to produce a minimum measurement. Table 17-1 shows readings taken to measure the thinnest thicknesses of the drywell shell. The results indicate that all of the areas have thickness greater than the 0.736 inches, except one area. Area 9 as shown in Table 17-1, has a reading below 0.736 inches. Inspectors' observations indicate that this area 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 areas around the spot and the average is shown in Table 17-1.

Table 17-1 shows that one area was less than 0.736" in 1992 and another area in 2006. All other areas were greater then 0.736".

These areas and their location are shown on figure 17-2. The figure presents the areas with readings less than 0.736 inches as squares and areas with readings over 0.736 inches as triangles.

Table 17-1 Bay # 17 Thinnest UT Data

Location	1992 Measurement (inches)	2006 Measurement (inches)
1	0.916	0.909
2	1.150	0.663
3	0.898	0.894
4	0.951	0.963
5	0.913	0.822
6	0.992	0.909
7	0.970	0.970
8	0.990	0.960
9	0.736	0.970
10	0.830	0.844
11	0.770	NA
Average	0.918	0.890

7.17.2 Bay #17 Very Local Wall Thickness Evaluation (Pressure Only)

All individual readings were greater than the acceptance criteria of 0.490". The thinnest reading was in area 2, was 0.663 inches in 2006.

7.17.3 Bay 17 Local Wall Thickness Evaluation (Local Buckling)

Table 17-2 Summary of Measurements Below 0.736 Inches

9	0.720"	0.970"	0.351"	0.200"	0.871"	1.121"	7.17.3.1
2	1.150"	0.663"					7.17.3.2

7.17.3.1 Area 9

The calculated "Evaluation Thickness" of area 9 in 1992 is greater than 0.736". Therefore this area meets the acceptance criteria. Since the 2006 UT measurement was much greater than the 1992 value a corresponding "Evaluation Thickness" for 2006 was not considered and only the 1992 value used for the evaluation.

7.17.3.2 Area 2

The 1992 value for area 1 is not considered credible. The basis for this statement is that the corresponding corrosion rate would have to be 35 mils per year for the 1992 value to be credible. This amount of corrosion would have been observed by the visual coating inspections. Especially since the corrosion byproducts, which are between 5 to 10 times less dense than the carbon steel, would create a blister in the area which would be about 2 ½" in diameter. However the "worst case" evaluation was performed in reference 3.8 by applying a 35 mil per year rate on the thinnest reading found in 2006 (location 7 and in bay 13 which is 602 mils). The evaluation showed that that location would not corrode to the less than the very local criteria (490 mil) prior to the next committed inspection, which is 2008.

The individual thinnest reading for area 2 in 1992 was greater than 0.736". Therefore this area was not characterized with a micrometer and depth measurements are not available. This area cannot be evaluated using the "Evaluation Thickness". Therefore area 2 will be evaluated against the local buckling criteria per section 6.2.

Area 2 has a single reading of 0.663" in 2006. This single point was determined by the inspectors to be the thinnest within this area. Figure 17-3 plots area 2 and all other close by areas recorded in 1992 and 2006. Figure 15-3 overlays a 36" by 36" area on these areas. The center 12" by 12" of he area is overlaid on top of area 2.

Figure 17-4 and 17-5 shows the profile of the 36" by 36" area with the single thickness overlaid on the curve depicting the acceptance criteria. Figure 17-4 shows the profile along the horizontal axis and figure 17-5 shows the profile along the vertical axis. These figures show that the local buckling criteria is met.

7.17.3.3 Combined Effect of Locally Thin Areas on Buckling

There are several conservative factors associated with the size and the location of the locally thin areas which cannot be quantified but are judged to be substantial in demonstrating that the measured thickness are adequate. These are described below.

7.17.3.3.1 Refer to figure 17-7. The locally thin area for this bay that is less than 0.736 inches is not located between the centerline of the vent lines. The 12" by 12" locally thin area is locate approximately at +20" to +56" of the vent line.

The local buckling criteria (section 6.2) is based on sensitivity studies that placed a 36" by 36" locally thin grid on the area of the finite element model that had the highest buckling stresses. This area is located between the centerlines of the vent lines (+66" to –66 as shown in figure 17-2). Areas between +20" to +56" from the vents lines had less compressive stresses. Review of the original GE study (see appendix F) shows that stresses in this region are at least 10% less then the stresses between the centerline of the vent lines. Therefore the necessary wall thickness to maintain the required safety factor for portions of the vessel under the vent lines is less (by at least 10%) than the calculated required uniform thickness of 0.736".

7.17.3.3.2 A second factor is the cumulative size of the two locally thin areas, which are significantly much smaller than the analyzed 36" by 36" area (see the figure in section 6.2). The total volume of this 36" by 36" area when compared to the volume of a similar 36" by 36" area with a uniform thickness of 0.736" correspond to a reduced volume of 72.0 cubic inches.

The cumulative volume of two locally thin areas is less than 0.634 cubic inches (see the table below).

Area	Thinnest reading inside the area (inches) (Column 2)	Equivalent volume loss of 2 ½ inches diameter area with thickness equal to thinnest readings (Column 2) when compared to a uniform thickness of 0.736 inches 0.736 – Column 2)* 3.142*(2.5/2)**2
2	0.633	0.549
9	0.720	0.085
	Total	0.634

Therefore the comparison of the "as found" volume reduction which is less than 0.634 cubic inches to the "analyzed" volume reduction of 72 cubic inches leads to the conclusion that the effect on the buckling load factor is negligible.

In addition since the majority of the vessel in this bay is thicker than 0.736", the thicker areas will reinforce the locally thin areas. For example approximately 7776 square inches of surface area in this bay (of a total of 9072 square inches) is 892 mils or thicker (refer to figure 15-7). When compared to same surface area with a thickness of 0.736" there is a total increase in volume of at least 1210 cubic inches. (e .g 1210 = (0.892-0.736)* 7776). This additional volume will reinforce the locally thin areas.

7.17.4 Bay #17 General Wall Thickness Criteria (Buckling)

The UT measurements presented in Table 17-1 equal an average of 0.918 inches in 1992 and 0.892" in 2006. 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.

7.17.5 Conclusion

Figure 17-7 illustrates representative areas and thicknesses in this bay as follows:

Area A - This is a 12" high by 12 inches wide area, which is at least 0.663" thick. This thickness is based on section 7.17.3.2).

Area B - This is a 36" high by 36 inches wide area surrounding area, which is at least 0.850" thick. This thickness is based on section 7.17.3.2.

Area C- The remaining area of the Bay is 0.892 inches thick or greater. This thickness is based on the evaluation in section 7.17.4.

Therefore this bay meets the acceptance criteria based on the following:

1) All individual readings are greater than 0.490 inches.

2) Except for Area A, the entire bay has thickness greater than 0.736 inches.

3) Area A (which is limited to an area of 12" by 12") meets the acceptance criteria in section 6.2.

Figure 17-1 **BAY #17 DATA**

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".

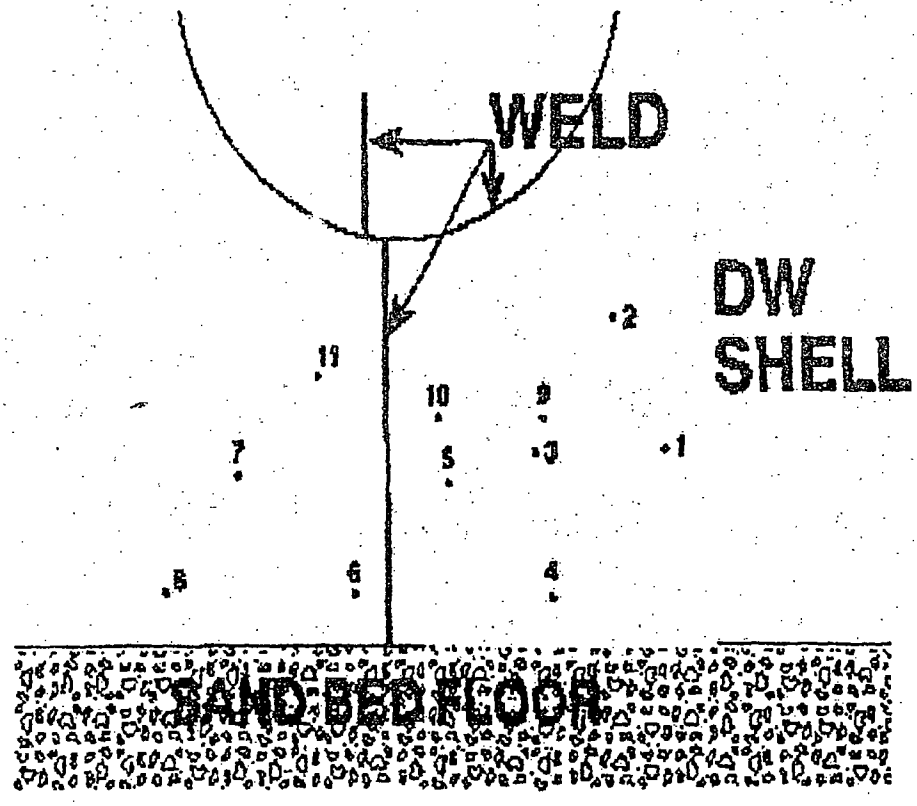

FIGURE (17)

Figure 17-2

Bay 17 2006
Spatial Relationship Of Locally Thin Areas

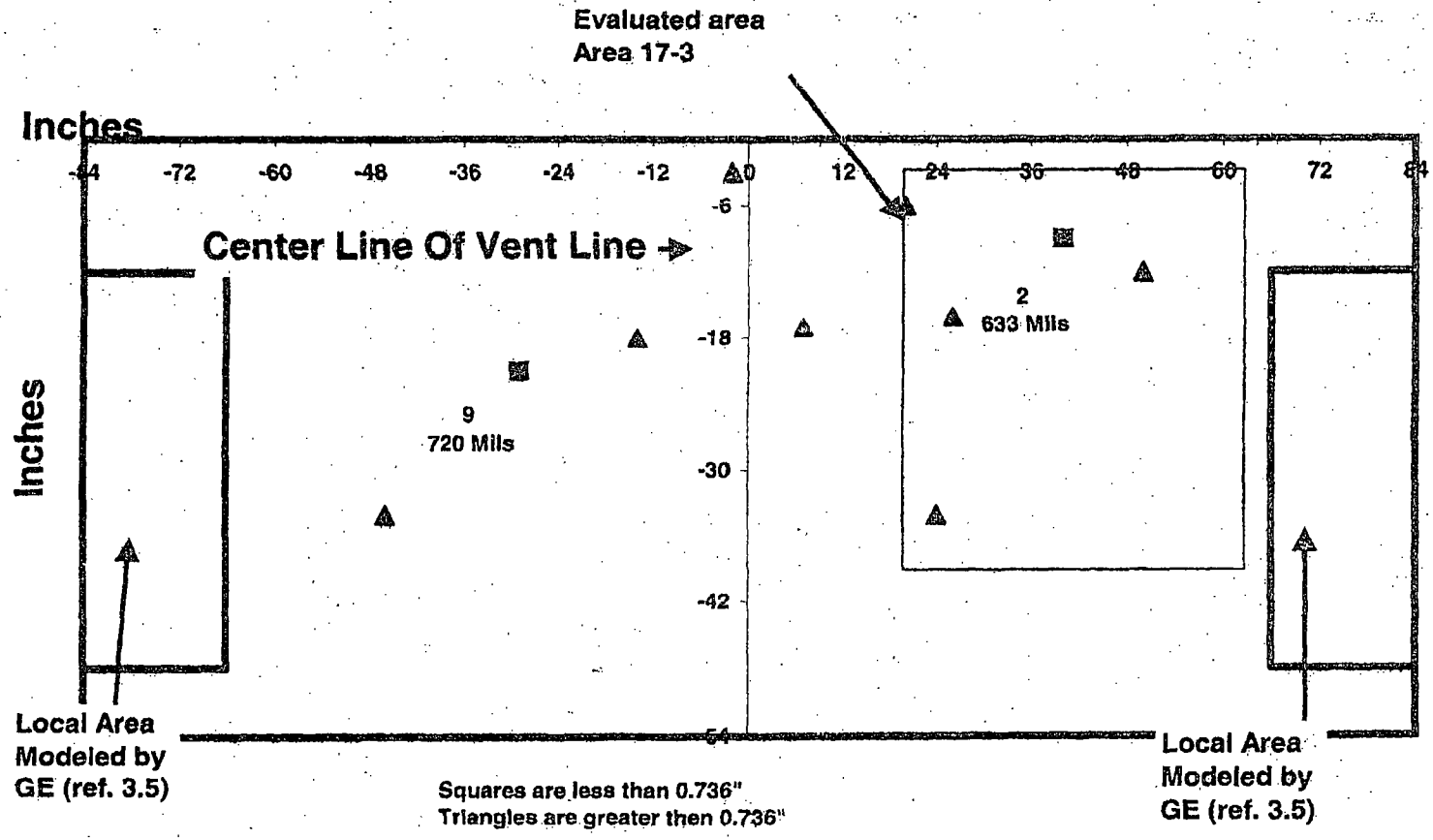

Figure 17-3

Bay 17 Locations 1, 2, 6, 7, 11 and 21 Evaluation Thickness

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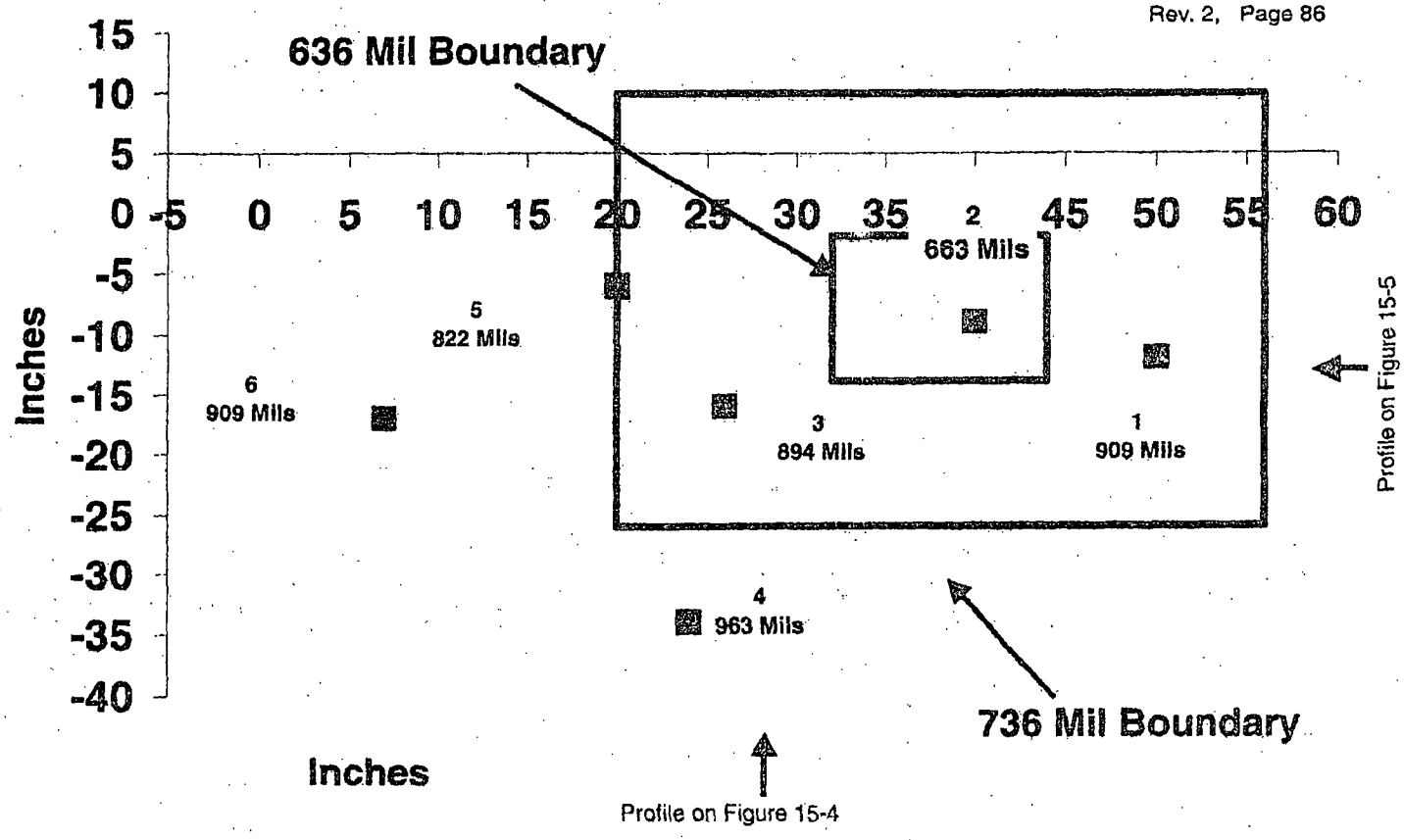

Figure 17-4

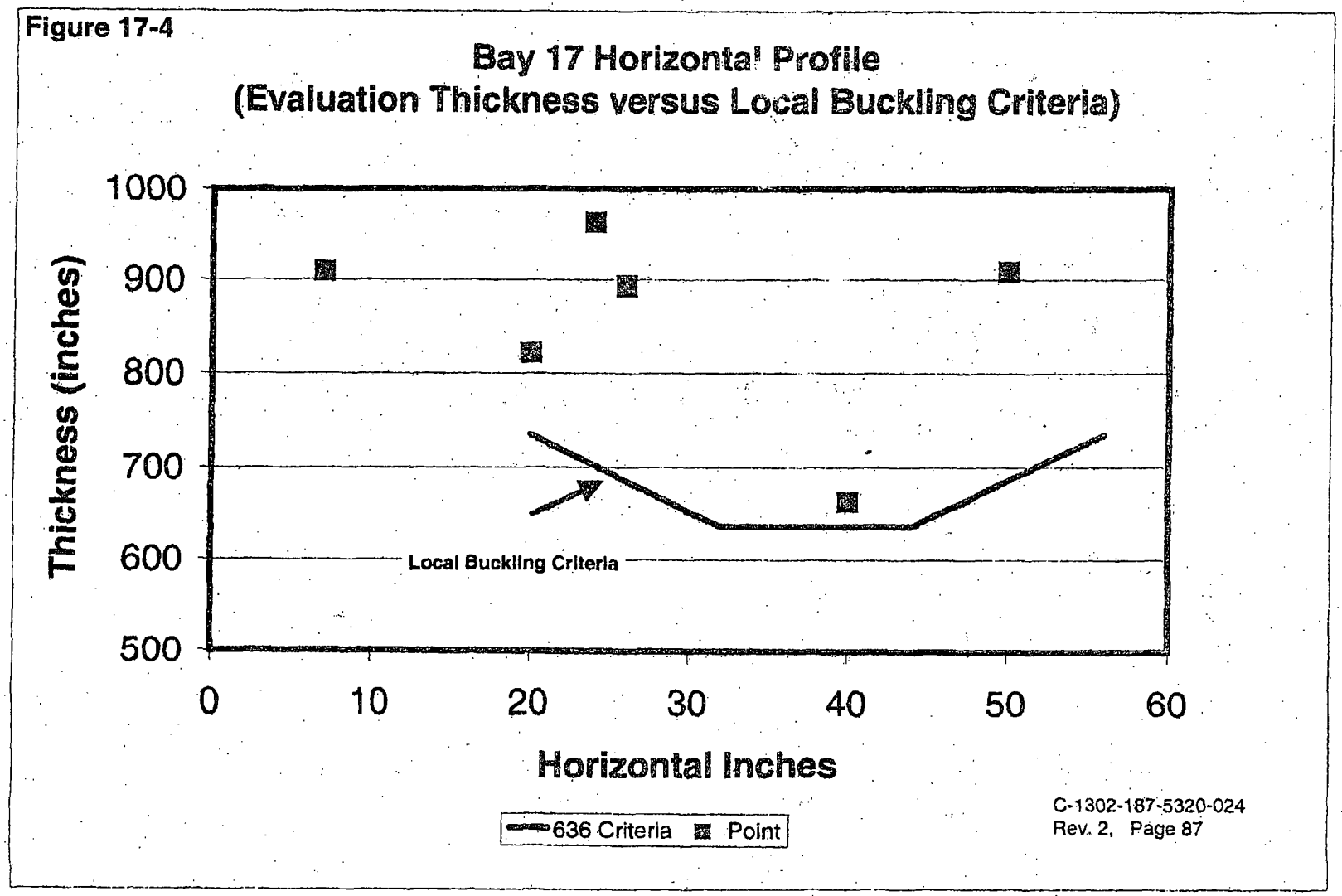

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Figure 17-5

Bay 17 Vertical Profile
(Evaluation Thickness versus Local Buckling Criteria)

Figure 17-3

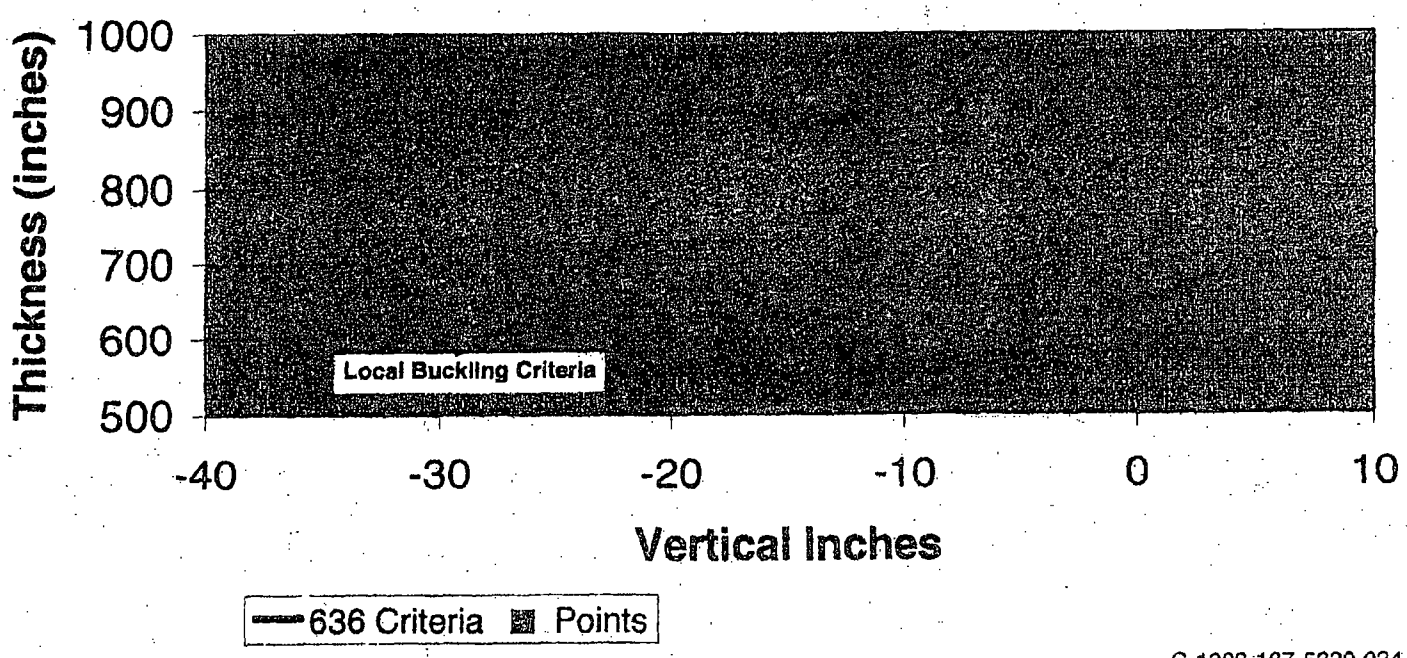

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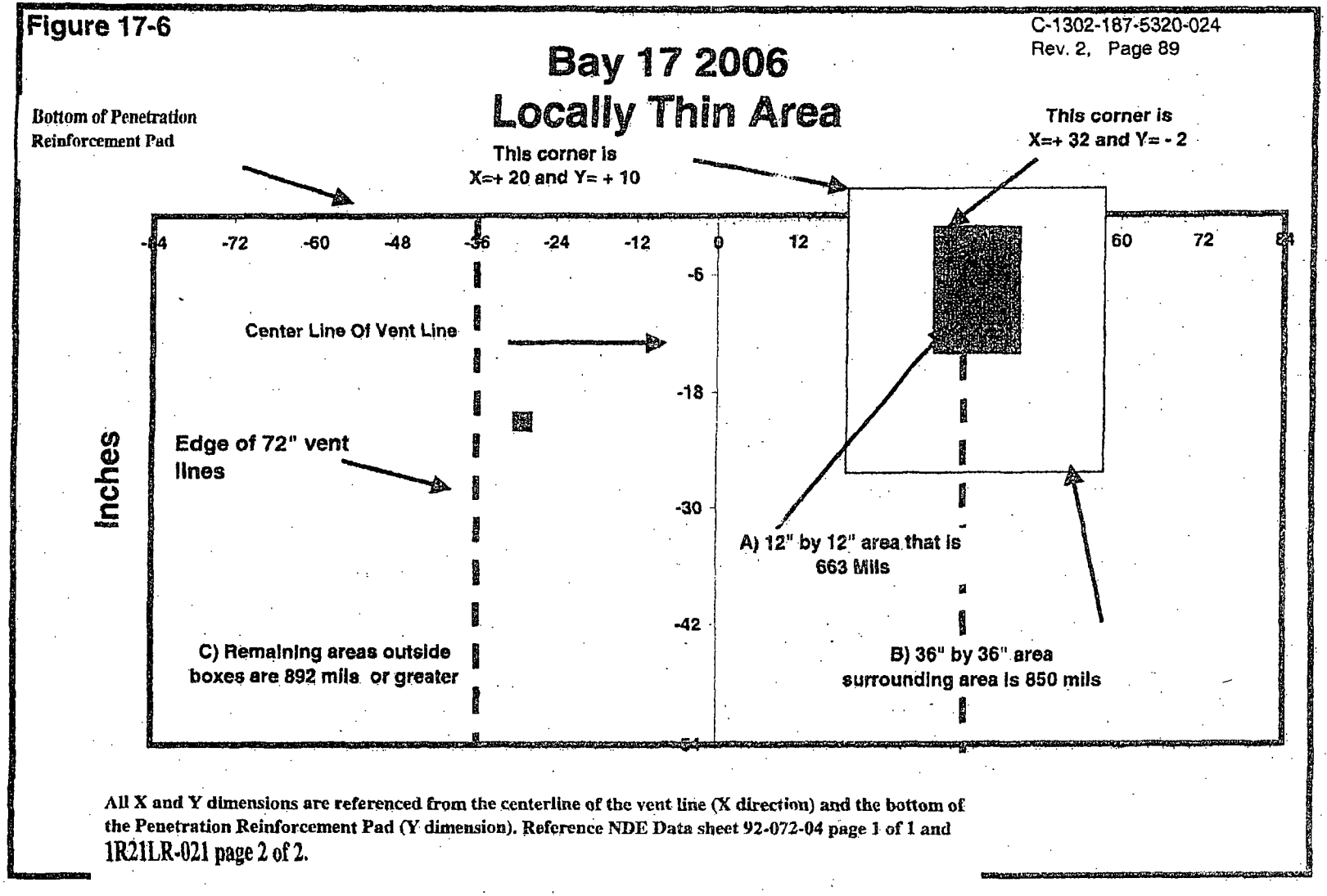
Figure 17-6



All X and Y dimensions are referenced from the centerline of the vent line (X direction) and the bottom of the Penetration Reinforcement Pad (Y dimension). Reference NDE Data sheet 92-072-04 page 1 of 1 and 1R21LR-021 page 2 of 2.

7.19 UT EVALUATION BAY 19 SUMMARY

The outside surface of this bay is rough and very similar to bay 17. Areas 1 through 7 as shown in Table 19-1, 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 (references 3.6). 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 areas were selected to represent the thinnest areas based on the visual observations of the shell surface (Fig. 19-1). These areas are a deliberate attempt to produce a minimum measurement. Table 19-1 shows readings taken to measure the thinnest thicknesses of the drywell shell. The results indicate that all of the areas have thickness greater than the 0.736 inches.

7.19.1Bay #19 General Wall (Sandbed Region) Thickness Evaluation

Table 19-1 shows that no areas were less than 0.736" in 1992 and three areas in 2006. All other areas were greater then 0.736". Since the area were greater than 0.736" in 1992 depth measurement were not performed in 1992. Therefore these area will be evaluated per section 6.2.

These areas and their location are shown on figure 19-2. The figure presents the areas with readings less than 0.736 inches as squares and areas with readings over 0.736 inches as triangles.

Table 19-1 Bay # 19 Thinnest UT Data

Location #	1992 UT Measurements (inches)	2006 UT Measurements (inches)
1	0.932	0.867
2	0.924	0.850
3	0.955	0.894
4	0.940	NA
5	0.950	0.883
6	0.860	NA
7	0.969	0.820
8	0.753	0.771
9	0.776	0.788
10	0.790	0.736
11	NA	0.812
Average	**0.885**	**0.801**

7.19.2 Bay #19 Very Local Wall Thickness Evaluation (Pressure Only)

All individual readings were greater than the acceptance criteria of 0.490". The thinnest reading was in area 11, which was 0.712 inches in 2006.

7.19.3 Bay 19 Local Wall Thickness Evaluation (Local Buckling)

Table 19-2 Summary of Measurements Below 0.736 Inches

8	0.753	0.721	Not Available	NA	NA	NA	7.19.3.1
9	0.776	0.728	Not Available	NA	NA	NA	7.19.3.2
11	NA	0.712	Not Available	NA	NA	NA	7.19.3.3

7.19.3.1 Evaluation of Area 8

Refer to figure 19-2. Area 8 has a single reading of 0.721". This area is next to areas 1 (0.867"). These two areas are bounded by a 16" by 6" area. Since these single points were determined by the inspectors to be the thinnest within this area, the average of these two thicknesses is a conservative estimate of the average thickness of the 16" by 6" area (see assumption 4.3). The average of these three readings is 0.794", which is greater than 0.736". Therefore area 8 meets the 0.736" uniform criteria.

7.19.3.2 Evaluation of Areas 9 and 11

In 2006 area 9 had a single reading of 0.728 and area 11 had a single reading of 0.712". These single points were determined by the inspectors to be the thinnest within this area. Figure 19-3 plots area 9 and 11 along with area 10, which is 0.736". Figure 19-3 overlays a 36" by 36" area on these locations.

Figure 19-4 and 19-5 shows the profile of the 36" by 36" area with the single thickness overlaid on the curve depicting the acceptance criteria. Figure 19-4 shows the profile along the horizontal axis and figure 13-5 shows the profile along the vertical axis. These figures show that the local buckling criteria is met. Please note that Figure 19-4 does shows that the two locally thin area come close to the edges of the 36" by 36" acceptance criteria envelope. However since these areas are significantly smaller than the analyzed area and since the two areas are actually located at an azimuth of the drywell that sees less stress (7.19.3.3) the closeness to the envelop is judge to be inconsequential. Also these areas were found to be thinner than 0.736" at different times.

Most likely the 2006 data is more representative, which means that there is only one area in this bay, which is less than 0.736 inches.

7.19.3.3 Combined Effect of Locally Thin Areas on Buckling

There are several conservative factors associated with the size and the location of the locally thin areas which cannot be quantified but are judged to be substantial in demonstrating that the measured thickness are adequate. These are described below.

7.19.3.3.1 Refer to figure 19-7. The locally thin area for this bay that is less than 0.736 inches is located directly under the vent line.

The local buckling criteria (section 6.2) is based on sensitivity studies that placed a 36" by 36" locally thin grid on the area of the finite element model that had the highest buckling stresses. This area is located between the centerlines of the vent lines (+66" to – 66 as shown in figure 19-2). Areas below the vents lines had less compressive stresses. Therefore locally thin areas located under a vent lines will have more margin than the same locally thin areas located between the centerline of the vent lines. Review of the original GE study (see appendix F) shows that stresses under the vent line are at least 20% less then the stresses between the centerline of the vent lines. Therefore the necessary wall thickness to maintain the required safety factor for portions of the vessel under the vent lines is substantially less (by at least 20%) than the calculated required uniform thickness of 0.736".

7.19.3.3.2 A second factor is the cumulative size of the locally thin areas, which are significantly much smaller than the analyzed 36" by 36" area (see the figure in section 6.2). The total volume of this 36" by 36" area when compared to the volume of a similar 36" by 36" area with a uniform thickness of 0.736" correspond to a reduced volume of 72.0 cubic inches.

The cumulative volume of two locally thin areas is less than 0.251 cubic inches (see the table below).

Area	Thinnest reading inside the area (inches) (Column 2)	Equivalent volume loss of 2 ½ inches diameter area with thickness equal to thinnest readings (Column 2) when compared to a uniform thickness of 0.736 inches (0.736 – Column 2)* 3.142*(2.5/2)**2
8	0.721	0.080
9	0.728	0.043
10	0.736	0.000
11	0.712	0.128
	Total	0.251

Therefore the comparison of the "as found" volume reduction which is less than 0.251 cubic inches to the "analyzed" volume reduction of 72 cubic inches leads to the conclusion that the effect on the buckling load factor is negligible.

In addition since the majority of the vessel in this bay is thicker than 0.736", the thicker areas will reinforce the locally thin areas. For example approximately 7680 square inches of surface area in this bay (of a total of 9072 square inches) is 800 mils or thicker (refer to figure 15-7). When compared to same surface area with a thickness of 0.736" there is a total increase in volume of at least 490 cubic inches. (e .g 490 = (0.800-0.736)* 7680). This additional volume will reinforce the locally thin areas.

7.19.4 Bay #19 General Wall Thickness Criteria (Buckling)

The UT measurements presented in Table 17-1 equal an average of 0.885 inches in 1992 and 0.801" in 2006. 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.

7.19.5 Conclusion

Figure 19-7 illustrates representative areas and thicknesses in this bay as follows:

Area A - This is a 16 inches high by 6 inches wide area, which is at least 0.794" thick. This thickness is based on section 7.19.3.2).

Area B - This is a 36" high by 36 inches wide area is at least 0.720" thick. This thickness is based on section 7.19.3.1.

Area C- The remaining area of the Bay is 0.800 inches thick. This thickness is based on the evaluation in section 7.19.4 or greater.

Therefore this bay meets the acceptance criteria based on the following:

1) All individual readings are greater than 0.490 inches.

2) Except for Area B, the entire bay has thickness greater than 0.736 inches.

3) Area C (which is limited to an area of 36" by 36") meets the acceptance criteria in section 6.2.

Figure 19-1

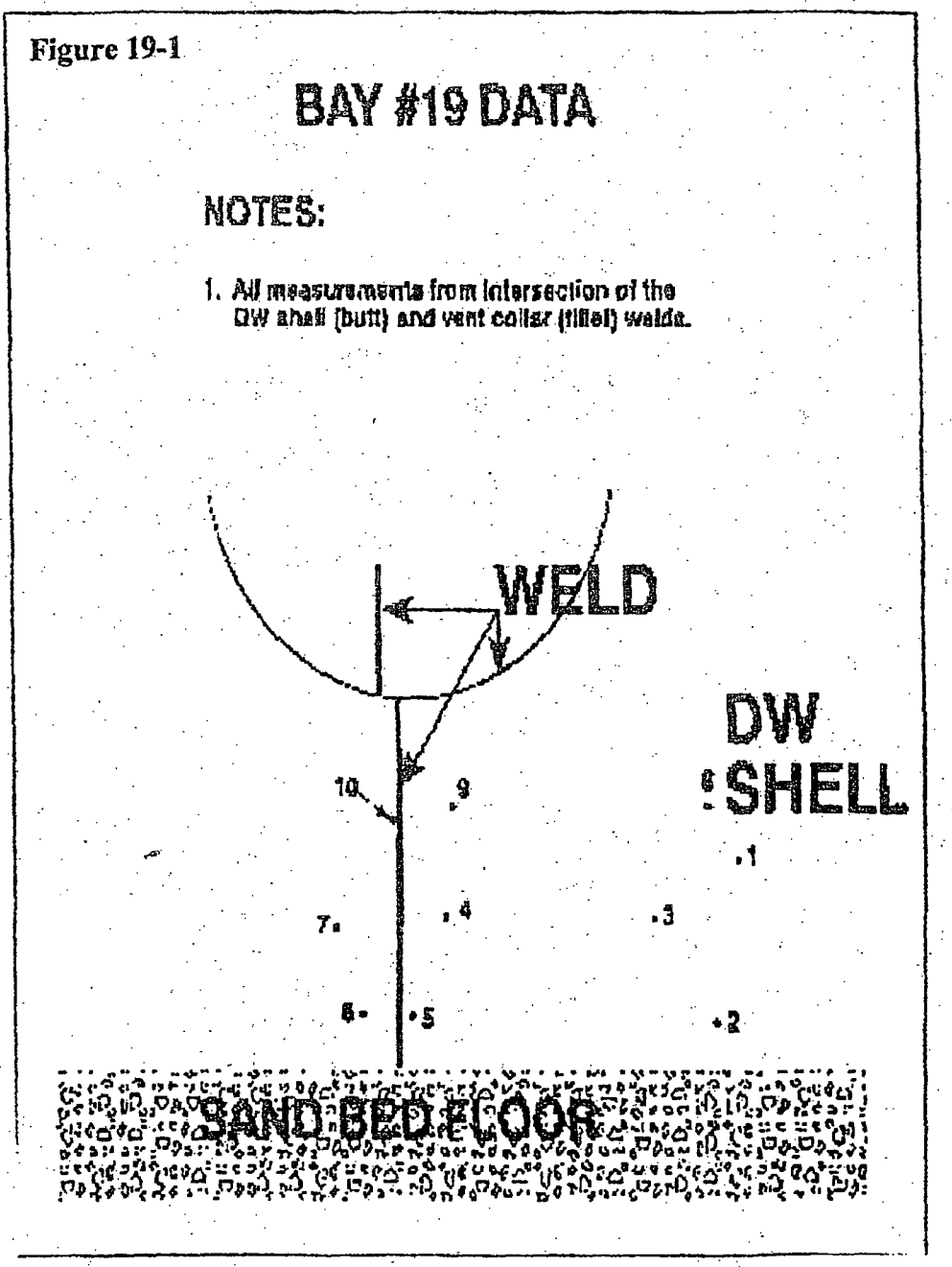


FIGURE (19)

Figure 19-2

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Bay 19 2006
Spatial Relationship Of Locally Thin Areas

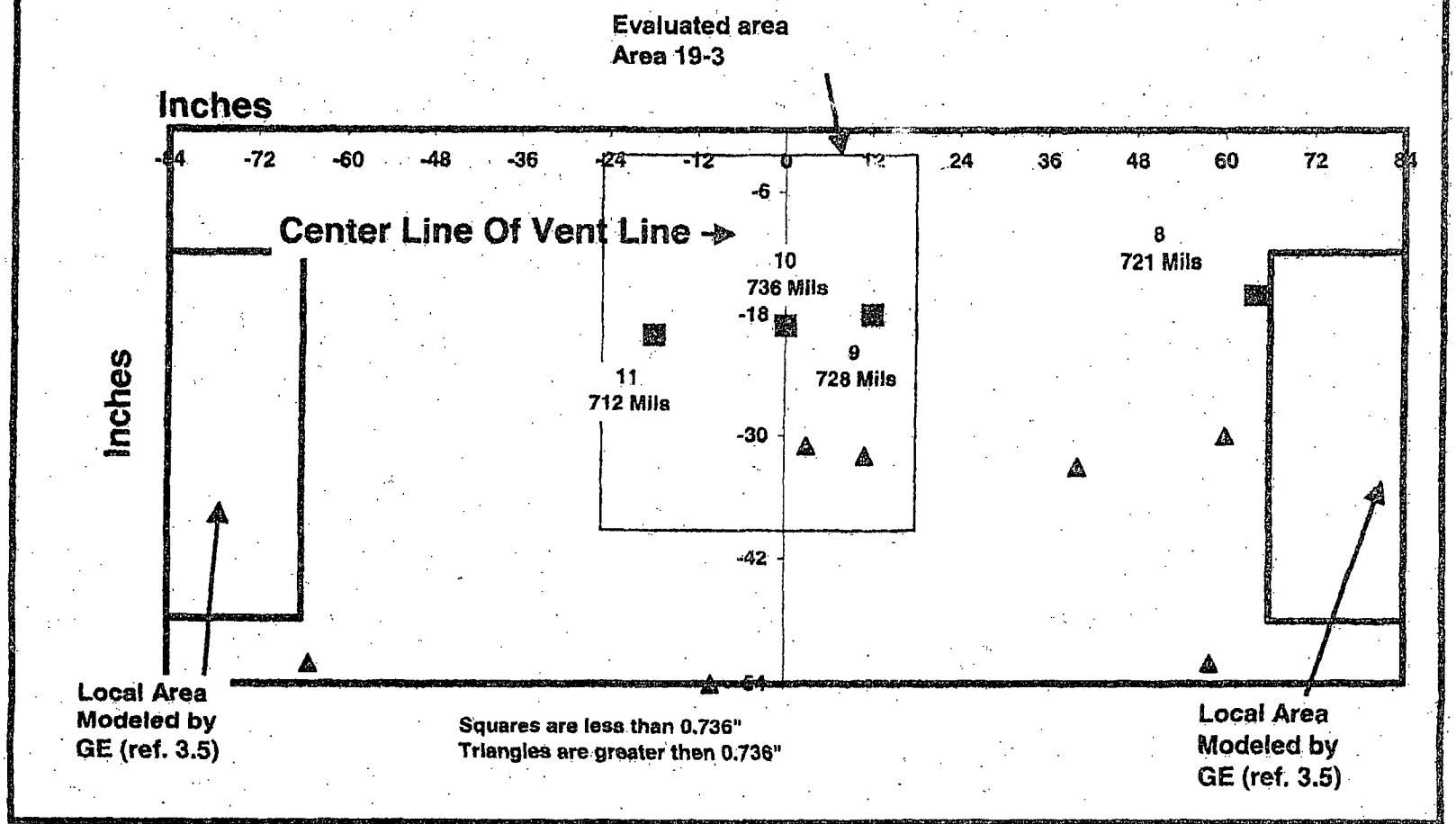

Figure 19-3

Bay 19 Locations 1, 2, 6, 7, 11 and 21 Evaluation Thickness

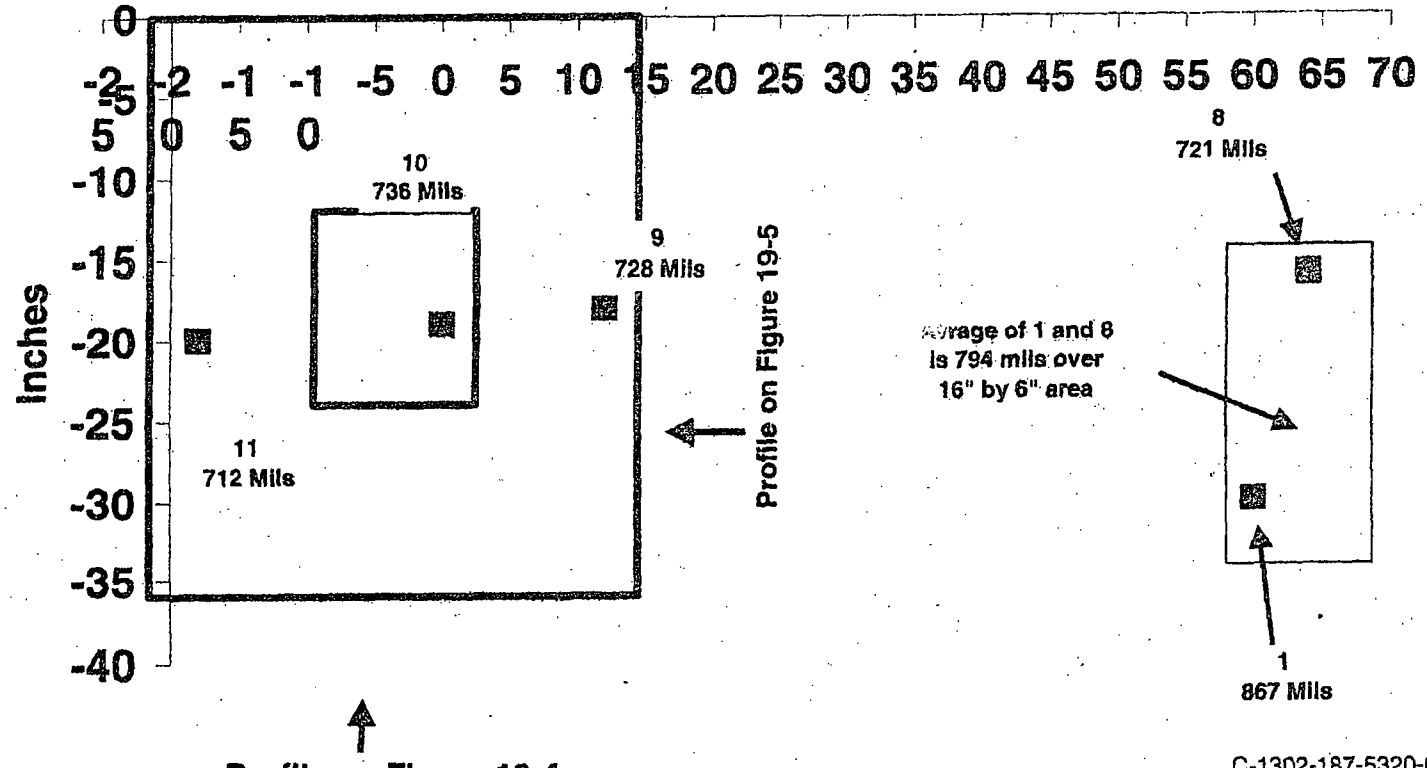

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Figure 19-4

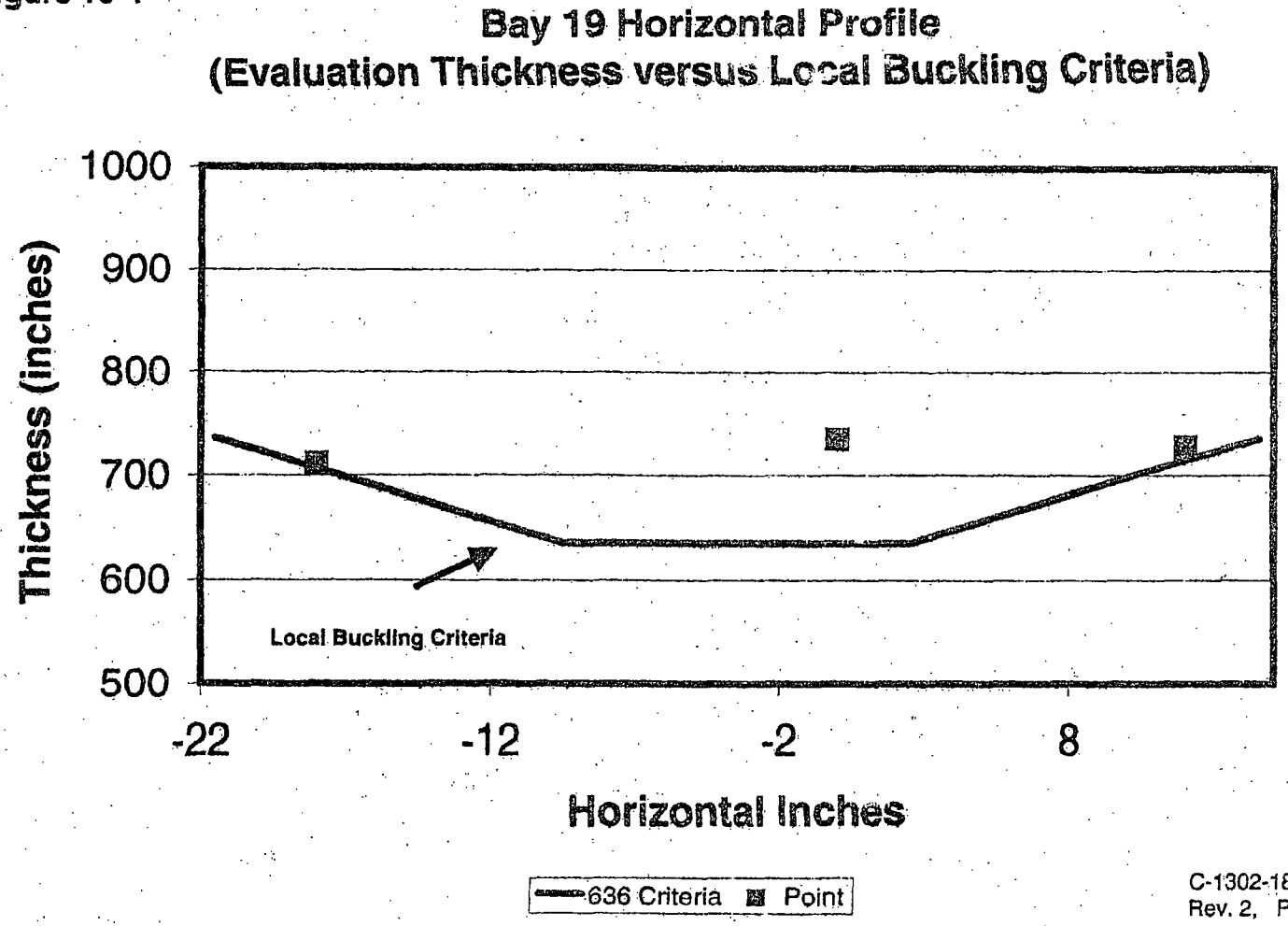

Figure 19-5

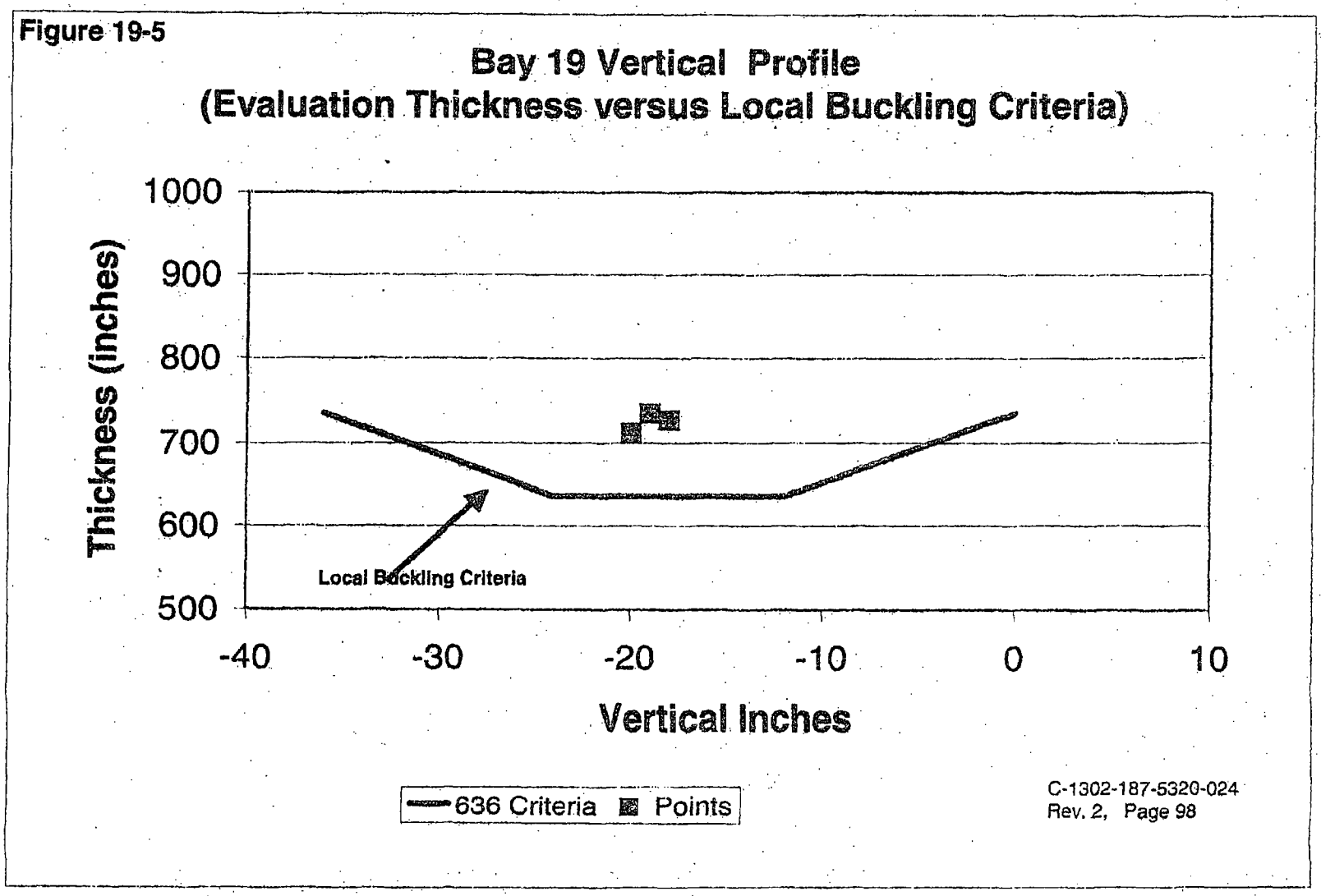

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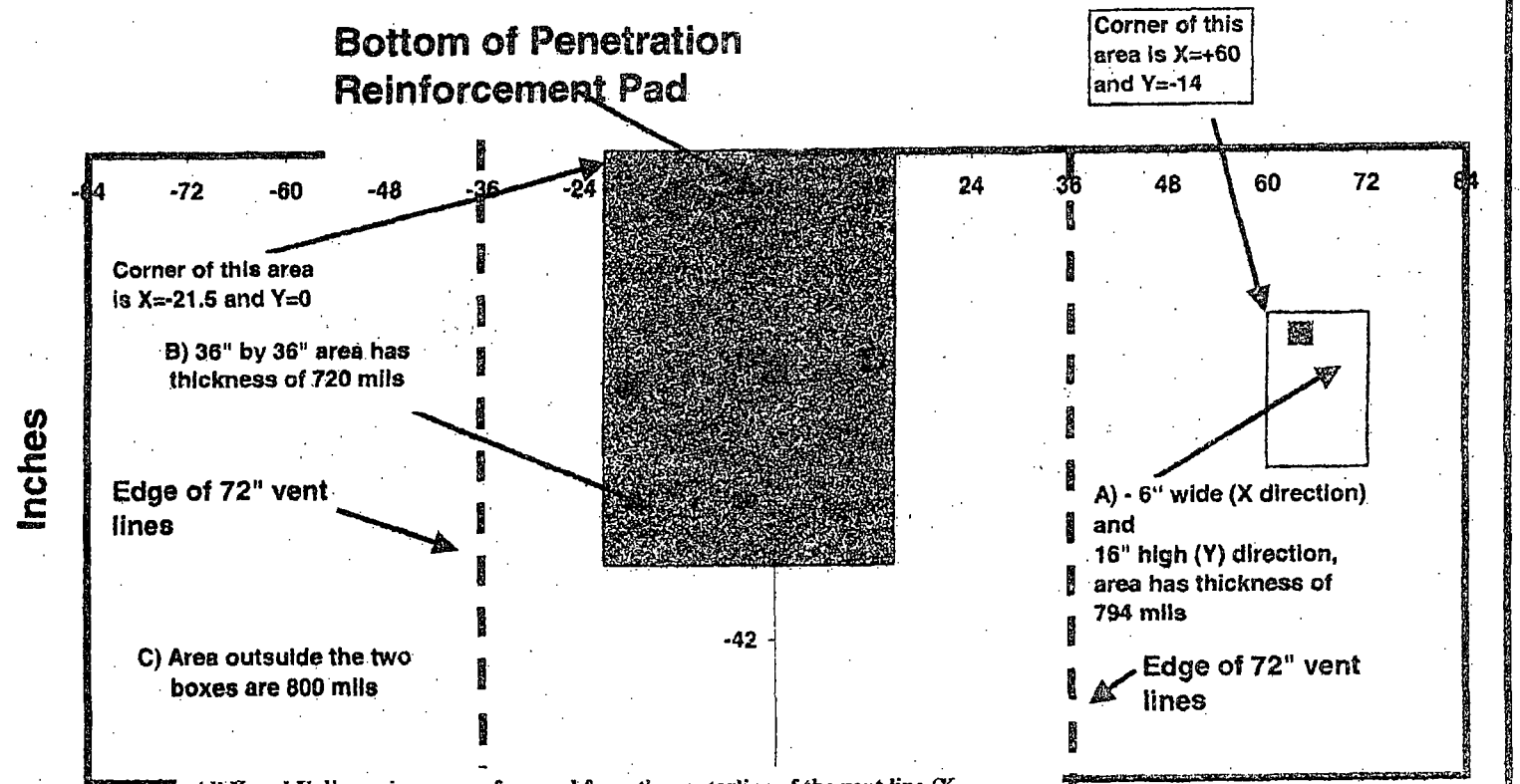
Figure 19-7

Bay 19 2006
Locally Thin Areas



All X and Y dimensions are referenced from the centerline of the vent line (X direction) and the bottom of the Penetration Reinforcement Pad (Y dimension). Reference NDE Data sheet 92-072-02 page 1 of 1 and 1R21LR-020 page 2 of 2.

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.

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O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	2	104 of 183
Originator	**Date**	**Reviewed by**		**Date**
Peter Tamburro	3/21/07	Julien Abramovici		

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=Sc/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	

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Peter Tamburro	3/21/07	Julien Abramovici		

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	

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Peter Tamburro	3/21/07	Julien Abramovici		

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	

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Originator	**Date**	**Reviewed by**		**Date**
Peter Tamburro	3/21/07	Julien Abramovici		

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	

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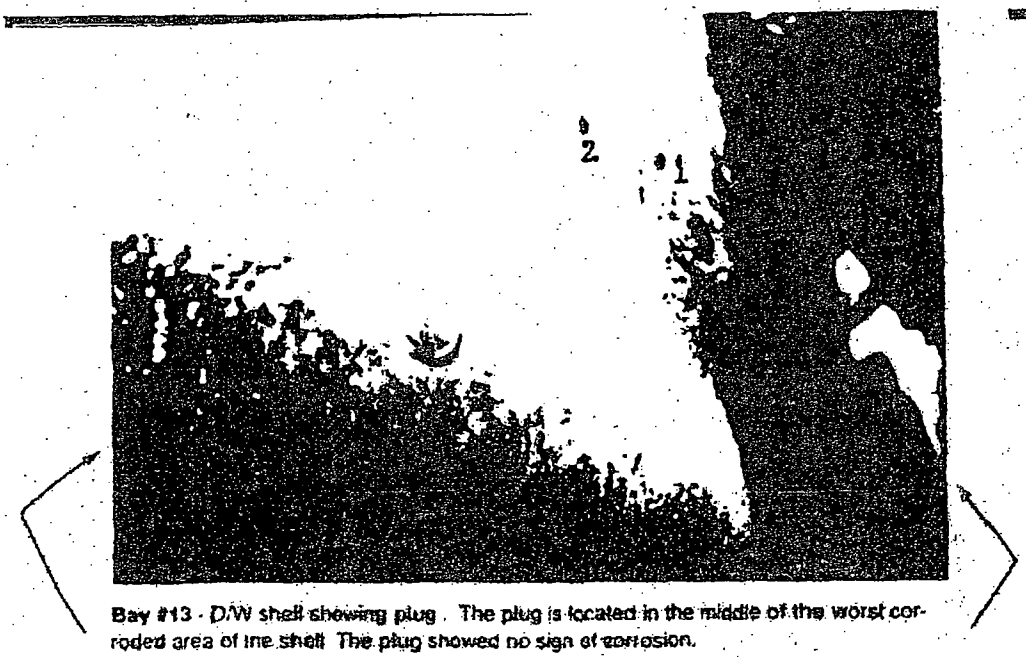
Sand Bed Region - Typical condition found on initial entry.

Corrosion product on drywell vessel



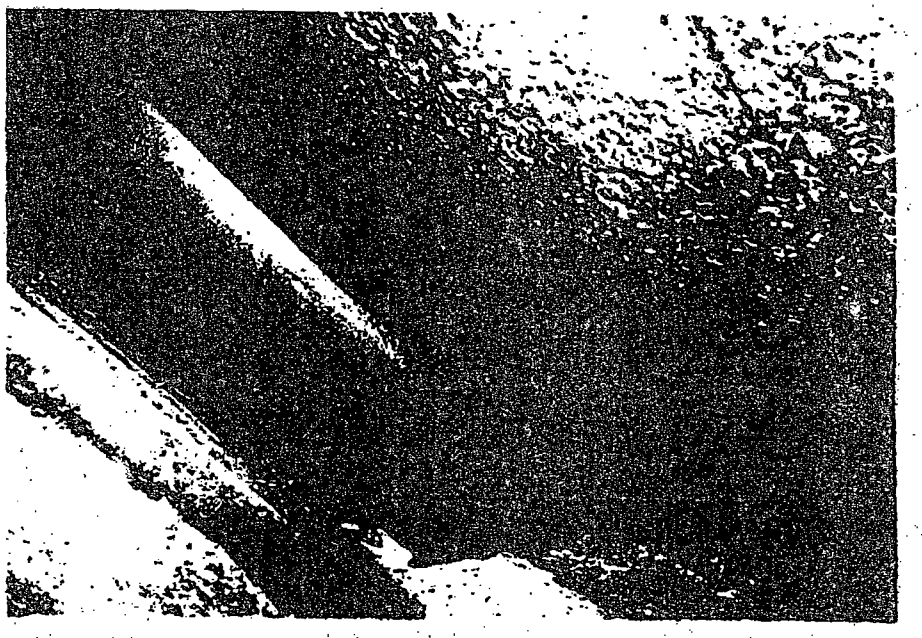
Bay #13 - D/W shell showing plug . The plug is located in the middle of the worst corroded area of the shell. The plug showed no sign of corrosion.

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

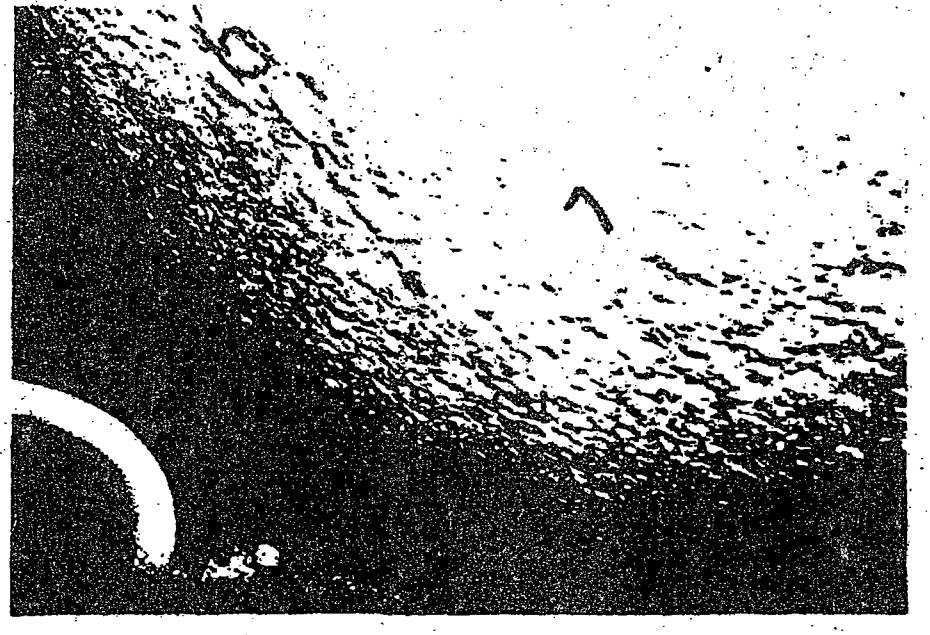
Bay #1 - Looking at the worst corroded area on shell near vent tube collar/ring. The ground spots seen here correspond to UT spot 20.2: 2.3

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

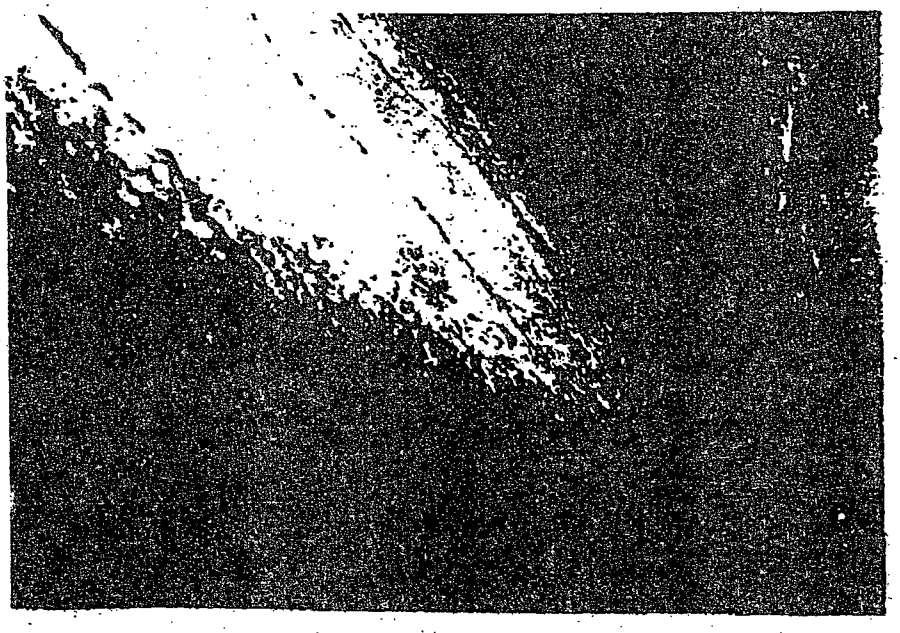
Bay #13 - Looking towards Bay #11 - Upper right corner of DW shell. Note (1) - Grinding depth on UT spot #1 & 2 (2) - A part of Drill Tally Ring" as delineated by marking end @ locations of UT spots 3,4,13 & 17. The photo-enlight (although blurred by flash reflection) shows 1/8" projection of plug.



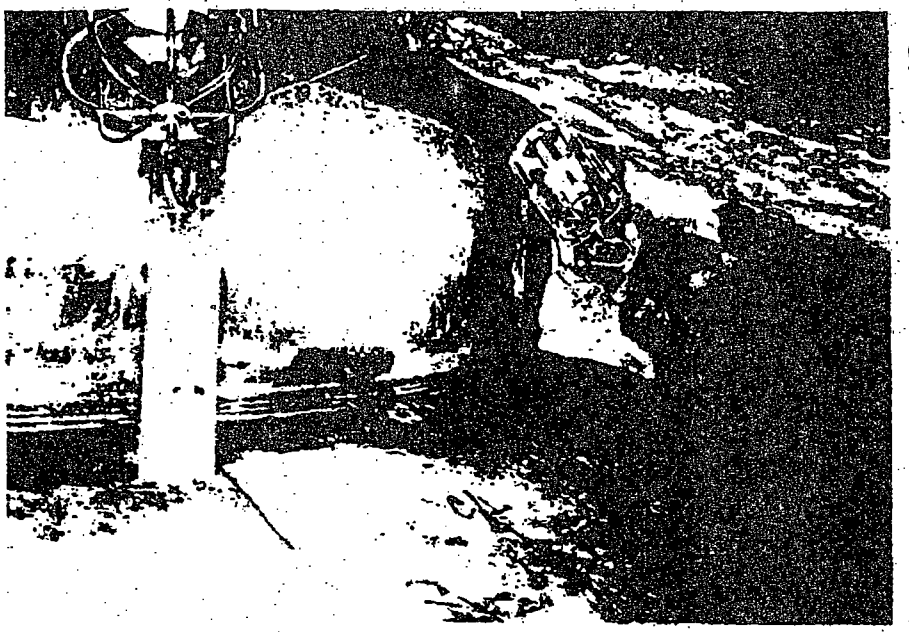
Bay #15 Looking towards Bay#17 which has been closed with foam for coating work in Bay #17. Note the typical surface of the D/W shell and localized corroded spot



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 depth between peaks and valleys in the 0.25" - 0.40"

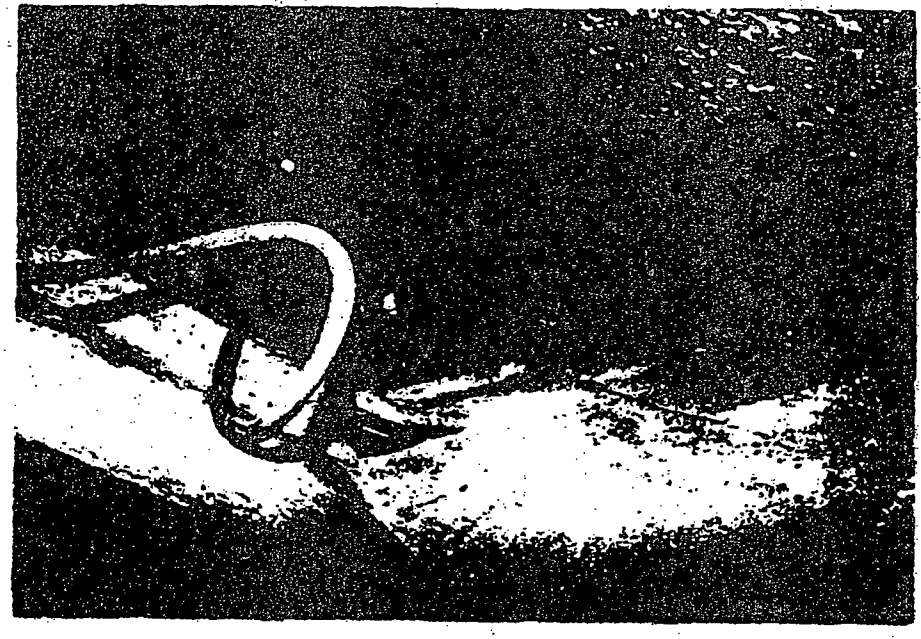


Bay #15 Looking toward Bay #13 showing portions of D/W shell and concrete floor, after removal of loose debris / sand / rust. The concrete floor in this bay is one of the better ones. However - Note (1) no drainage channel and (2) cratered holes near shell corner



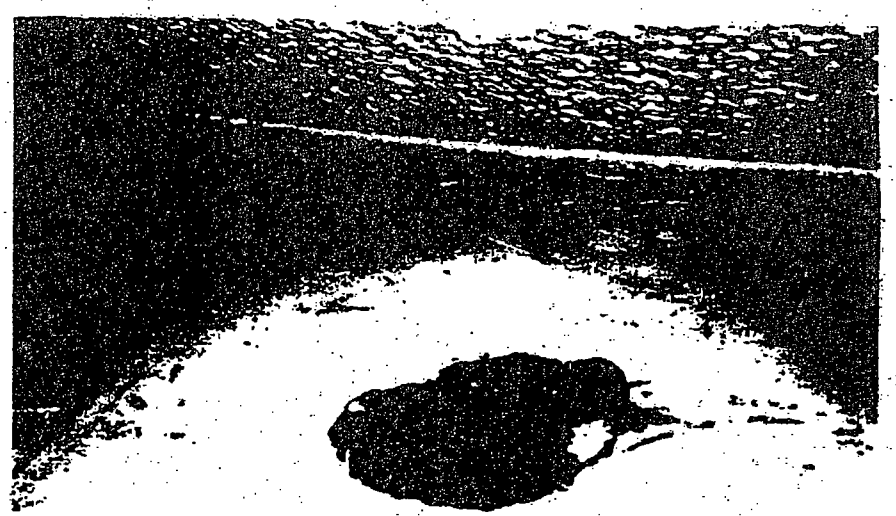
Bay #15 - Note the original lead primer on vent tube OD surface. The "Tub Ring" was less prominent on the shell in this bay except a portion in lower left corner. Also note presence of lead primer on vent collaring plate.

Bay #13 Looking toward Bay #11 - Lower right corner of O/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

CC Charge No. 5544-57307 Request No. 92-C92

1 **To be filled in by Requestor**

Job Order No.	Short Form No.	BA No. 228295	Date of Request
Job Description: UT THICKNESS OF D/W LINER			
		System:	
Job Location: SAND BED AREA		Applicable Code/Specification: ASME XI	

Type of NDE requested: EAS

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

NDE Requested by: J SLATER FOR	Phone No.:	Date 12-5-92

Remarks: JOHN FLYNN

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

NDE Coordinator: J SLATER	Date

Instructions:

UT	PT	MT	RT	VT	ET
☒ 0°	Type	Dry	Isotope	☐ Direct	☐ Probe
☐ 45°	☐ A-1	☐ Red	☐ Ir[192]	☐ Weld Insp.	☐ Double
☐ 60°	☐ A-2	☐ Black	☐ Co[60]	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/closed/cond. rel.	Proc. No.
☒ Accept	N/A	Proc. No.
☐ Reject		Proc. No.
☐ Verify		Job start date / Job stop date
	NDE Coordinator	Date Closed: 1-25-93 / Date to DCC: 1-25-93

Yellow - Originator Final Copy Gold - Originator Initial Copy
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			Remarks
			Acc	Rej	Recordable	
92-072-21	UT	1-8-93				BAY 13
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: 8133ADM7230.01-2 (6/92)

A0001837

GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
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Originator	Date	Reviewed by		Date
Pete Tamburro	3/21/07			

GPU Nuclear

Oyster Creek - OC

NDE/ISI Report Log — Page ____ of ____

NDE Rep. #: 92-072

Test: ☐ PT ☒ MT ☐ VT ☐ RT ☒ UT ☐ ____

System/Location: DRYWELL SANDBED

Note: ____

Report #	Test Type	Date of Test	Results: Rej	Acc	Geometric	Remarks:
92-072-01	UT	12-5-92				BAY 17
92-072-02	UT	12-5-92				BAY 19
92-072-03	UT	12-11-92				BAY 19
92-072-04	UT	12-11-92				BAY 17
92-072-05	UT	12-11-92				BAY 19
92-072-06	UT	12-11-92				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	12-22-92				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
93-072-20	UT	1-8-93				BAY 7

Form ID: 8135ADM.7250/01-2.IE/82I

A0091537

Program	Xducer	Screen	Digital
1	5 mhz ¾" Single A31900 (SD	2"	2"
2	2.25 mhz ¾" Single F26902	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 ¾" single A31900 (SD)	1"	1"
8	2 mhz MSEB MC8524	1"	1"
9	5 mhz ½" delay GO-050Y single	2"	NONE
10	5 mhz ½" dual D14252	1"	1"
11	5 mhz ½" dual D14252	2"	2"

Sample for your info. JM

GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
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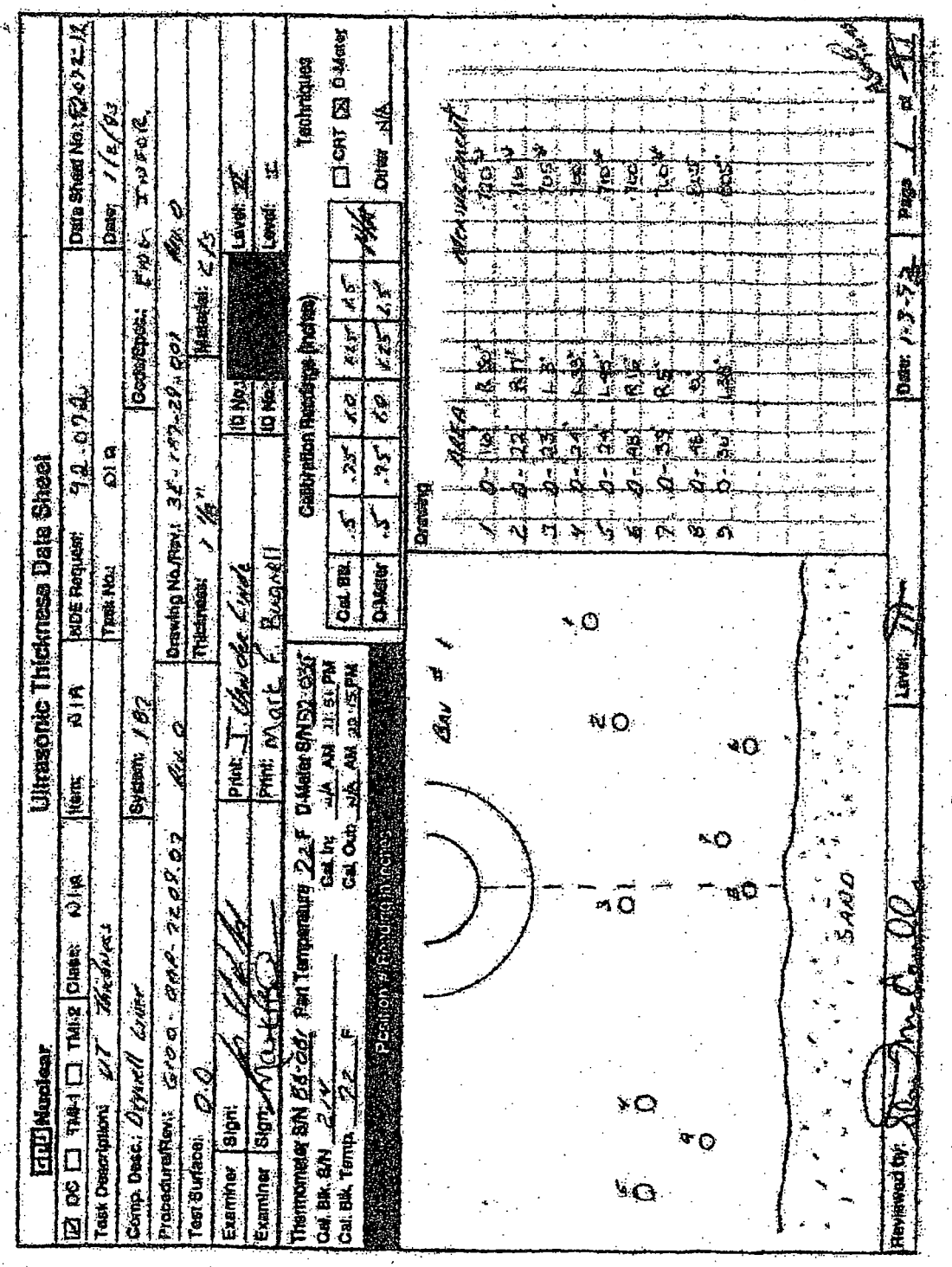
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



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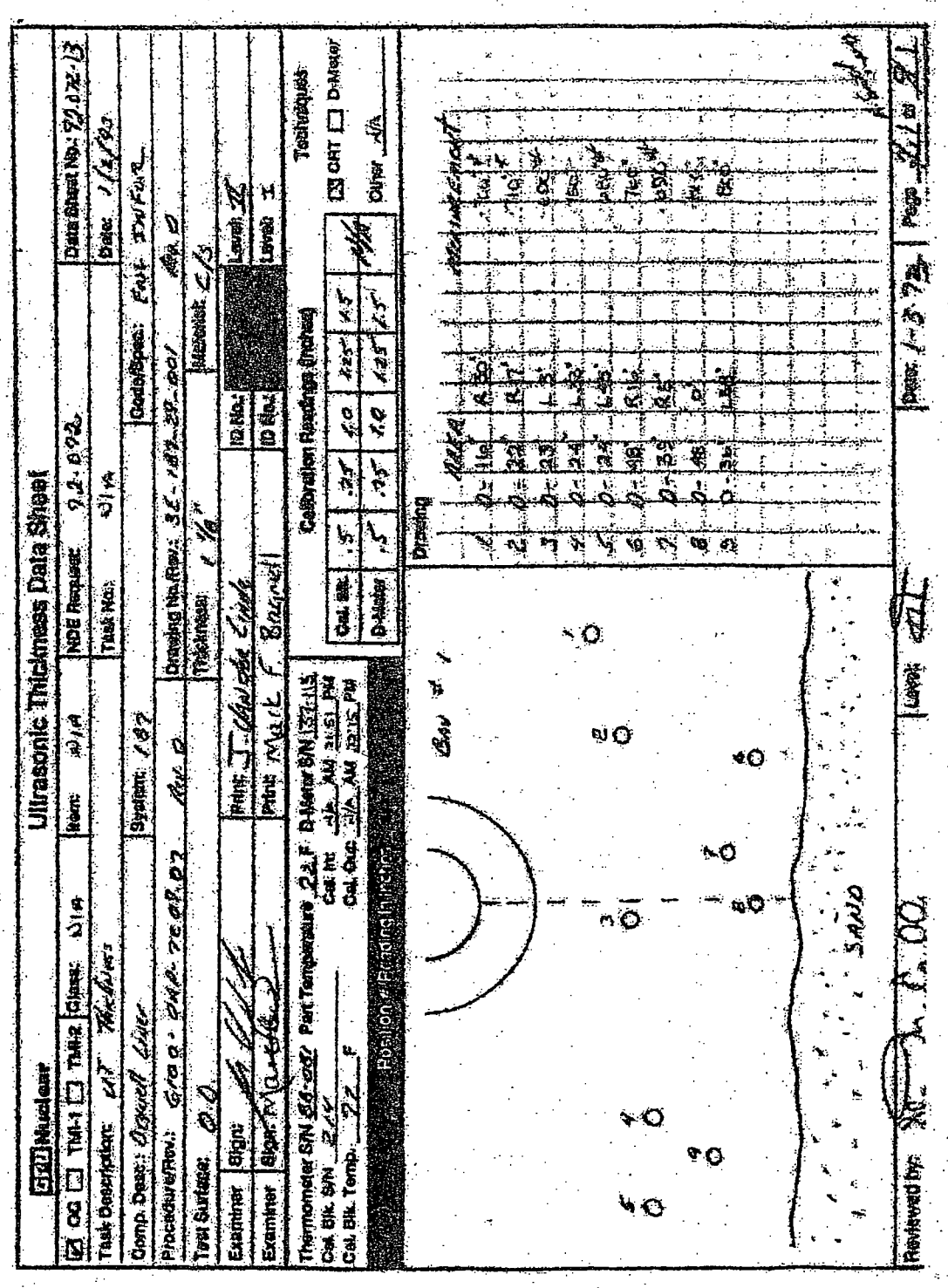
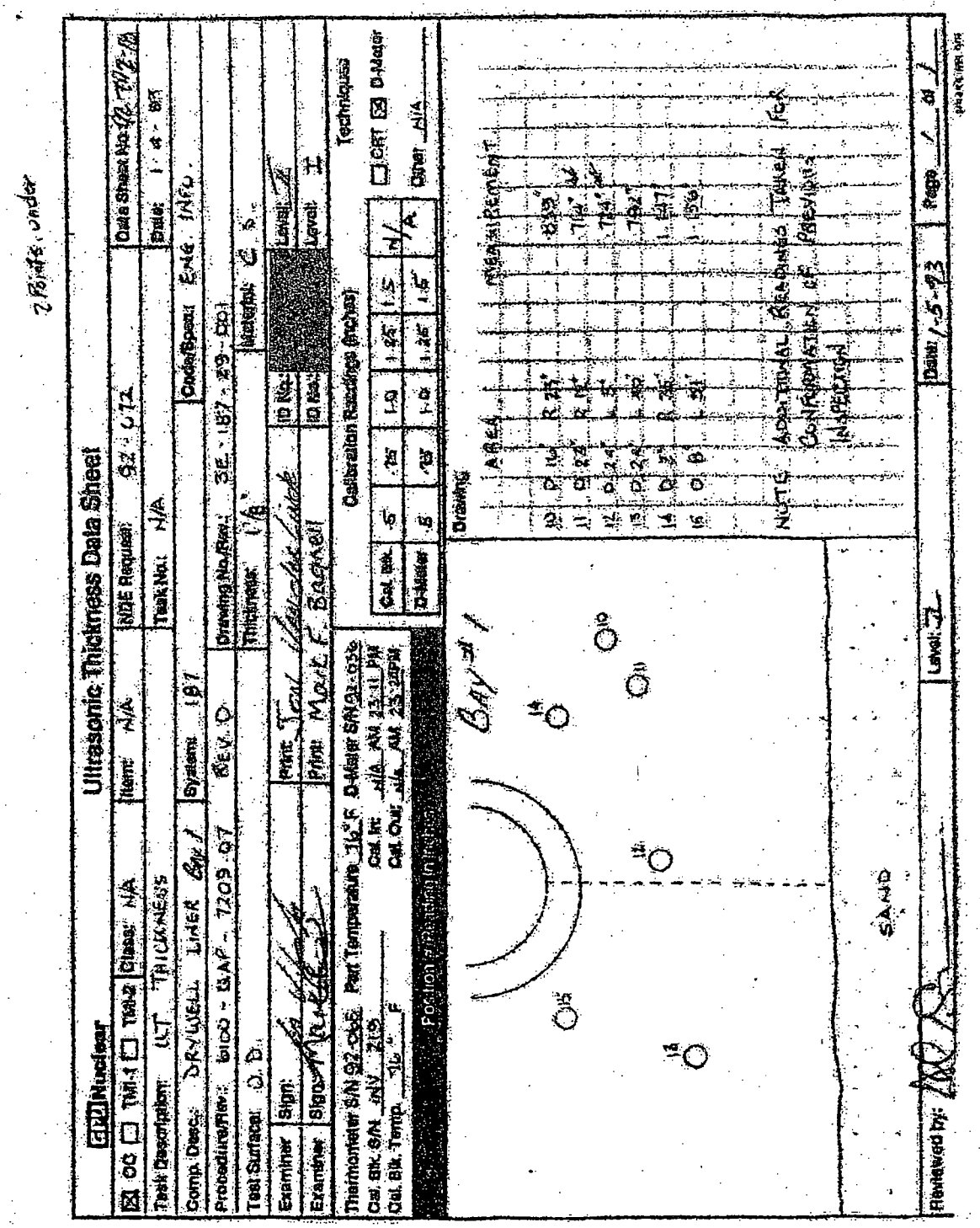
Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	123 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



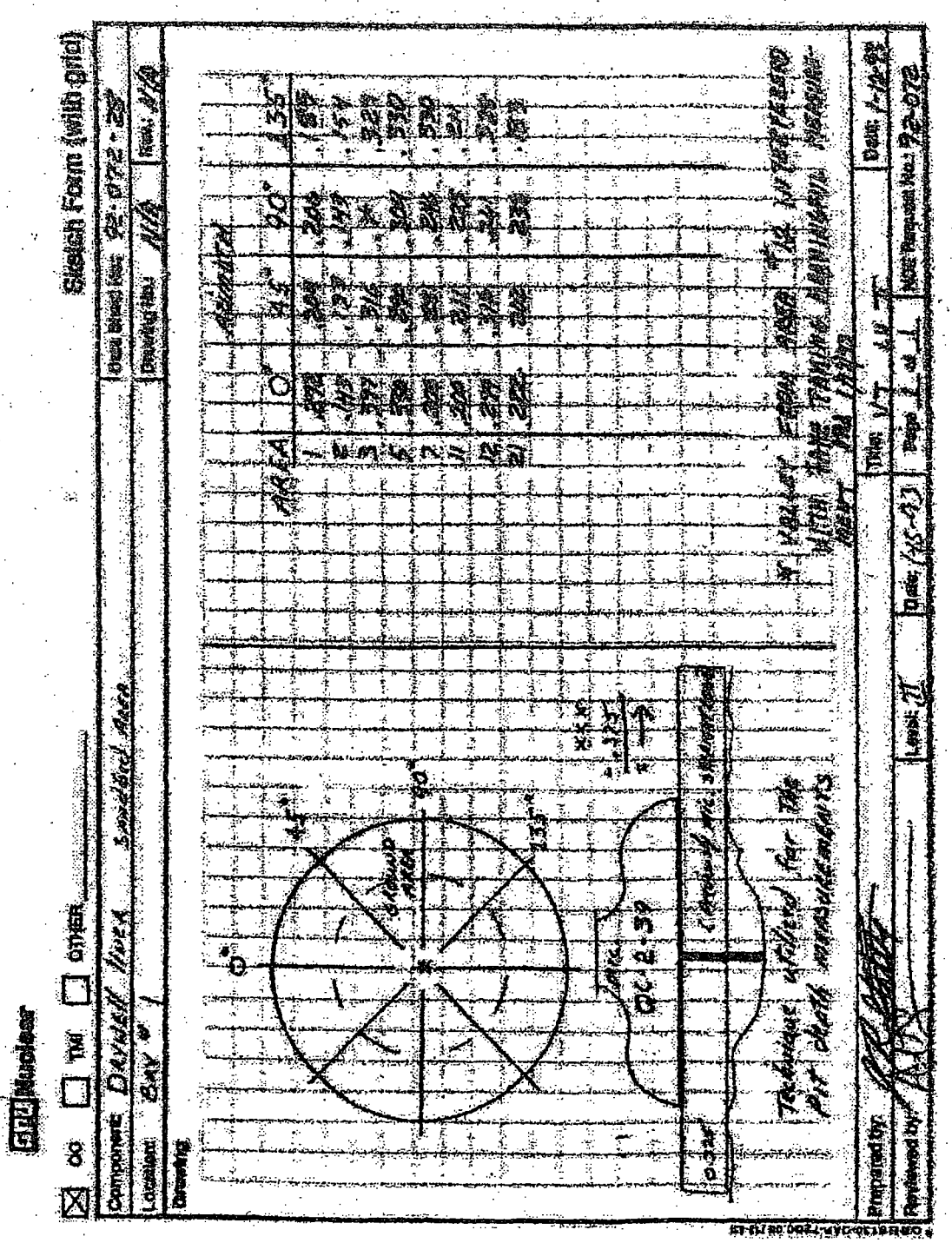
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	124 of 183
Originator	Date	Reviewed by		Date
Pete Tamburro	3/21/07			



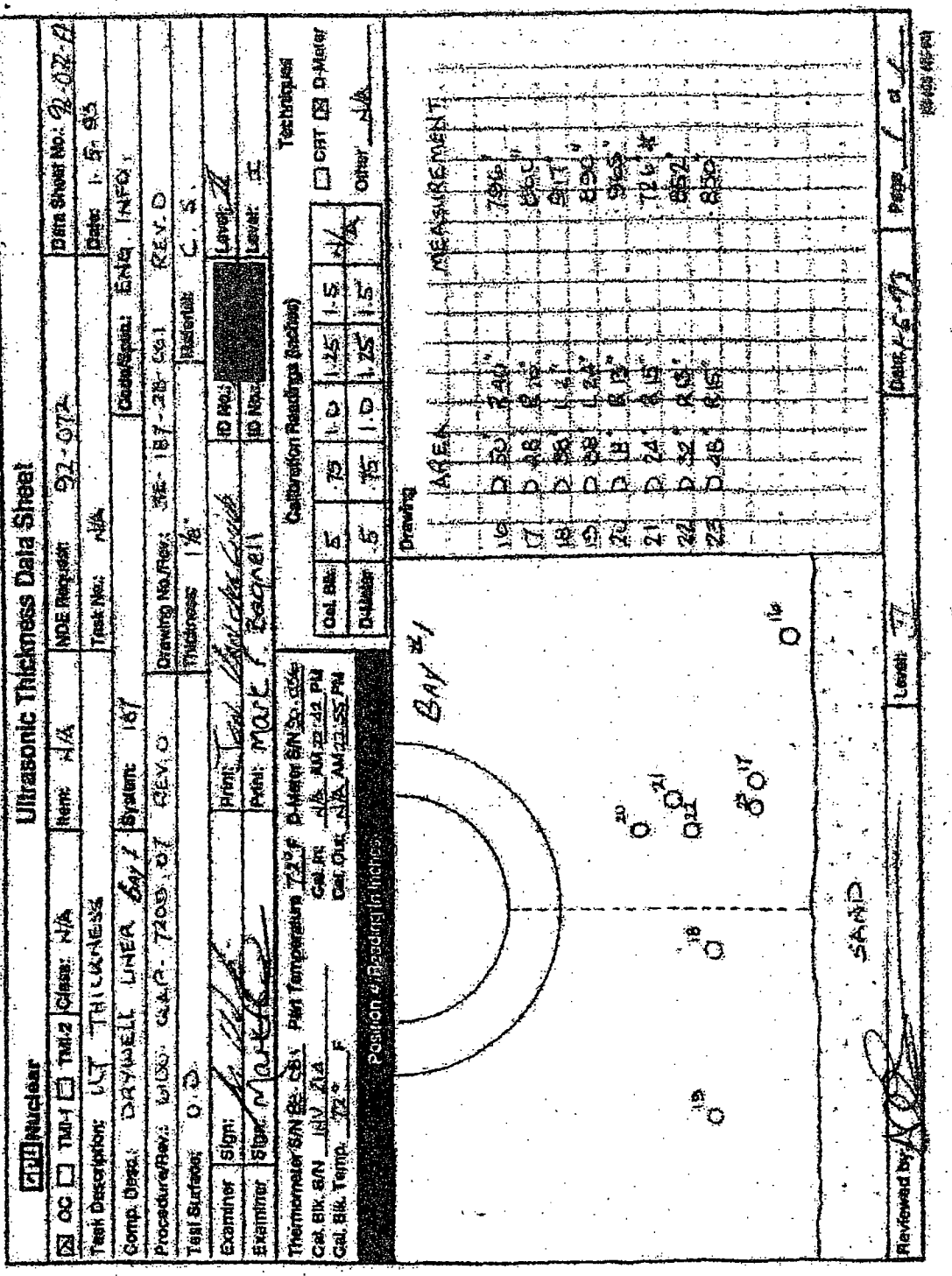
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	125 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



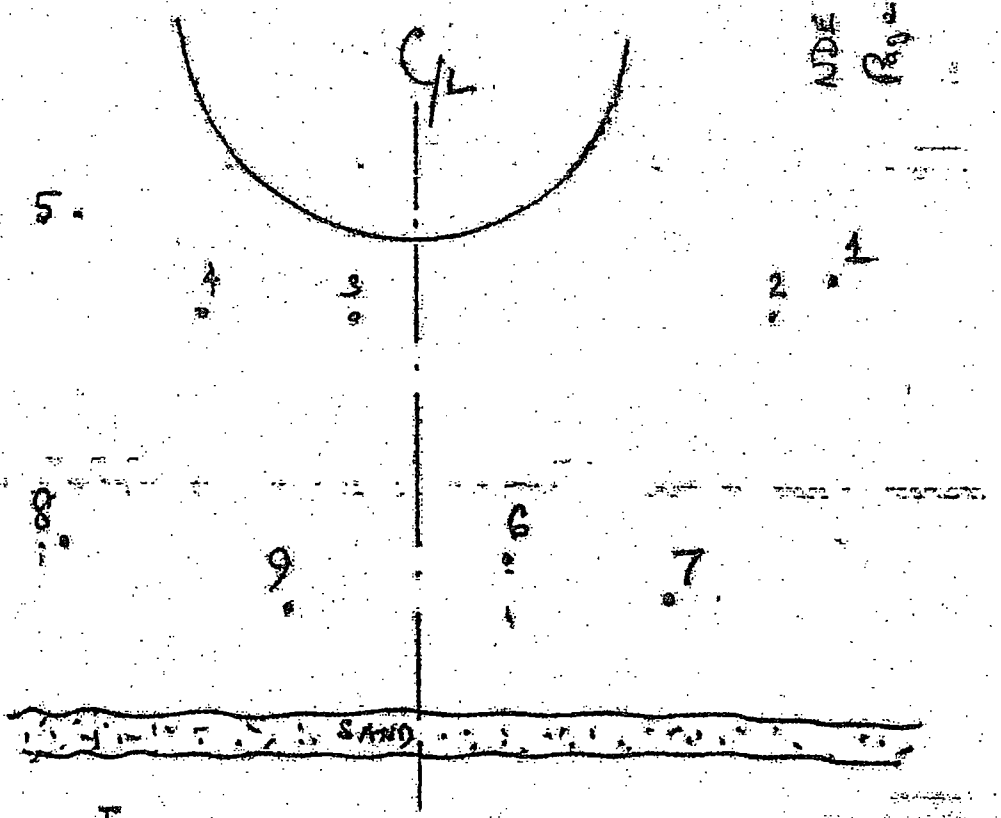
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	126 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	127 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



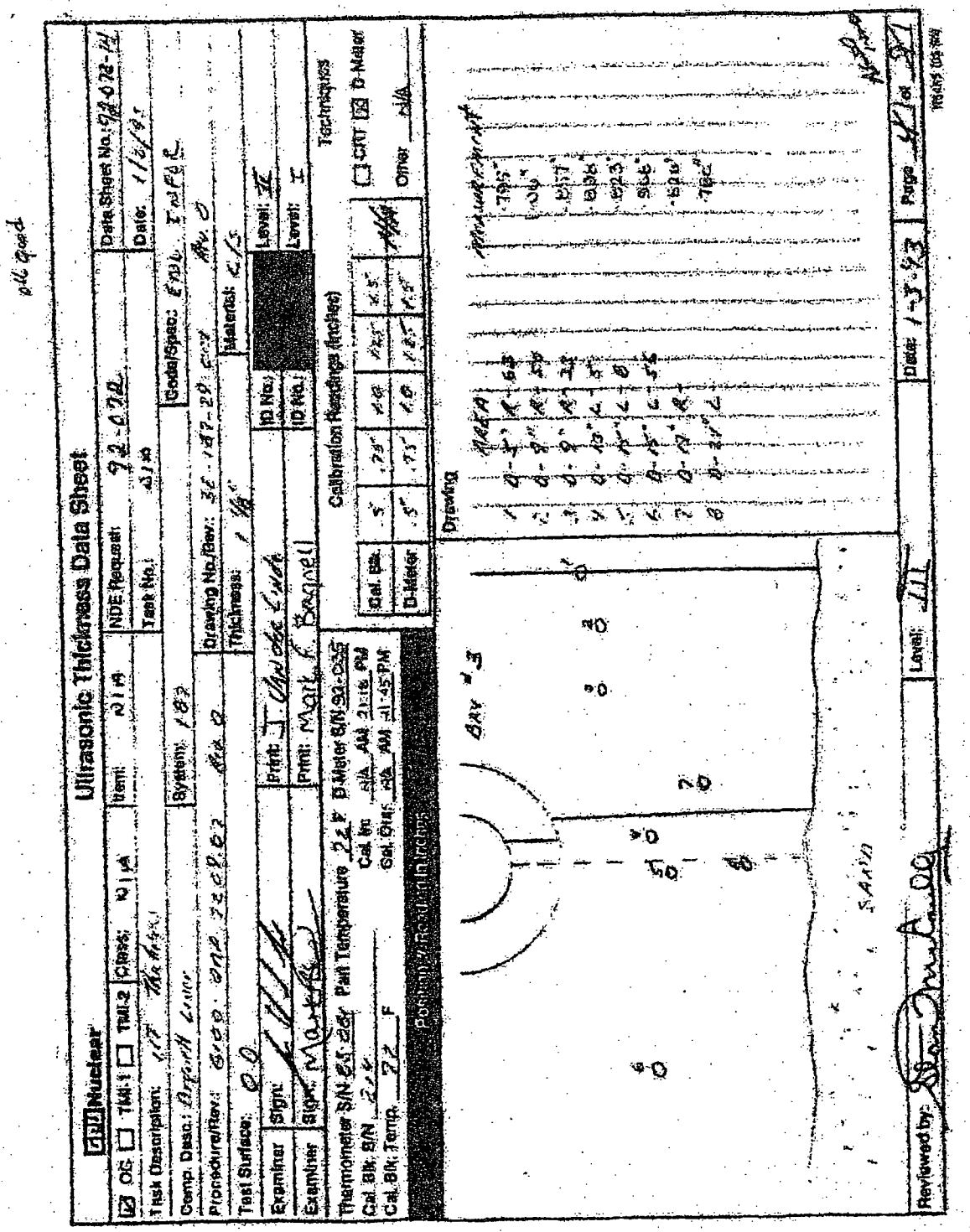
NDE Proc. 92.072 Rev. 3 Lvl II

INSPECTION SPOTS FOR UT
BAY #1

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

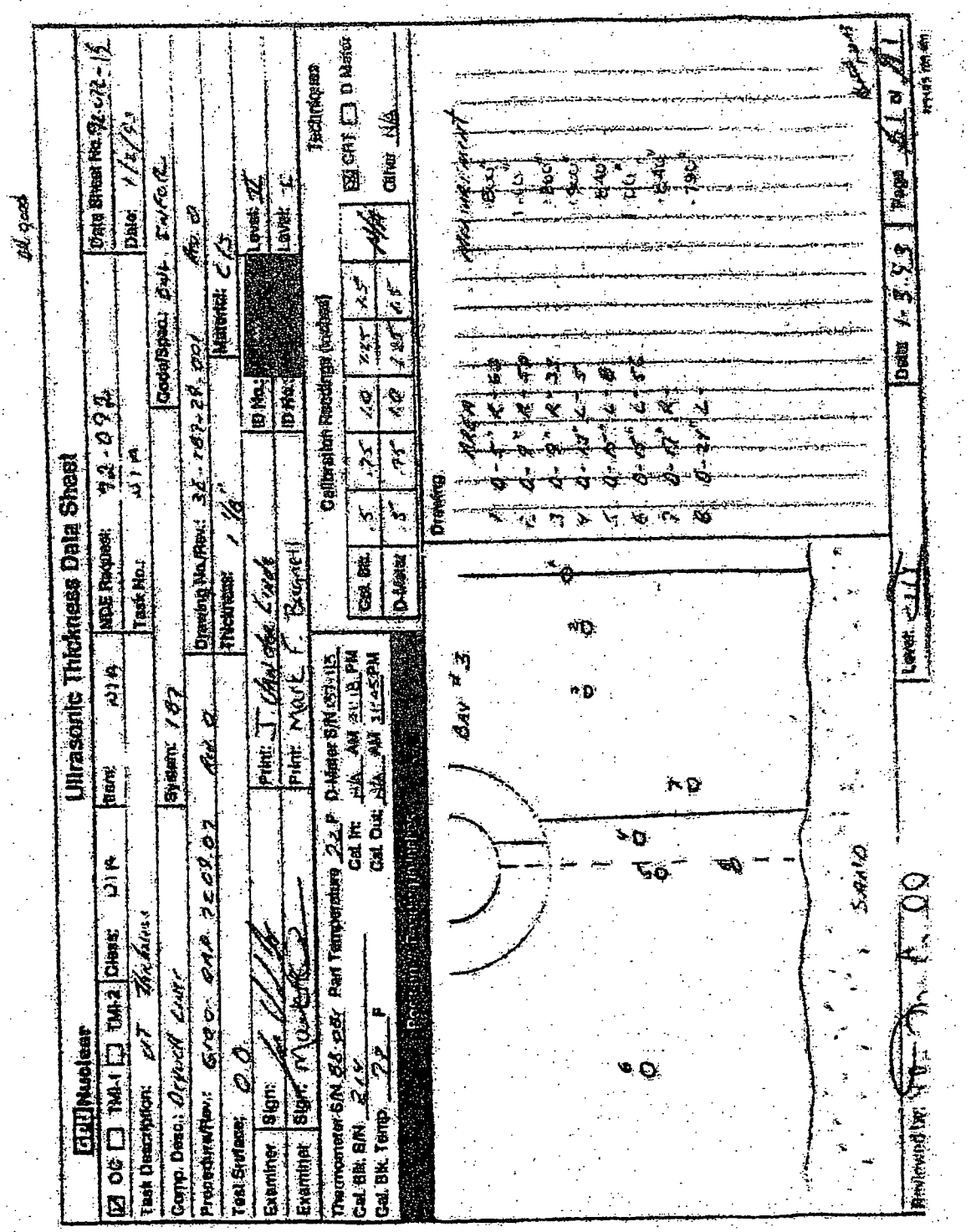
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	128 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



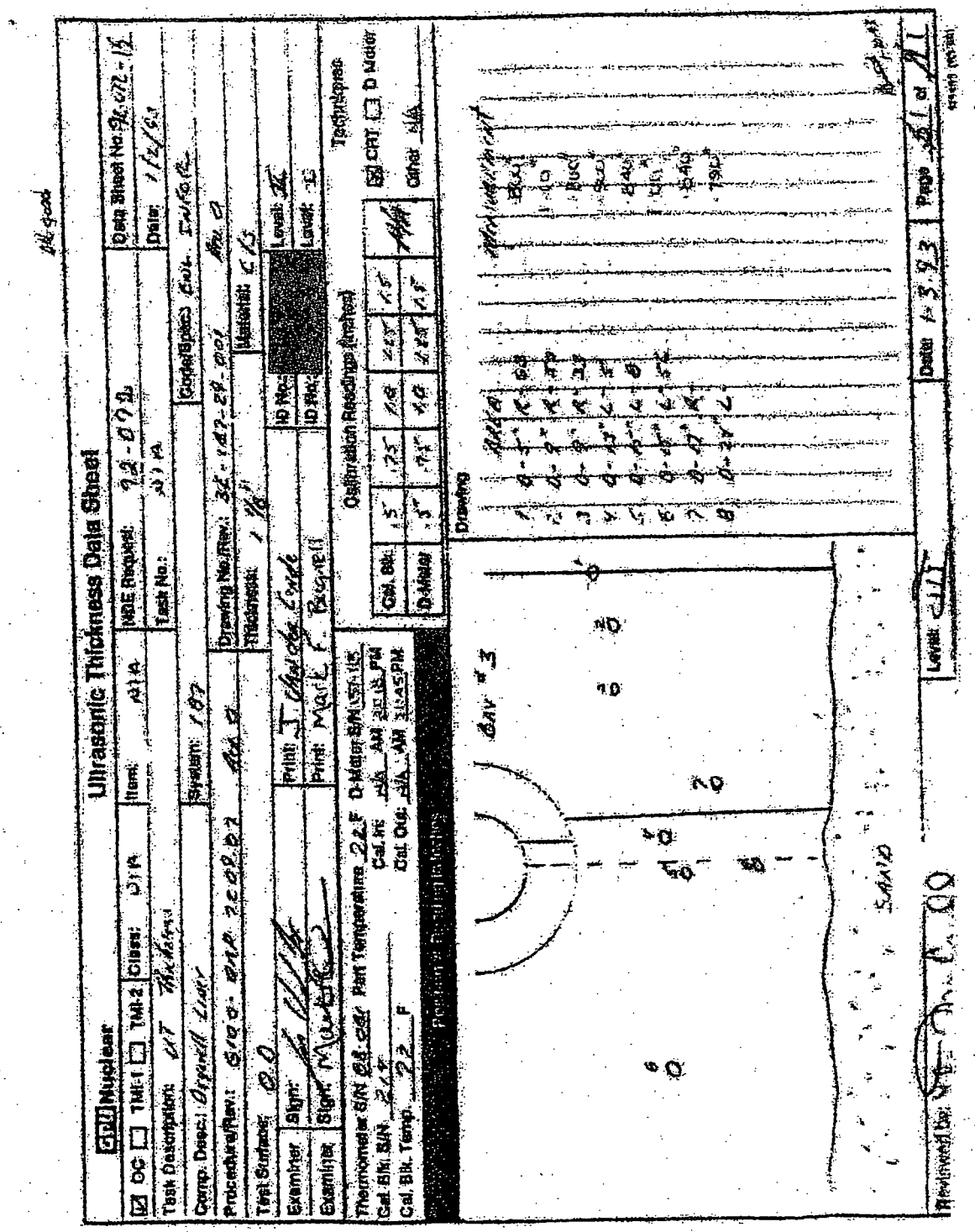
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	129 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



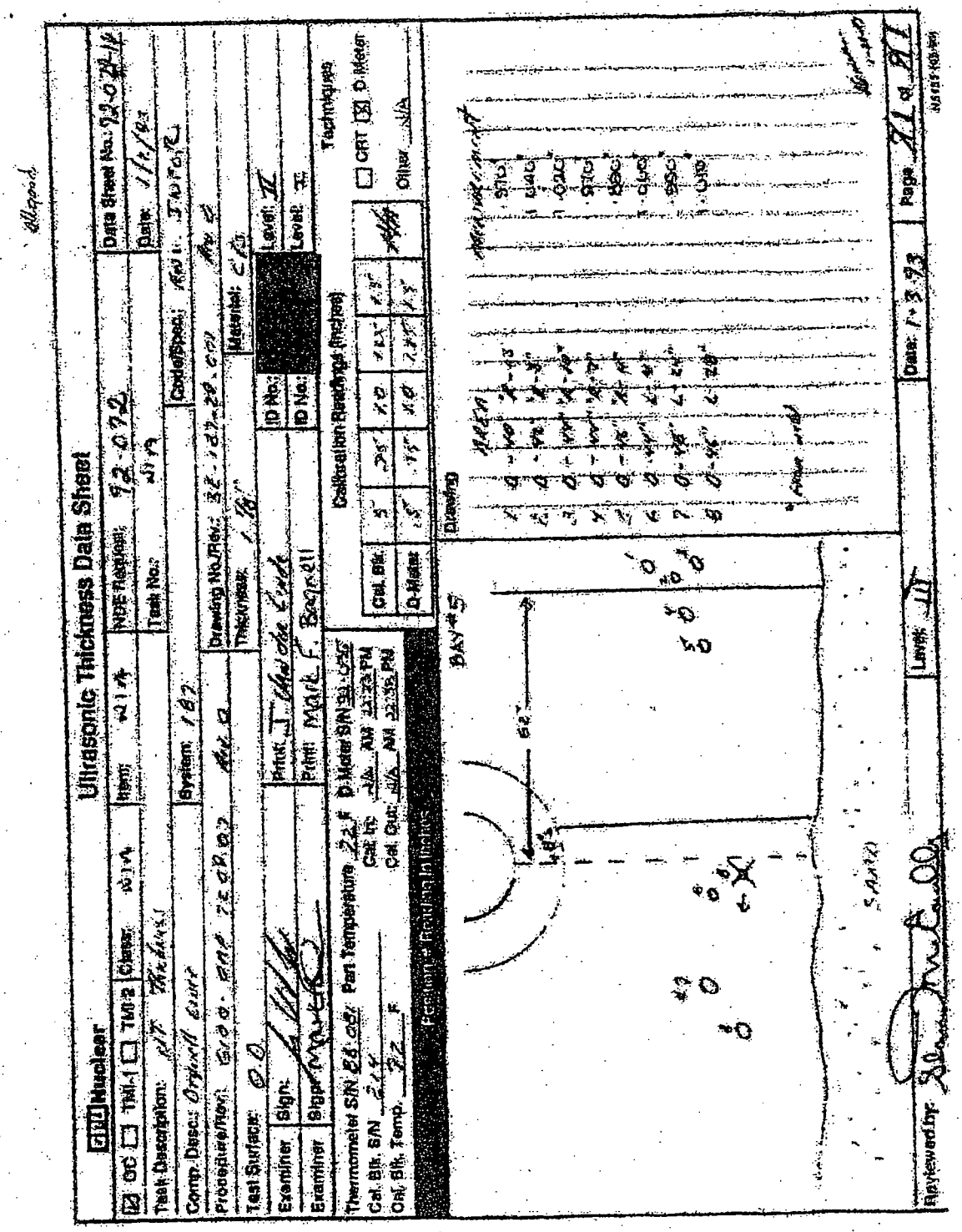
GPU Nuclear

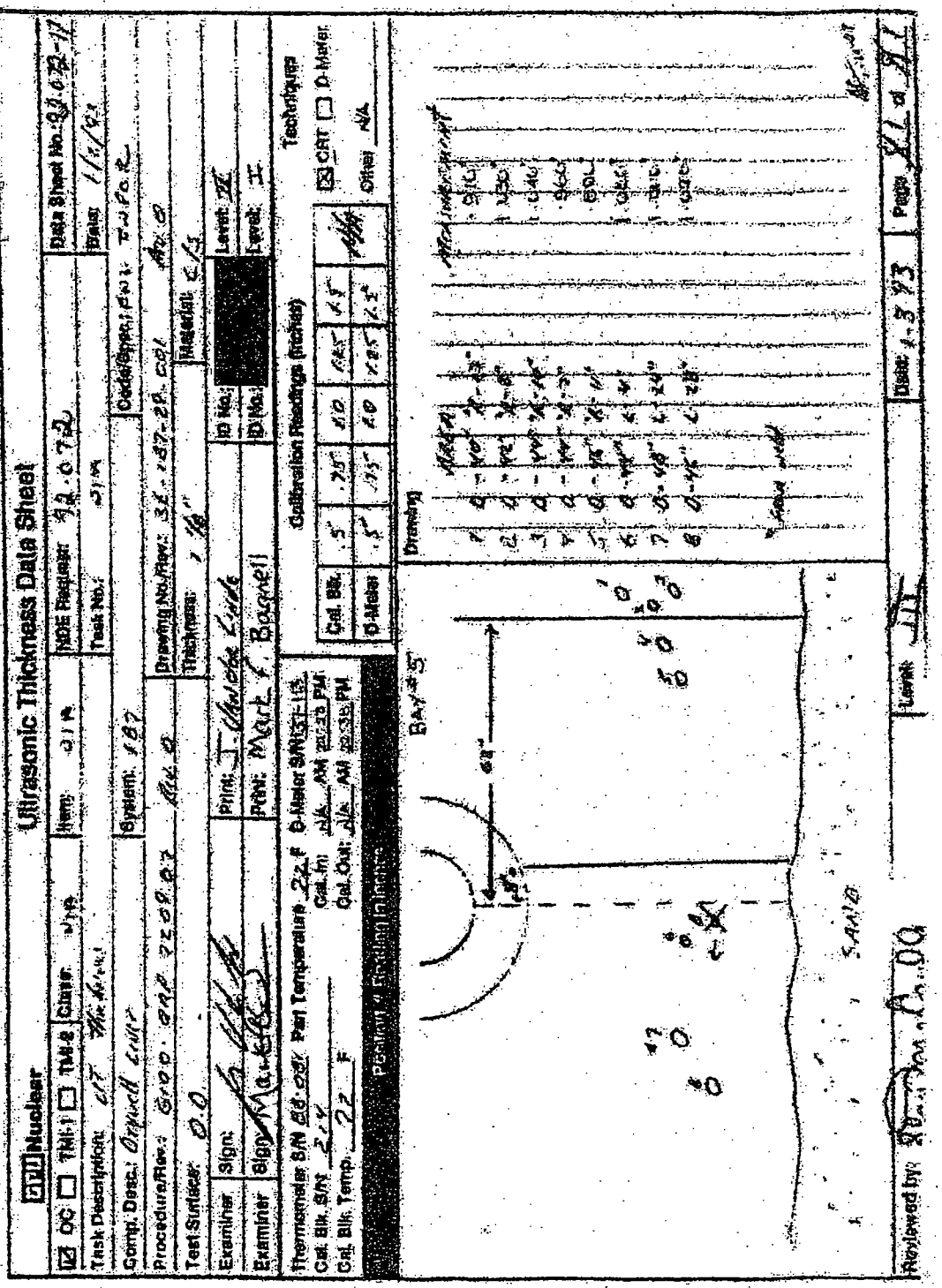
Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	130 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



GPU Nuclear

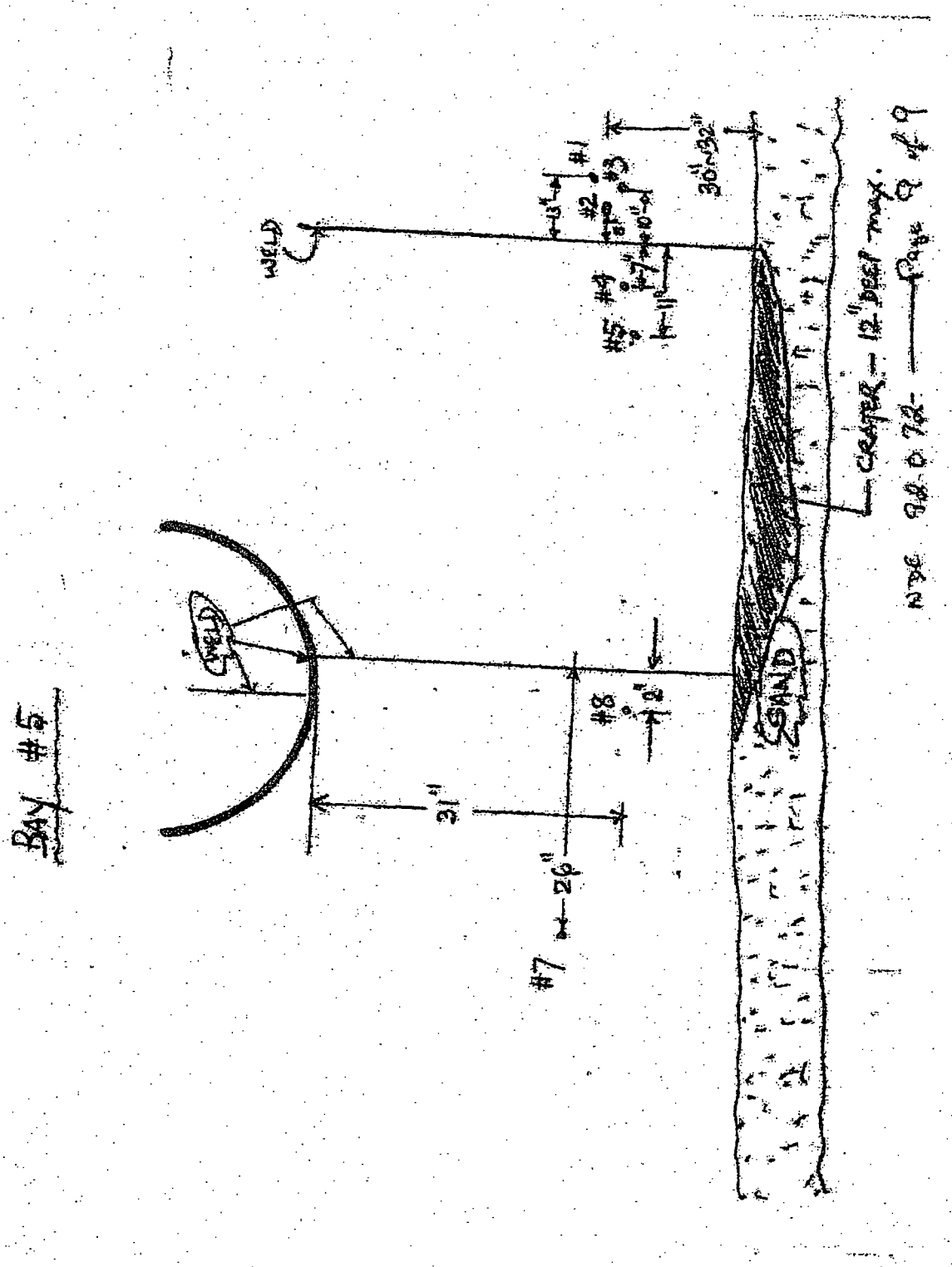
Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	131 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			




Ultrasonic Thickness Data Sheet
Nuclear
Data Sheet No. 9
Page 11 of 11
Date 4-3-93
Reviewed by
Level II
Drawing
Calibration Readings (inches)
Cal. Blk.
D-Meter
Other N/A
Test Surface: O.D.
Examiner
Examiner
Thermometer S/N
Cal. Blk. S/N
Cal. Blk. Temp.
Cal. In:
Cal. Out:
Part Temperature
D-Meter S/N
Position / Finding Criteria
Bay #5
SAND

GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	133 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



GPU Nuclear

Calibration Sheet

I-ISI (ITM) Cal Sheet# 92-103

System 187	Component Drywell Liner	Procedure 6100-QAP-7209.07	Rev 0

Examiner:	Signature: [signature]	Print: J. Vanicke Cuide	Initial: [initials]	ID# [redacted]	Level II
Examiner:	Signature: Mark [signature]	Print: Mark F. Bagnell	Initial: MB	ID# [redacted]	Level I

Instrument Settings
ID# 187-113
Model/Manuf Sonic 137 Staveley

Gain
Coarse 65
Fine n/a
Uncal n/a

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

Operation
(T&R) Normal
Frequency: 2.25 MHZ
Reject: ☒Off ☐On %
Filter: ☐Off ☒On 1 %
Damping: ☐Off ☒On 100 %

Rep Rate: 5000 Hz

Cal Standard
ID# 214
Size n/a Sch. n/a
Thickness .5 & .65
S/S (CS)
Temp 72 °F

Search Unit
ID# 8108524
Type MSEB
Freq 2 MHZ
Size .25"
Angle 0 Mode Long

Search Unit Cable
Type RG 58 Coax Length 2x6'

Couplant
Manu Sonotrace Batch# 35P-89-1-0C

Thermometer
S/N: 88-001 Cal Due 1-9-93

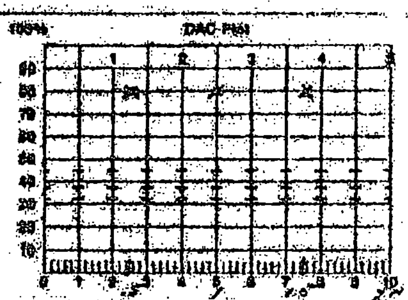
System Check
☐Exit Point n/a
☐Angle +/- 2

Cal Direction
☐Axial ☐Both
☐Circ ☒Normal

Date 1-2-93 Time 19:00

Reflector	Amplitude % of FSH	Screen Reading In Inches
.5	80	.5
.65	80	.65

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
.65	80	.65	80	.65	80	.65
Initials	[initials]		[initials]		[initials]	

Remarks:
Drywell liner thickness measurements
Digital utilized

Components Examined:
Bays # 1, 3 & 5

ANII Review

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

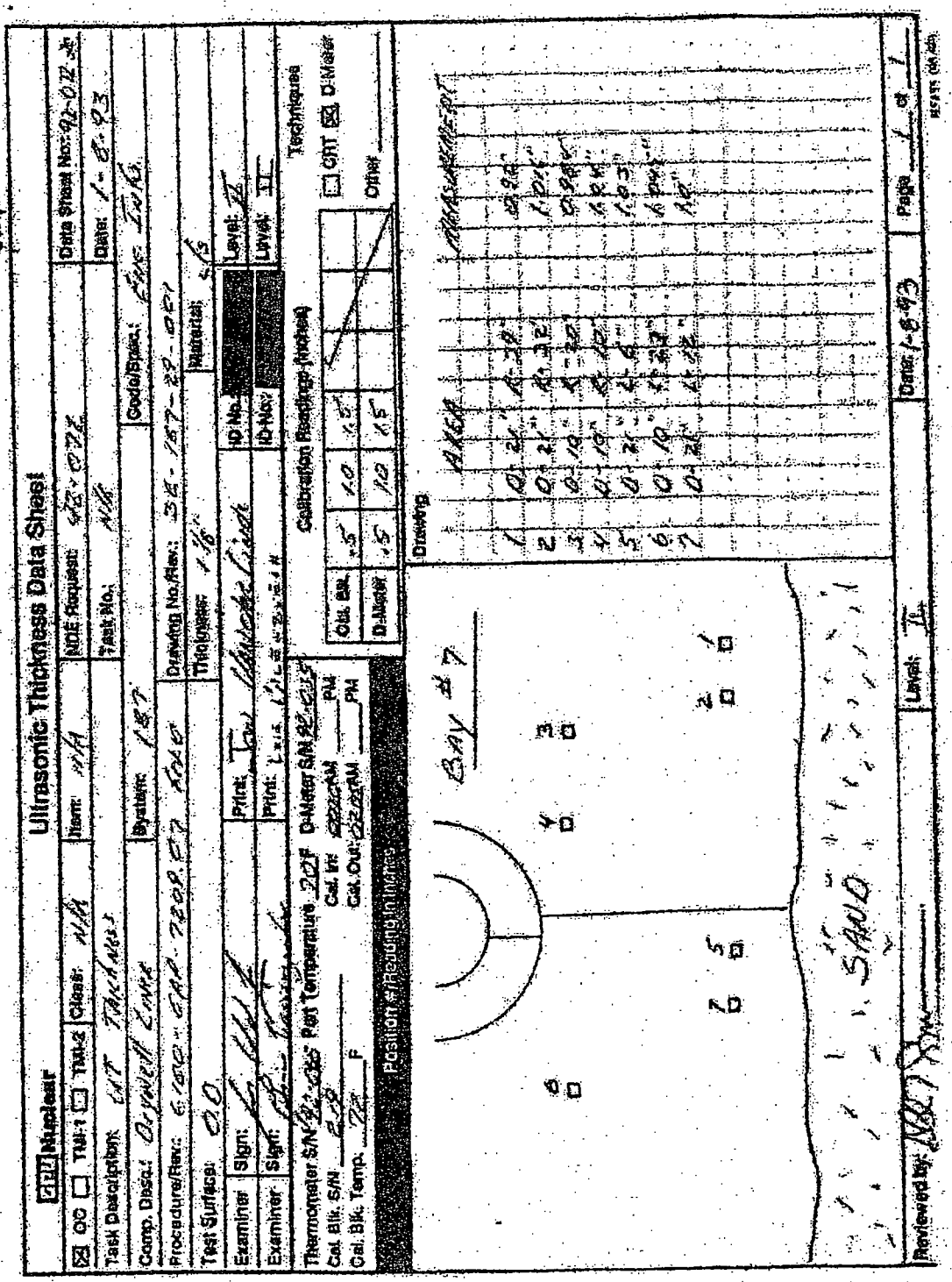
NDE Request# 92-072

#0327 (08-90)

GPU Nuclear

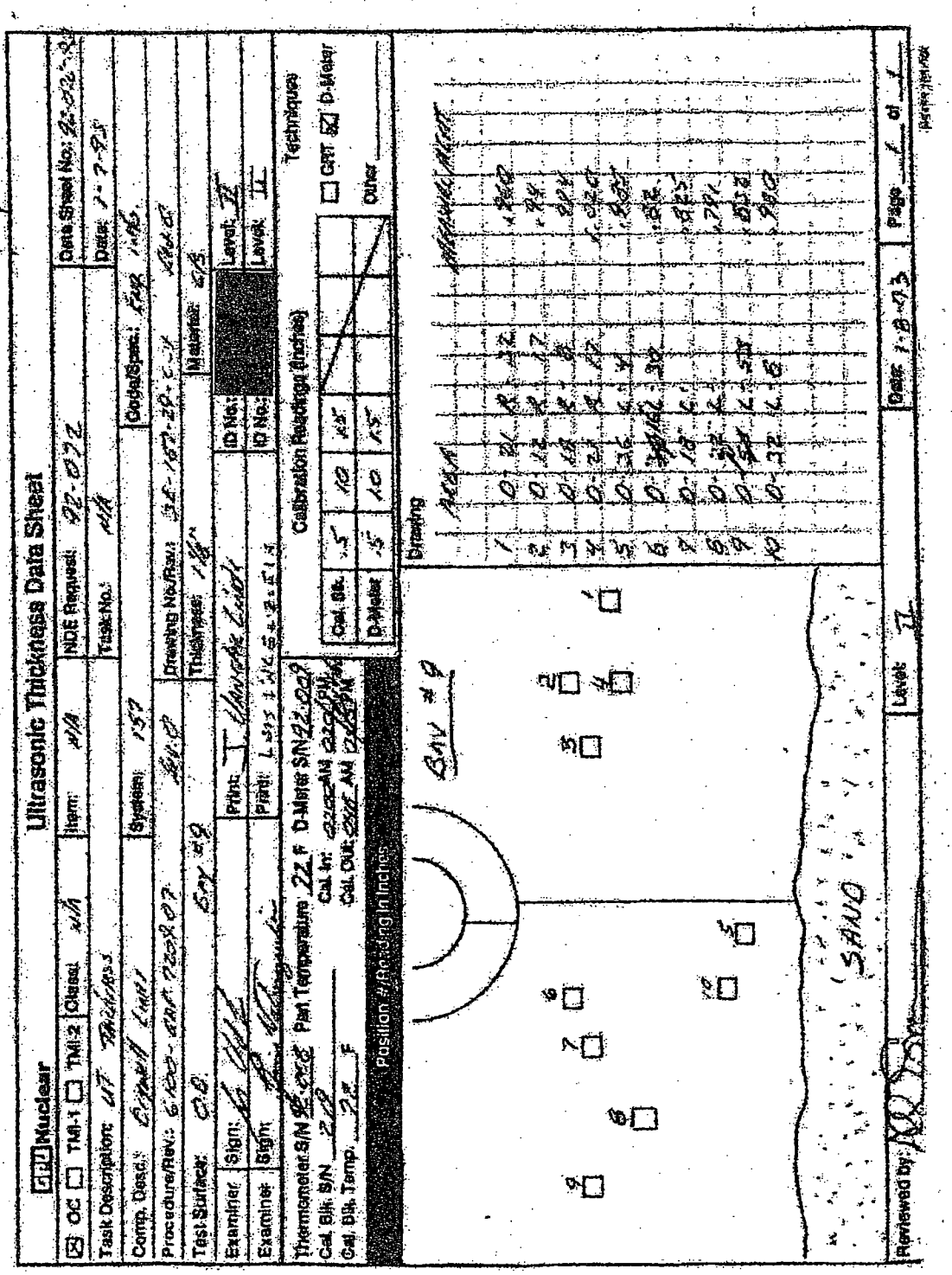
Subject O.C. Drywell Ext. UT Evaluation in Sandbed	Calc No. C-1302-187-5320-024	Rev. No. 3	Sheet No. 134 of 183
Originator Pete Tamburo	Date 3/21/07	Reviewed by	Date

OCLR00030809


Ultrasonic Thickness Data Sheet
Nuclear
QC
TMI-1
TMI-2
Class:
Item:
NDE Request:
Data Sheet No: 02-02
Task Description:
Task No:
Date:
Comp. Desc.:
System:
Code/Spec.:
Procedure/Rev.:
Drawing No./Rev.:
Thickness:
Material:
Level:
Test Surface:
Examiner
Sign:
Print:
ID No.:
ID-Next:
Calibration Readings (Nominal)
Obs. Bk.
D.Master
Drawing
Thermometer S/N
Part Temperature
Cal. Blk. S/N
Cal. Blk. Temp:
Cal. In:
Cal. Out:
Position # (Reading in Inches)
Bay #7
Technique
Other
Reviewed by:
Date:
Page

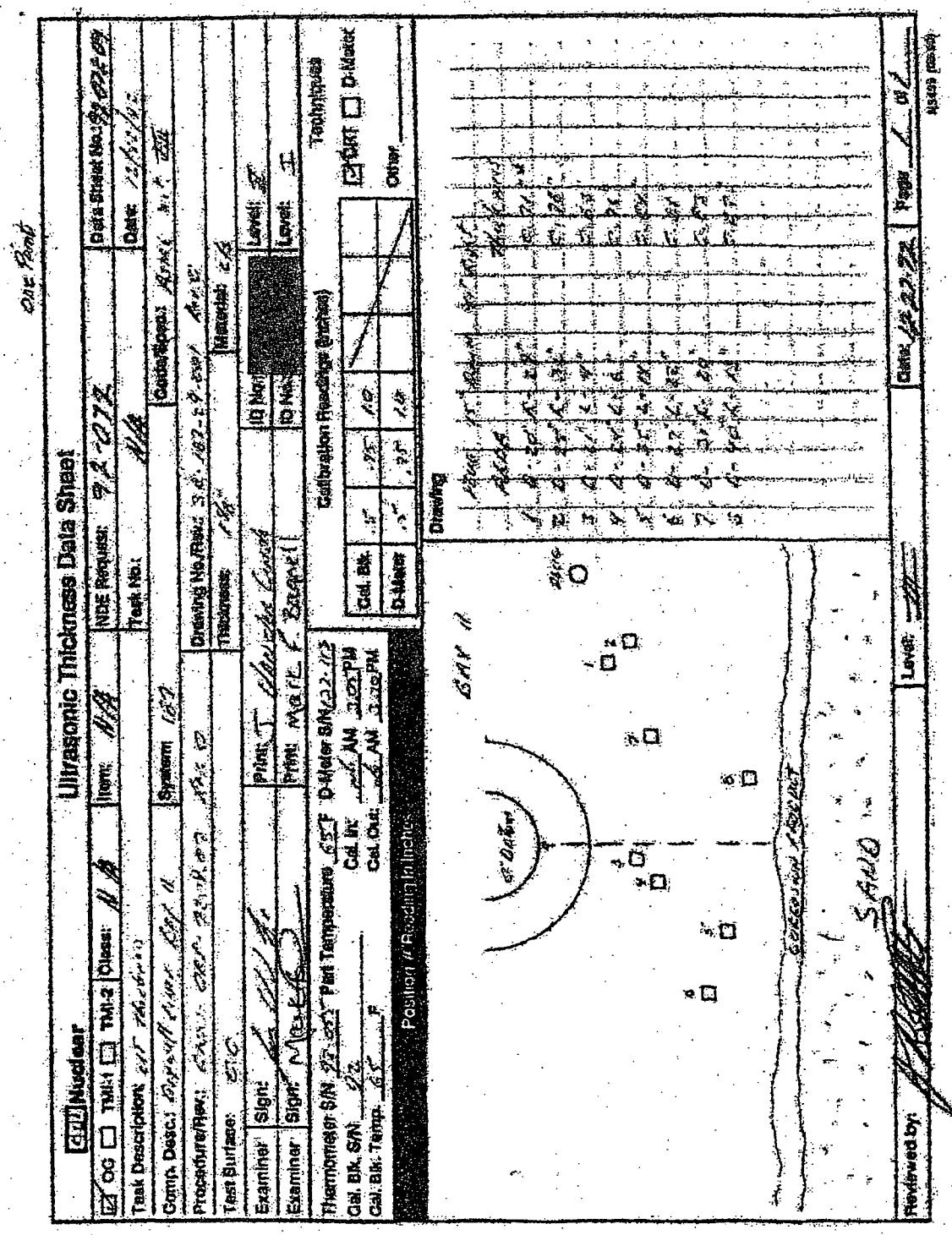
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	136 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	137 of 183
Originator	Date	Reviewed by		Date
Pete Tamburro	3/21/07			



GPU Nuclear

Subject	Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed	C-1302-187-5320-024	3	138 of 183
Originator	**Reviewed by**		**Date**
Pete Tambaro			
Date			
3/21/07			

ON PAINT

GPU Nuclear — **Ultrasonic Thickness Data Sheet**

☑ QC ☐ TM-1 ☐ TM-2 Class: NA Item: AA NDE Request: 92022 Data Sheet No: 92-022-0

Task Description: CRT Thickness Task No.: AA Date: 12/20/92

Comp. Desc.: Drywell Liner Bay 11 System: 187 Code/Spec.: ASME Sec III

Procedure/Rev.: GPUC-CRT-92-007 Rev Drawing No./Rev.: 3E-187-29-001 REV

Test Surface: O.D. Thickness: .18" Material: CS

Examiner Sign: [signature] Print: Timothy A Whitehead ID No.: [redacted] Level: II

Examiner Sign: [signature] Print: Mark F Bagnell ID No.: [redacted] Level: II

Thermometer S/N 92-025 Part Temperature 65 F D-Meter S/N 92-023

Cal. Blk. S/N 93 Cal. In: 11/6 AM 2:00 PM

Cal. Blk. Temp. 65 F Cal. Out: 11/6 AM 3:00 PM

Calibration Readings (inches)

Cal. Blk.	.18	.250	.120			
D-Meter	.18	.250	.120			

Techniques: ☐ CRT ☑ D-Meter Other: _____

Position / Reading in Inches

Drawing

Point	Area					
1	G-			G-		
2	G-			G-		
3	G-			G-		
4	G-			G-		
5	G-			G-		
6	G-			G-		
7	G-			G-		
8	G-			G-		

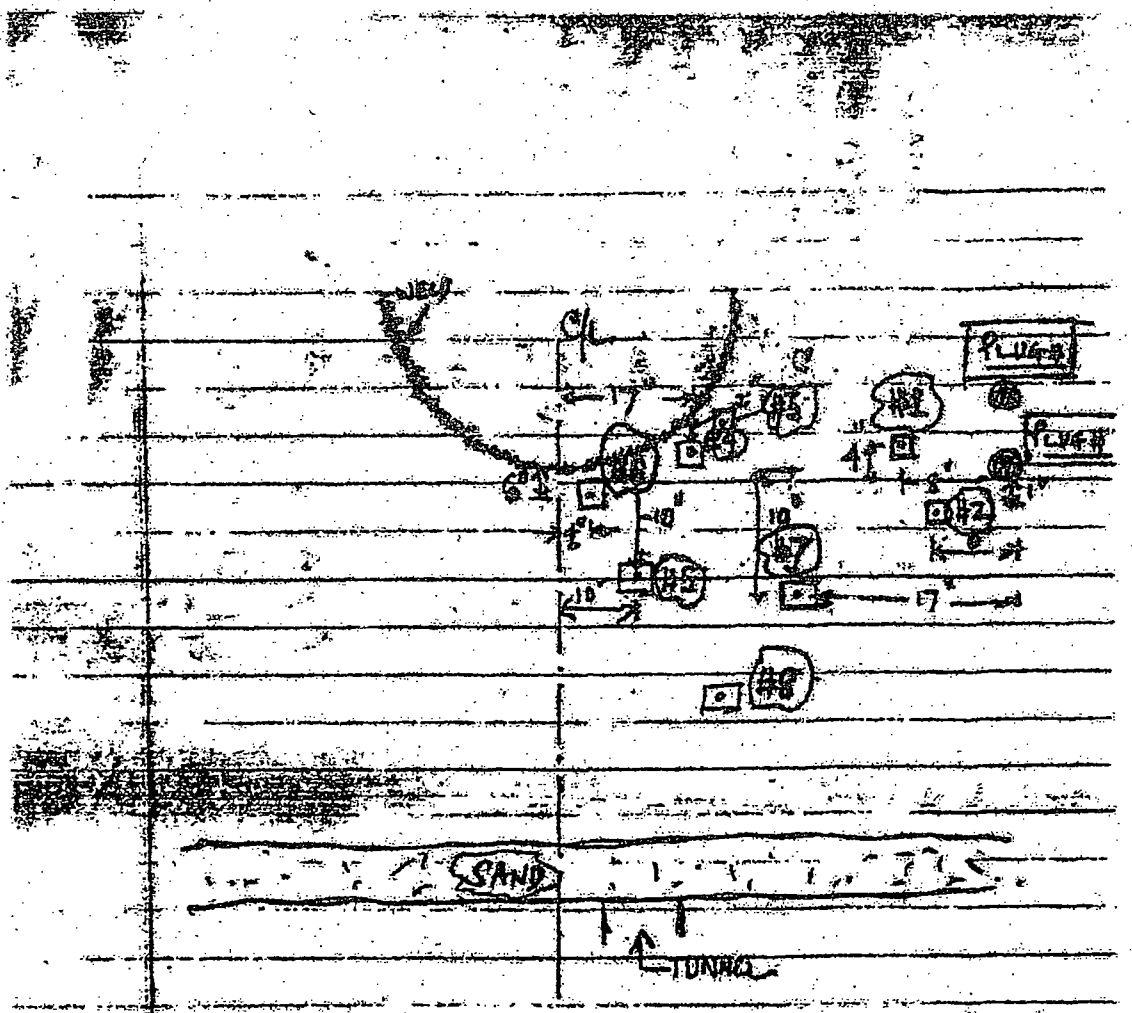
Reviewed by: [signature] Level: III Date: 12-27-92 Page 1 of 1

(Attach additional)

OCLR0030813

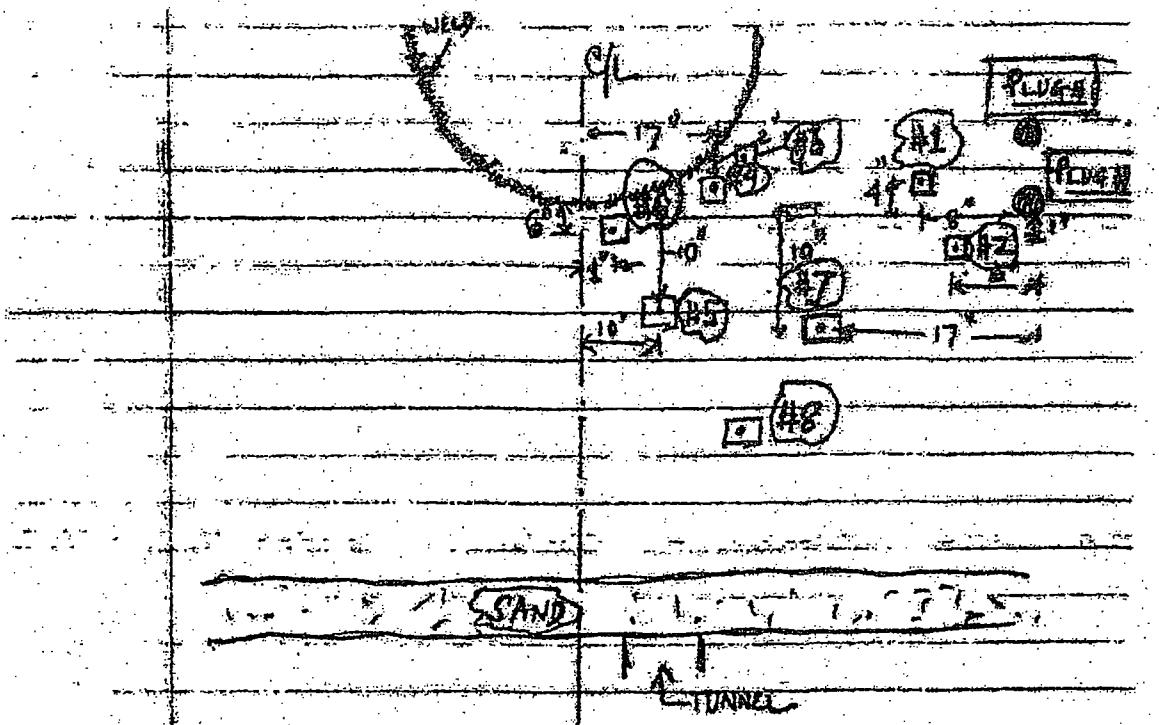
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	139 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tambarro	3/21/07			



BAY-11 — U.T. SPOTS FOR GRINDING

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

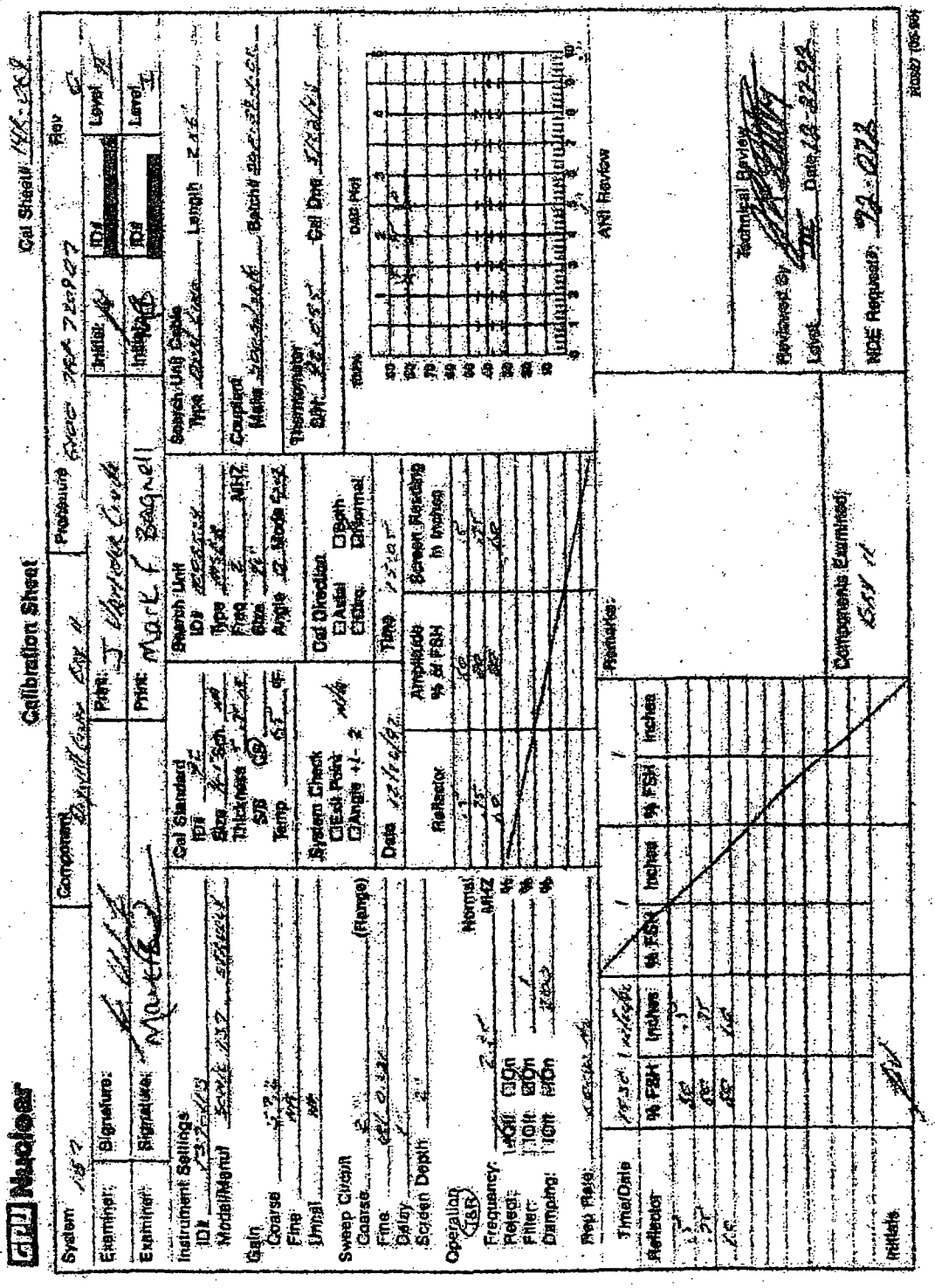


BAY-11 — U.T. SPOTS FOR GRINDING

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

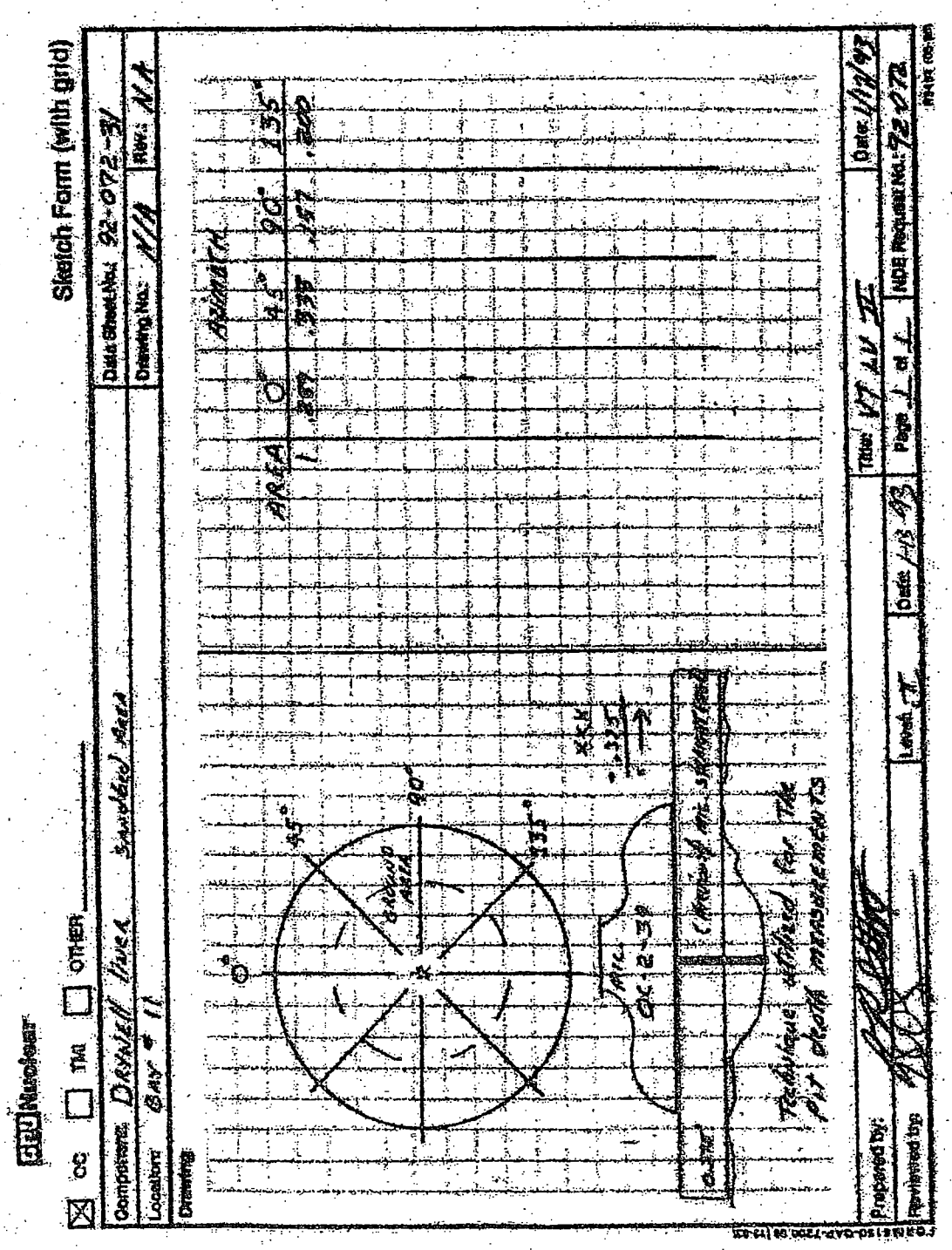
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	141 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



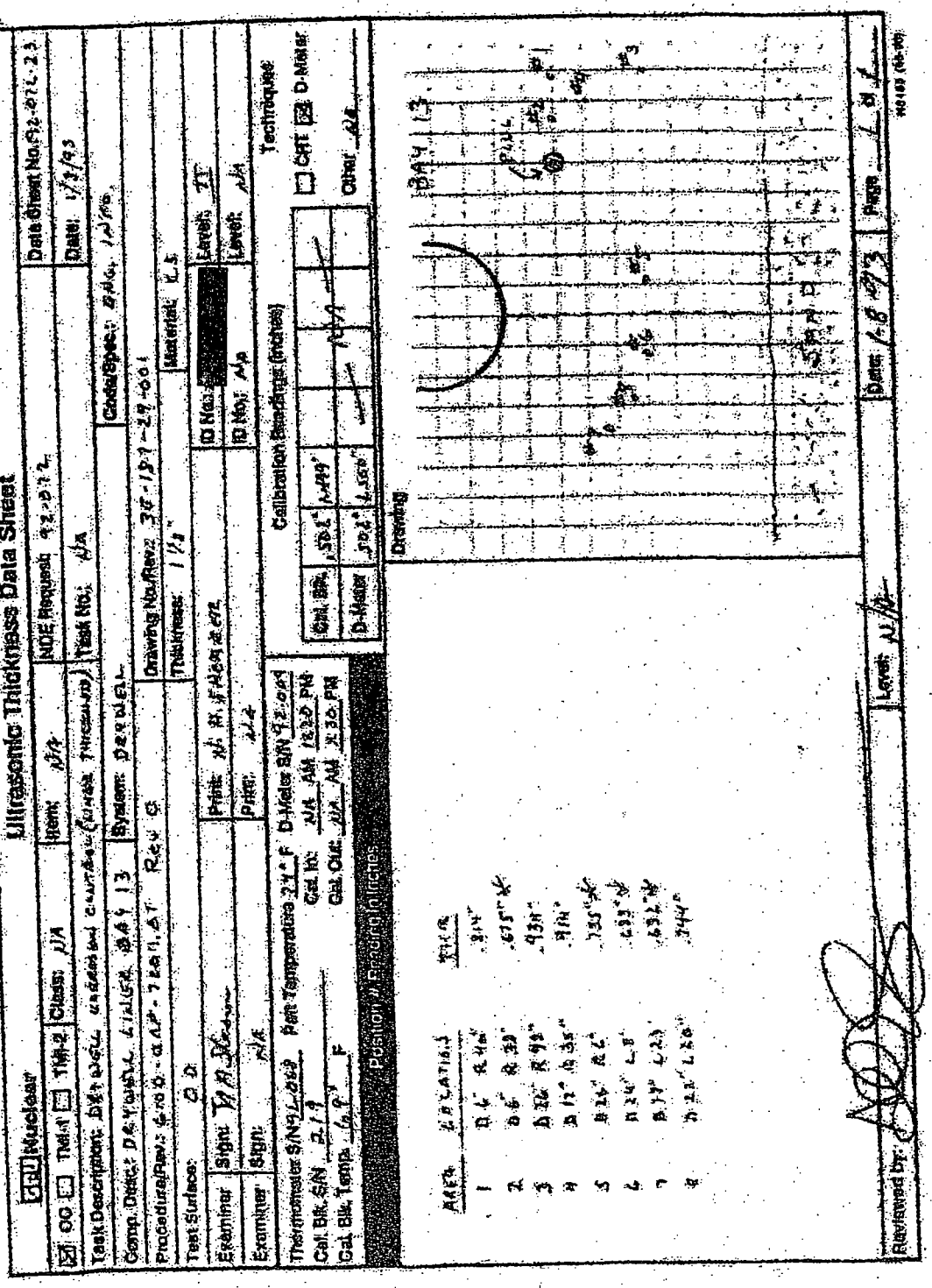
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	142 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



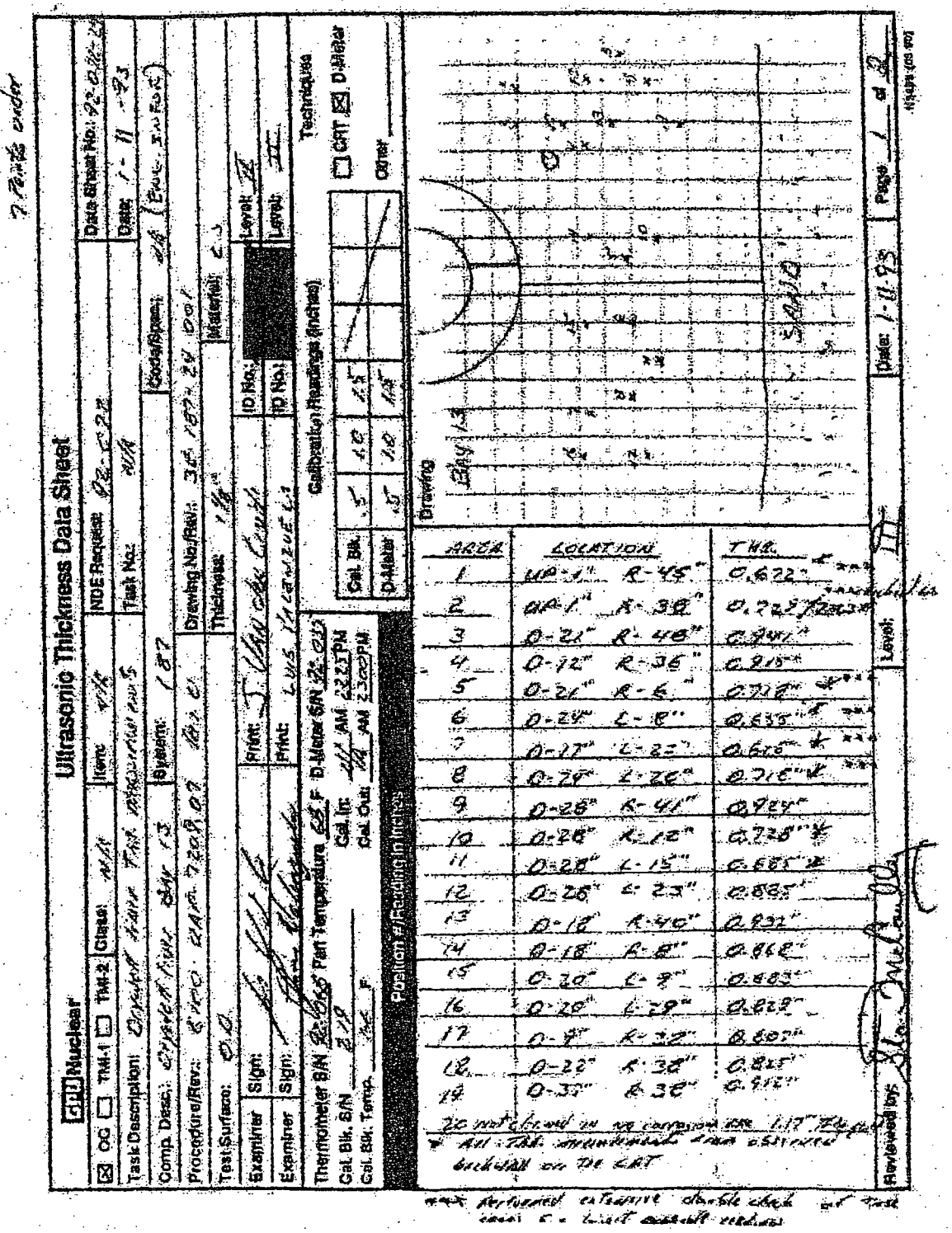
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	143 of 183
Originator	Date	Reviewed by		Date
Pete Tamburro	3/21/07			



GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	144 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



Ultrasonic Thickness Data Sheet

GPU Nuclear

OC ☐ TML-1 ☐ TML-2 Class: N/A Item: 4 Data Sheet No.: 02-C-22

Task Description: Drywell Plate Thickness Measurements Task No.: N/A Date: 1-11-93

Comp. Desc.: Drywell Plate Shell 13 Systems: 187 Code/Spec.: ASME Sec. III Subsec. NE

Procedure/Rev.: 6200-ISAP-7200.02 Rev. 2 Drawing No./Rev.: 36 Sheet 2 Rev. 004

Test Surface: O.D. Thickness: 1.12" Material: C.S.

Examiner Sign: Print: ID No.: Level:

Examiner Sign: Print: ID No.: Level:

Thermometer S/N: 22-013 Part Temperature: 62 °F D-Meter S/N: 22-013

Cal. Blk. S/N: 2.0 Cal. In: 11 AM 2221PM

Cal. Blk. Temp.: 62 °F Cal. Out: 11 AM 2300PM

Techniques: ☐ CRT ☒ D-Meter ☐ Other

Calibration Readings (inches)

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

Position # / Reading in Inches

Drawing

Bay 13

Sketch

Page 1 of 2

Date: 1-11-93

Level:

Reviewed by:

AREA	LOCATION	THK.
1	UP-1" R-45"	0.622"
2	UP-1" R-38"	0.723"
3	D-21" R-40"	0.941"
4	D-12" R-36"	0.915"
5	D-21" R-6"	0.718"
6	D-24" L-8"	0.635"
7	D-17" L-2"	0.628"
8	D-24" L-26"	0.716"
9	D-28" R-41"	0.924"
10	D-26" R-12"	0.736"
11	D-28" L-15"	0.685"
12	D-26" L-23"	0.685"
13	D-18" R-40"	0.932"
14	D-18" R-8"	0.966"
15	D-20" L-8"	0.685"
16	D-20" L-28"	0.822"
17	D-9" R-32"	0.807"
18	D-22" R-38"	0.815"
19	D-33" R-36"	0.912"

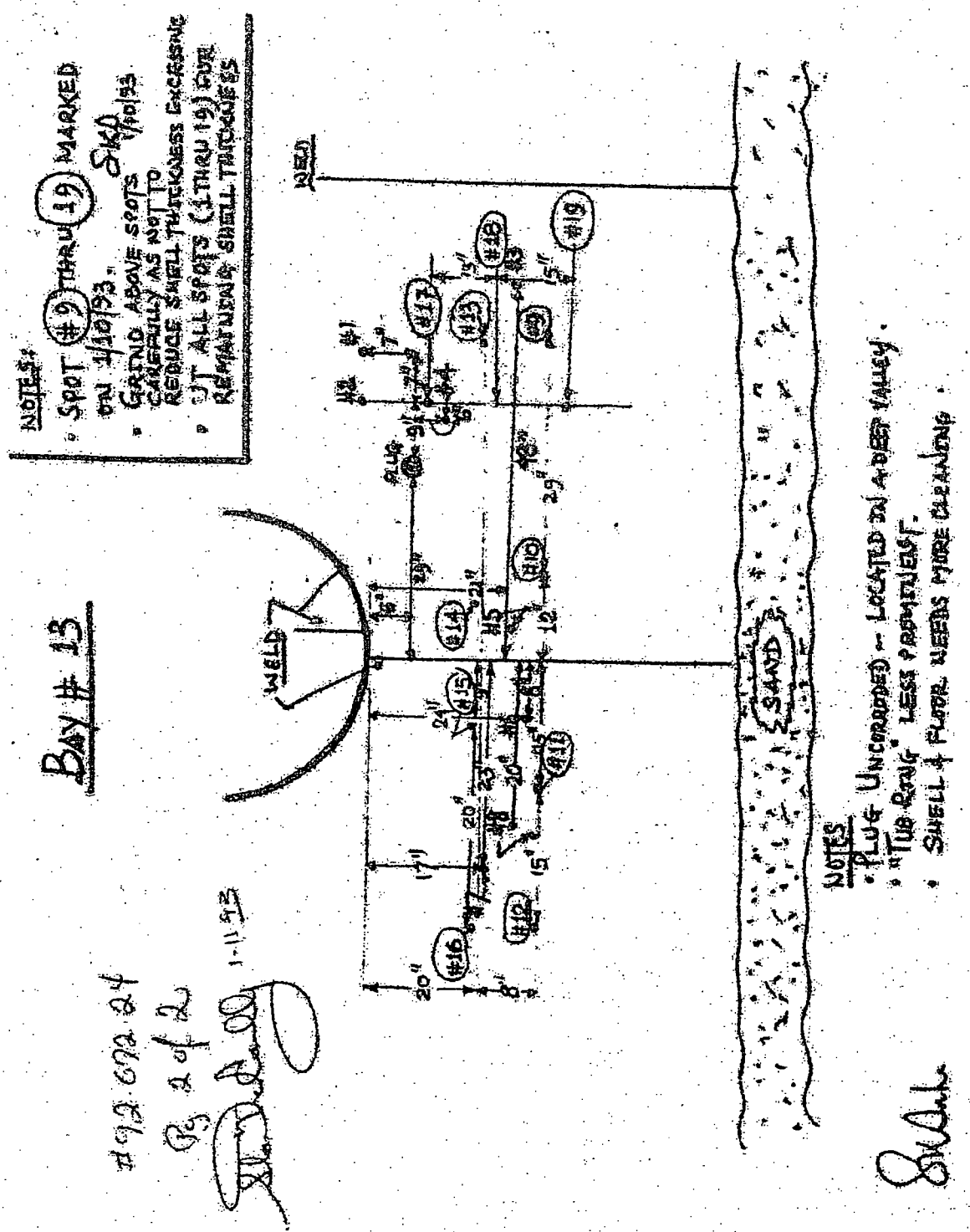
20 mil chrome in no corrosion area 1.12" Typ.

* All TML measurements taken directly backwall on the CRT

** Performed extensive double check of this area - Lost backwall readings

GPU Nuclear

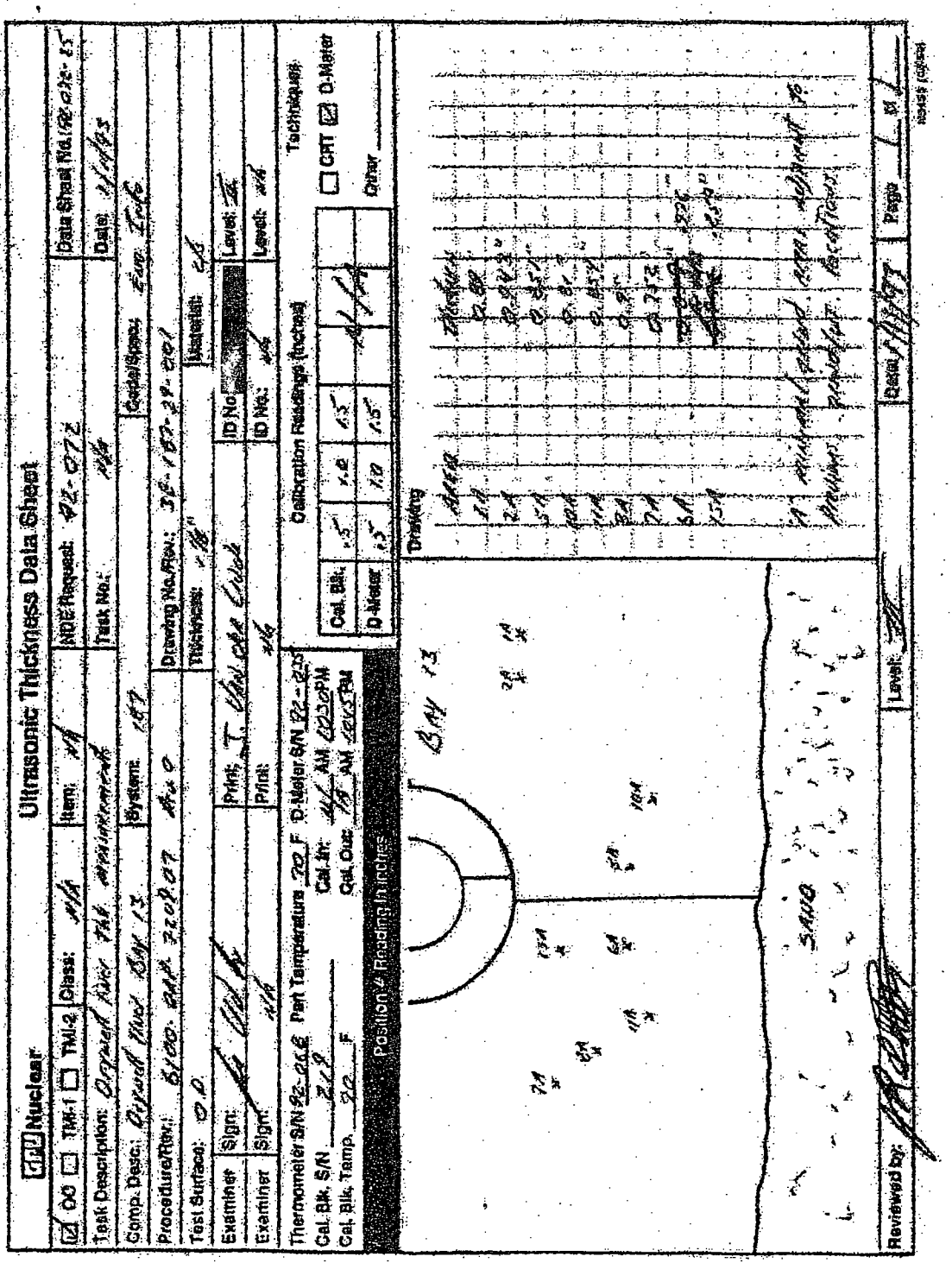
Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	145 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



#12,672.24
Pg 2 of 2

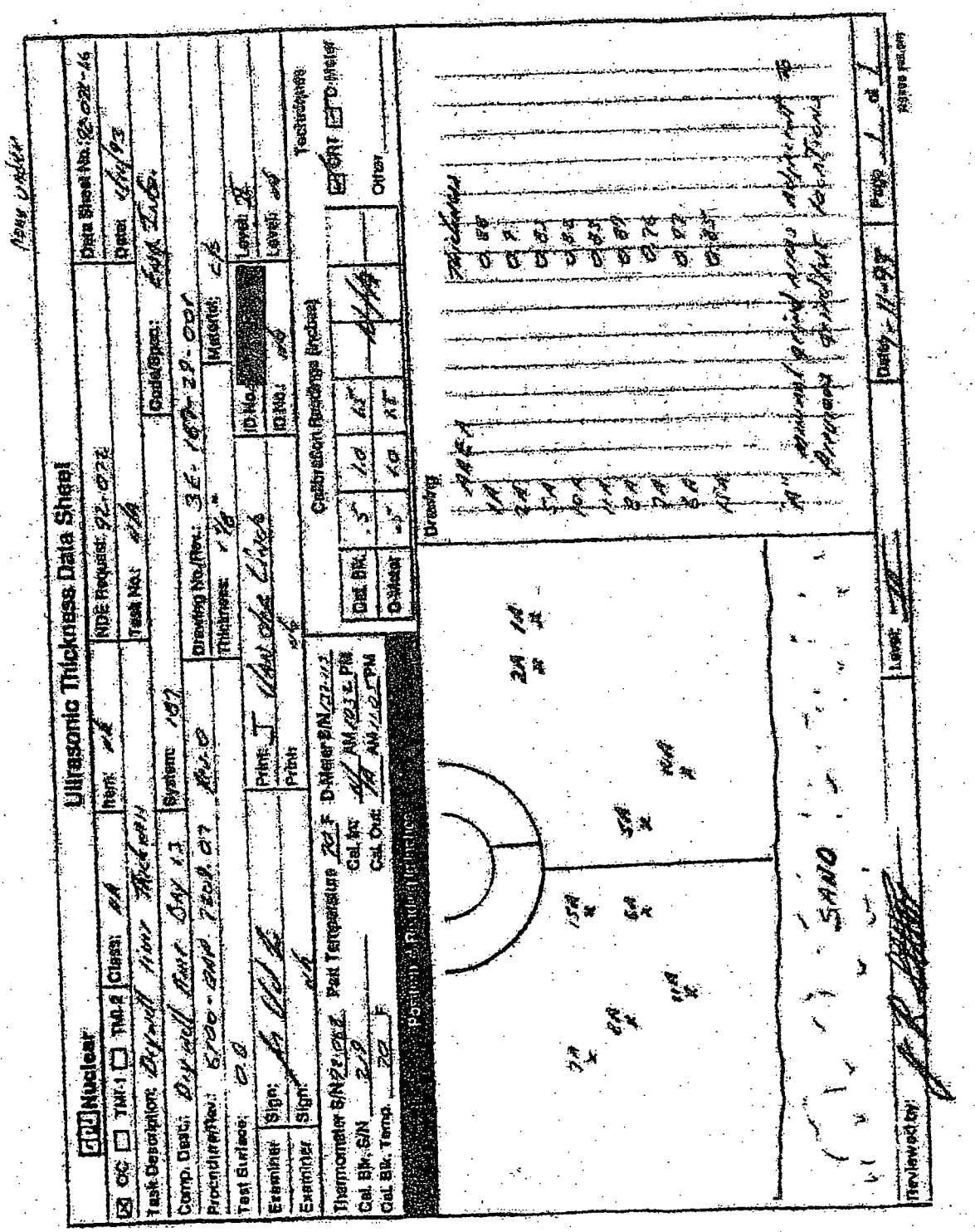
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	146 of 183
Originator	Date	Reviewed by		Date
Pete Tamburro	3/21/97			



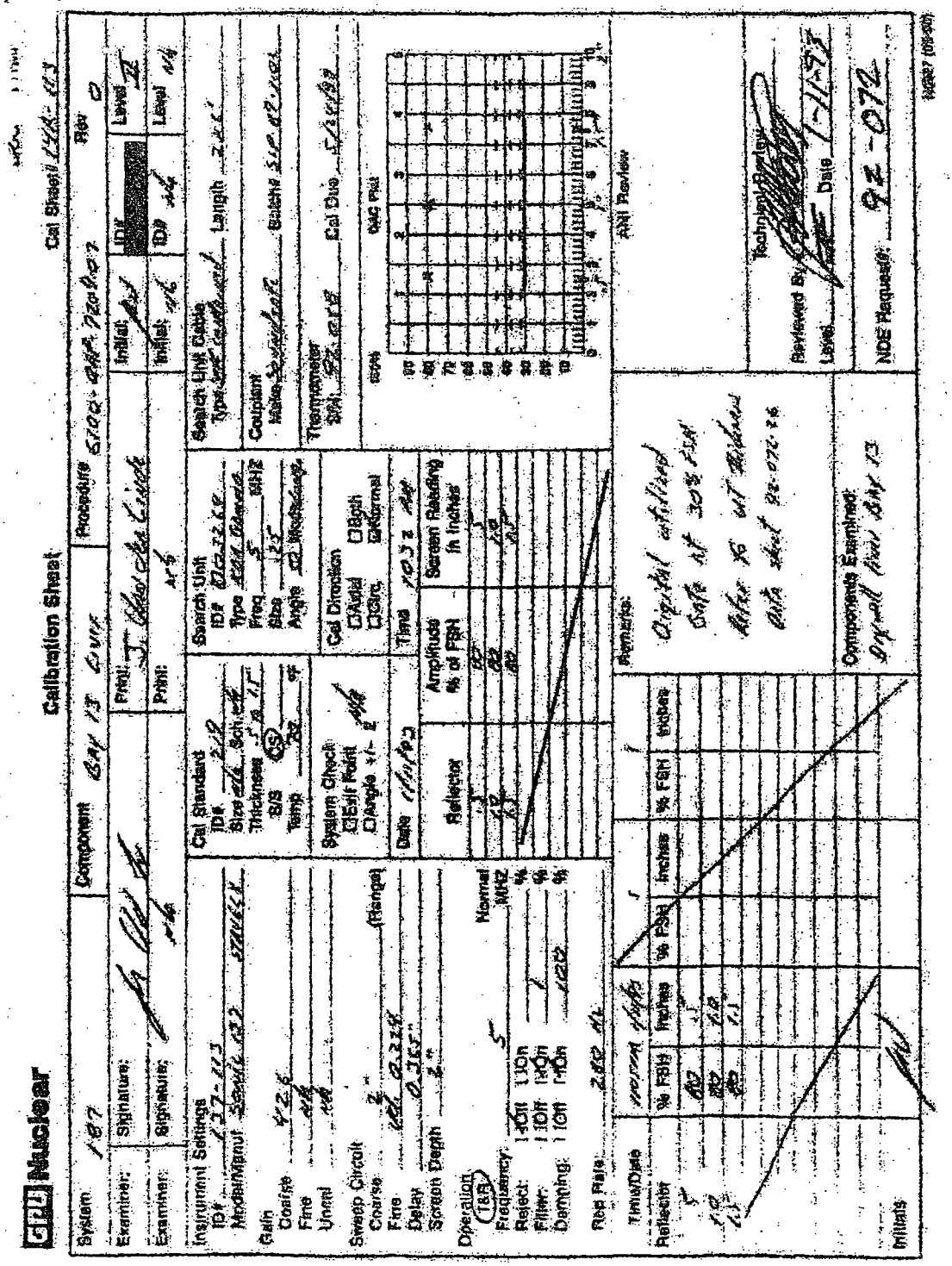
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	147 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



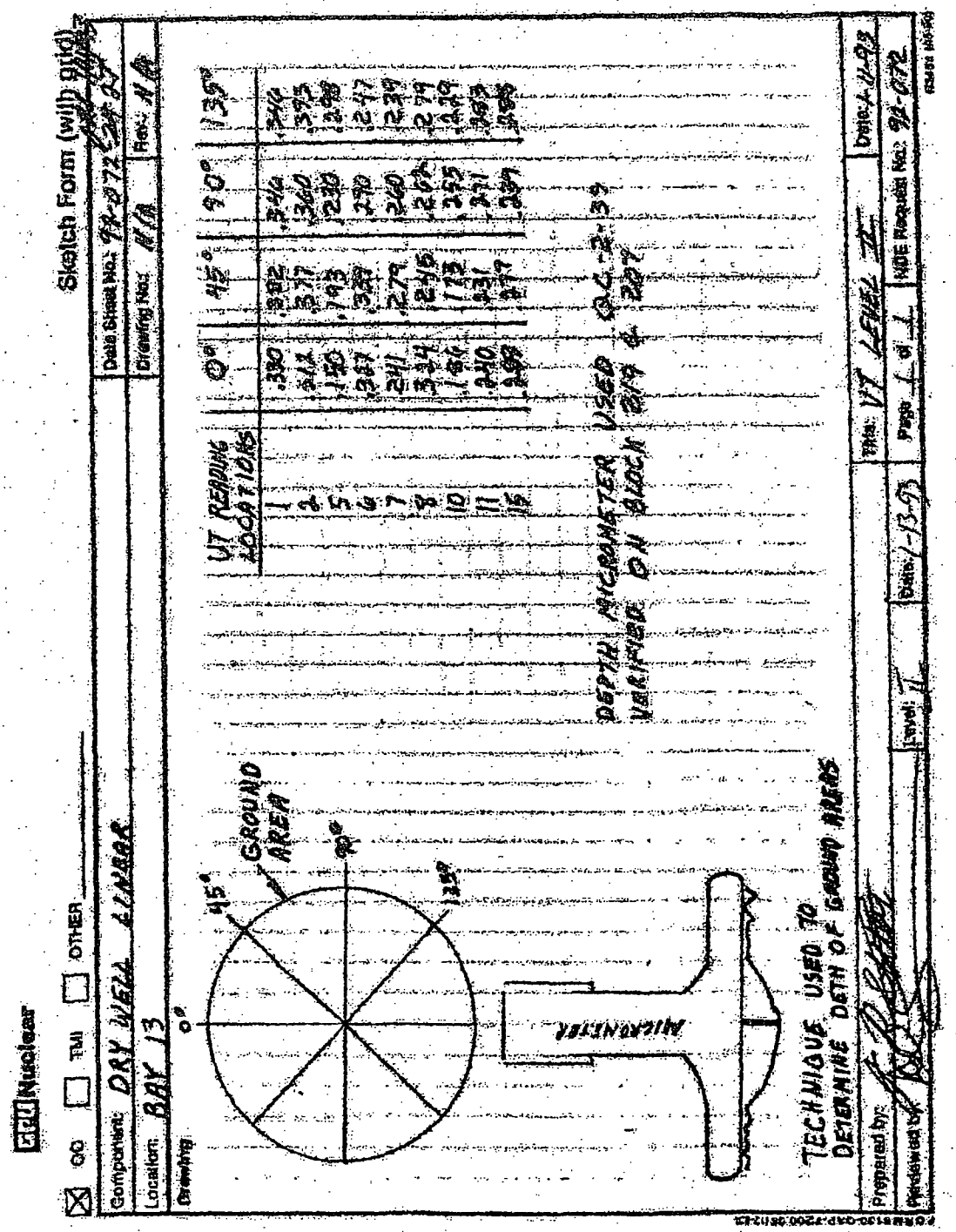
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	148 of 183
Originator	Date	Reviewed by		Date
Pete Tamburro	3/21/07			



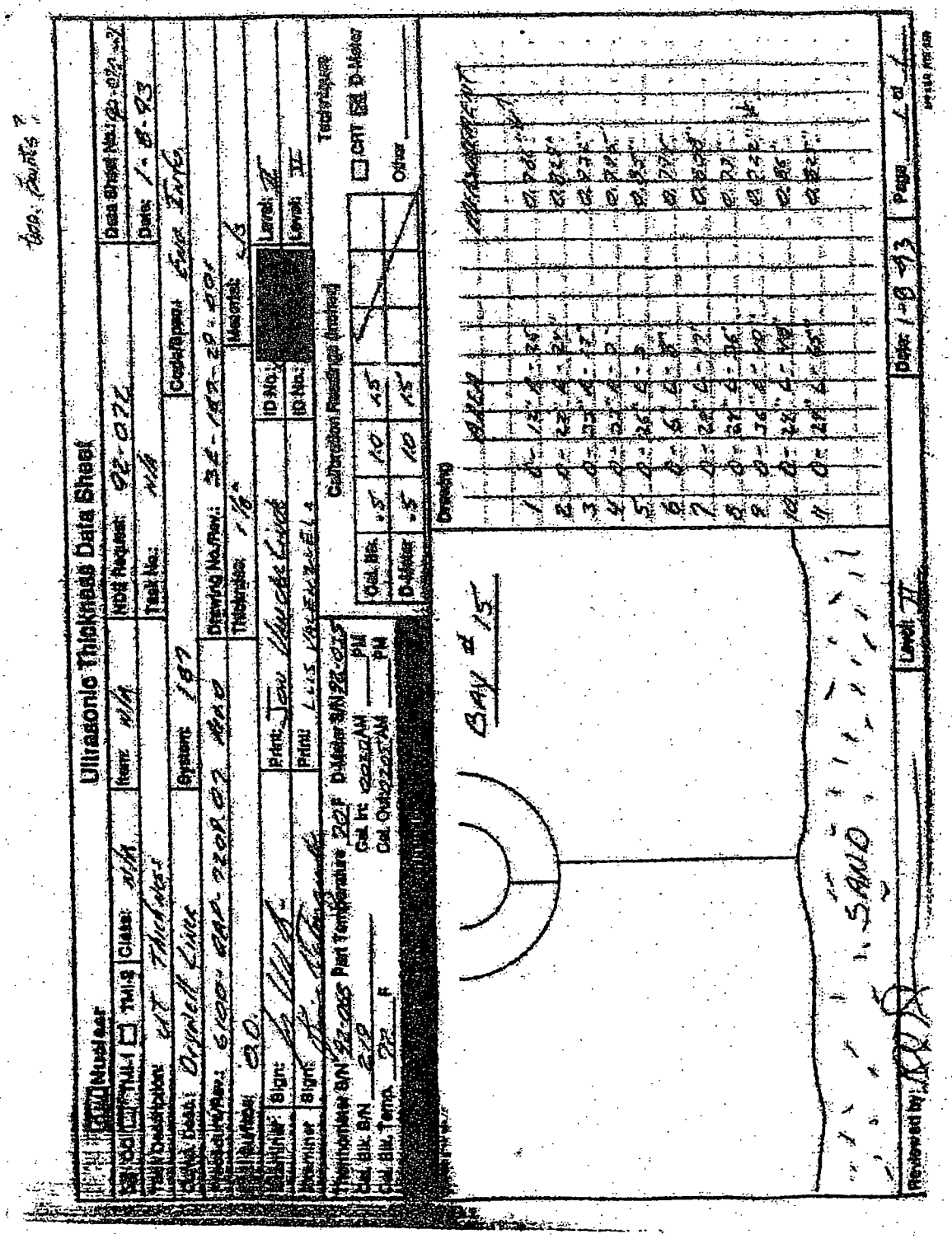
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	149 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	150 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	151 of 183
Originator	Date	Reviewed by		Date
Pete Tamburro	3/21/07			

Sketch Form (with grid)

GPU Nuclear ☒ OC ☐ TMI ☐ OTHER

Components: Drywell Liner Sandbed Area

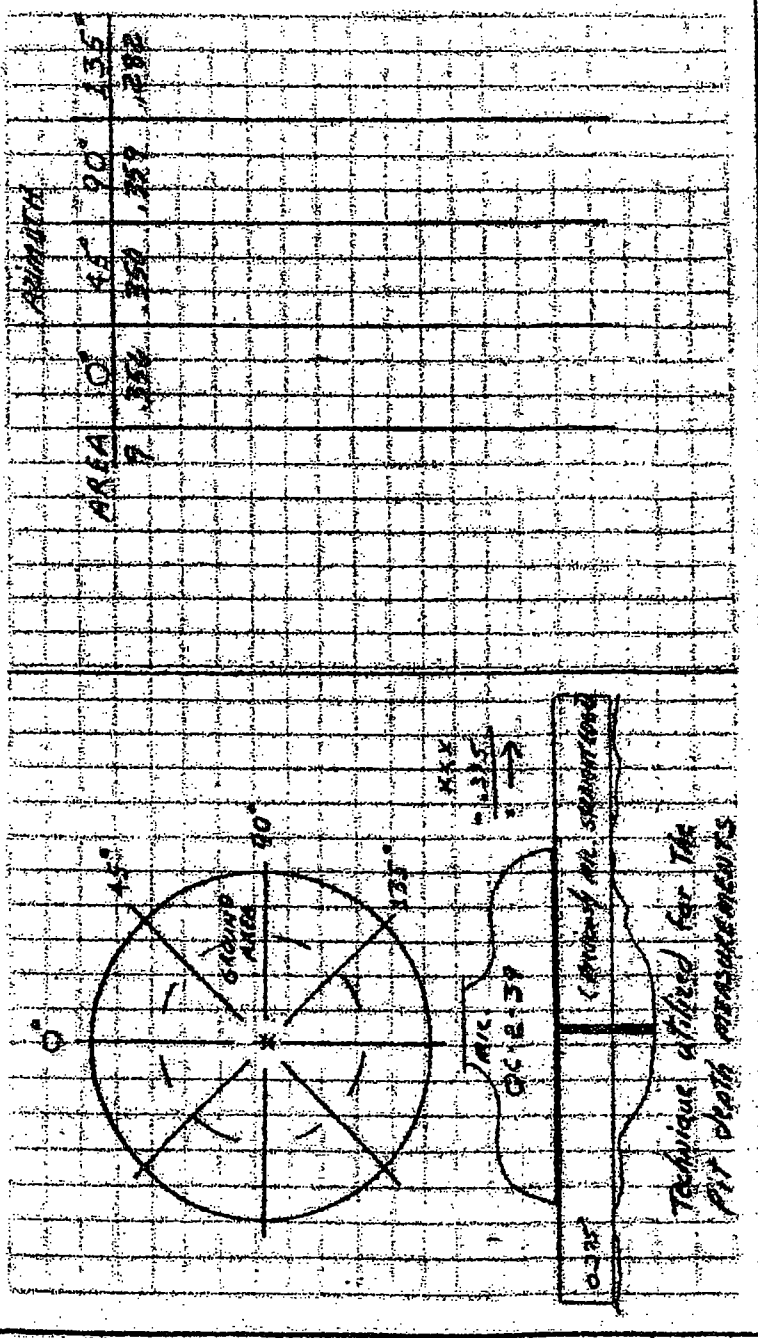
Location: Bay # 15

Drawing

Data Sheet No.: 92-072-20

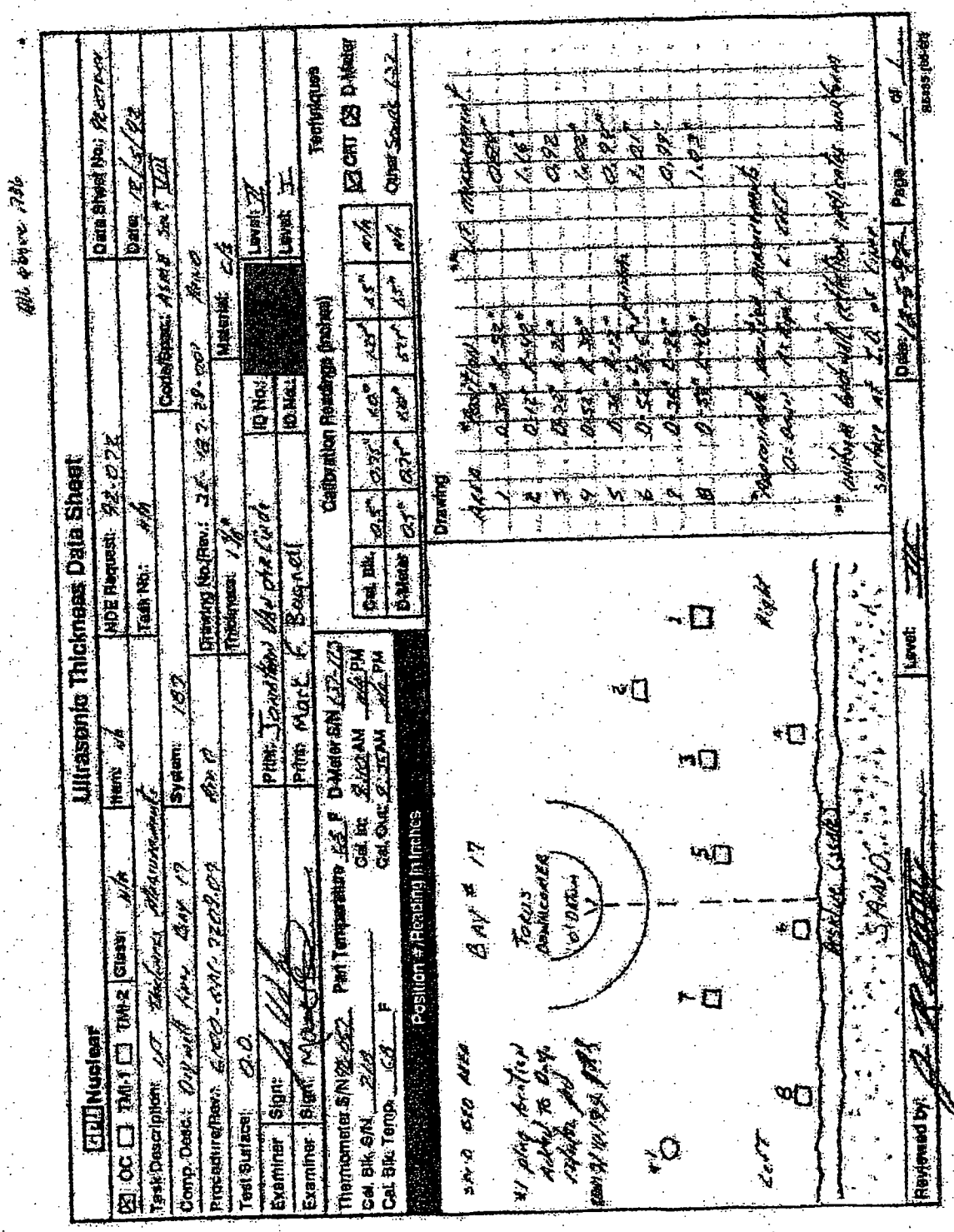
Drawing No.: N/A

Rev.: N/A



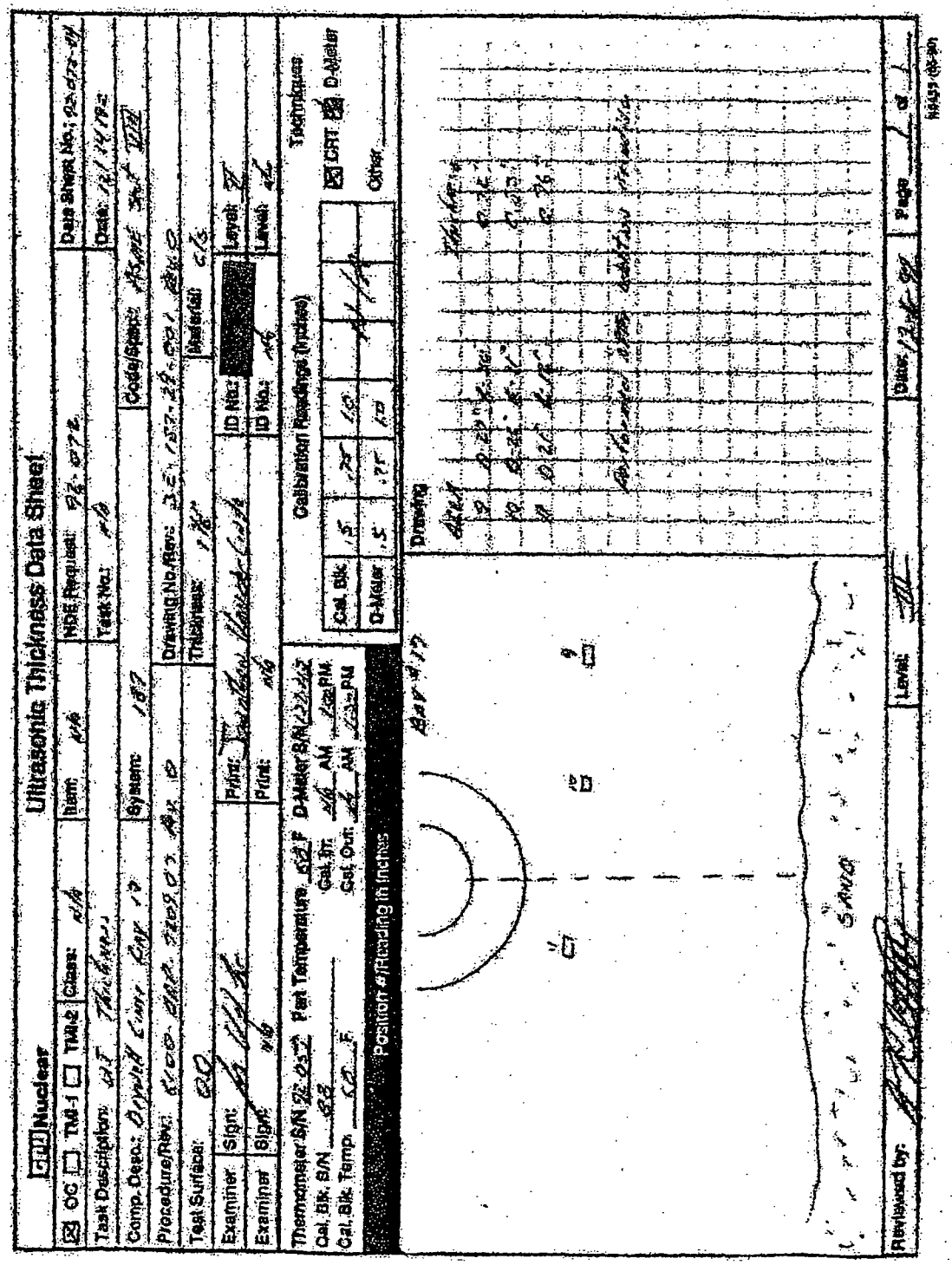
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	152 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



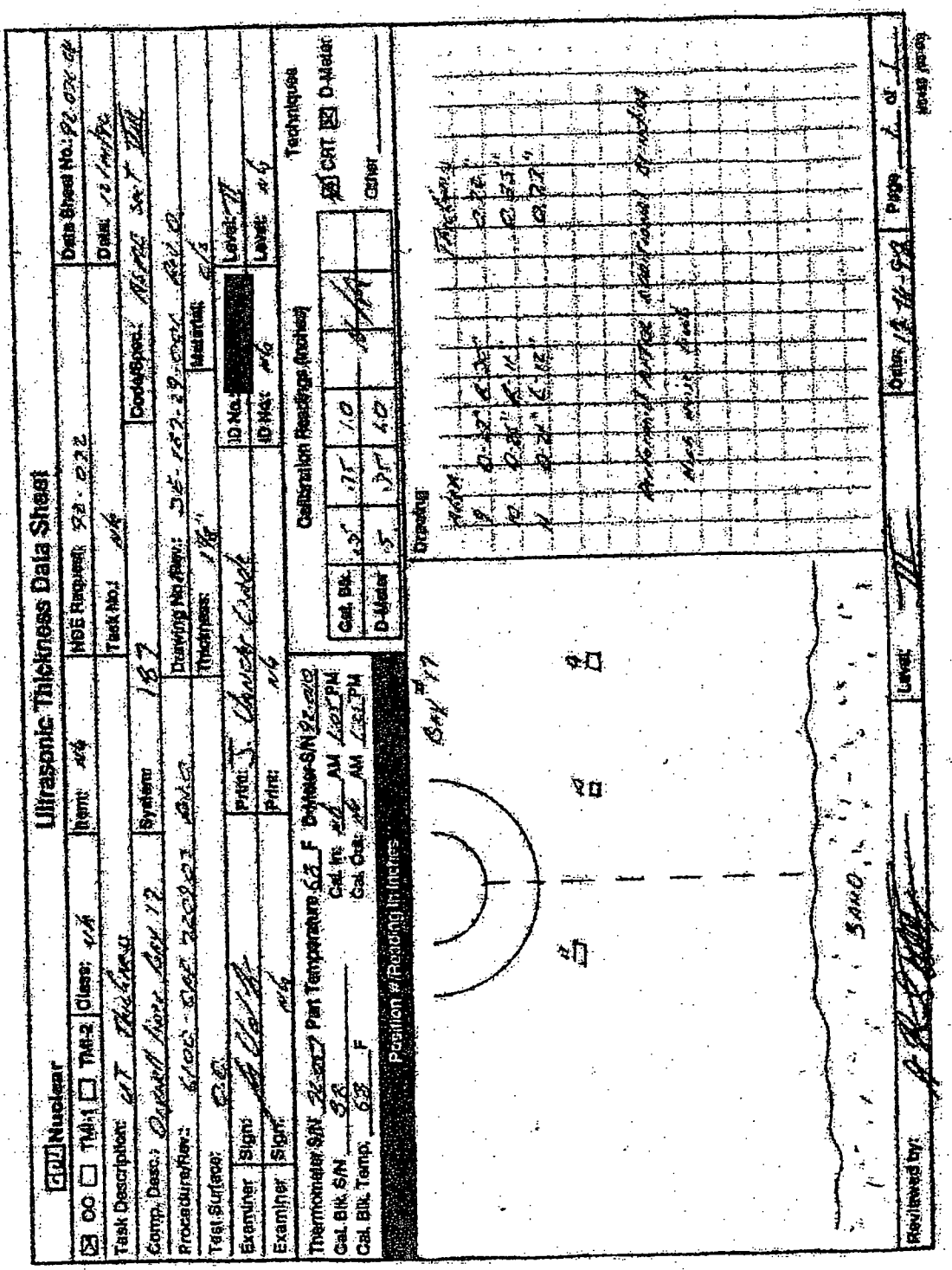
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	153 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



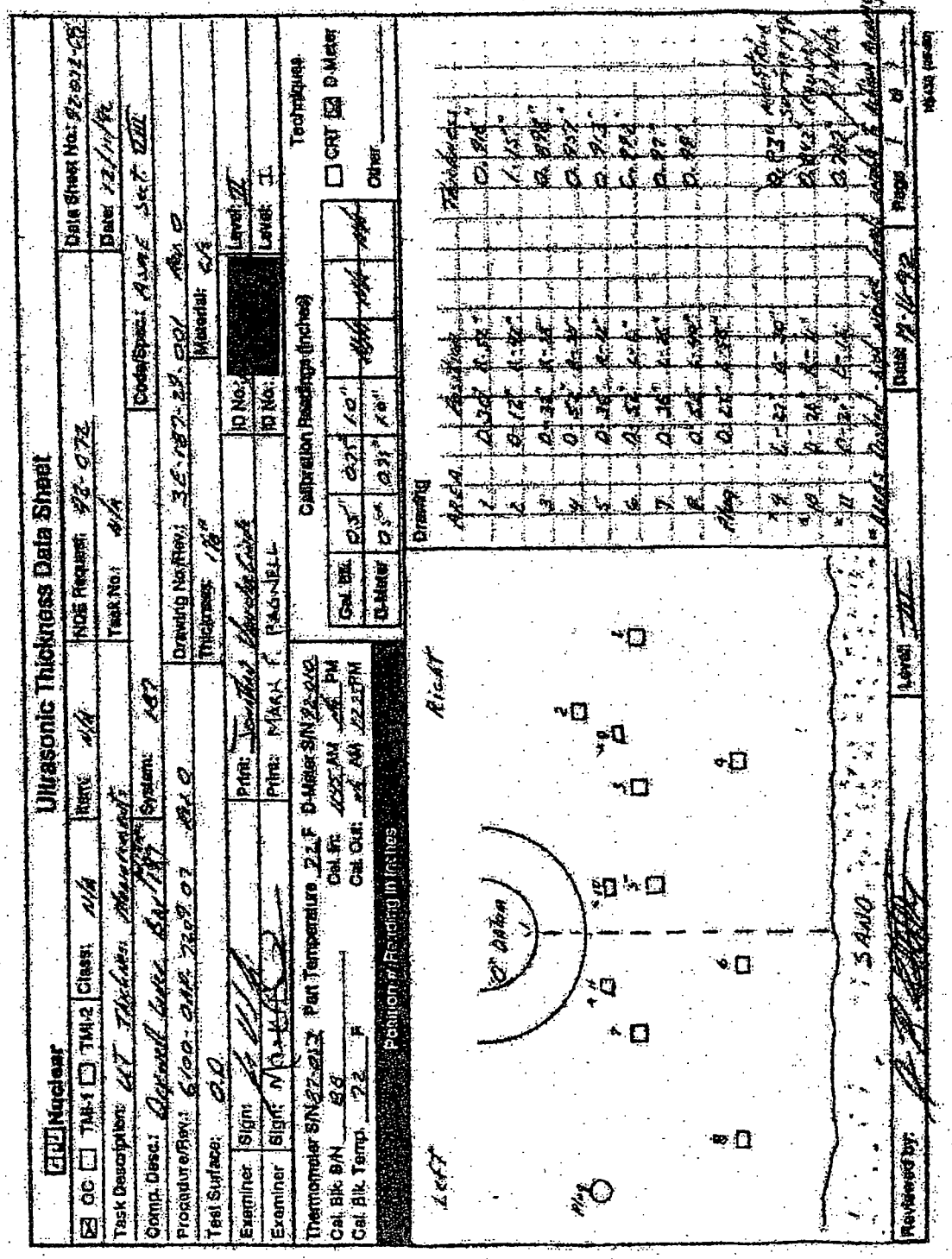
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	154 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



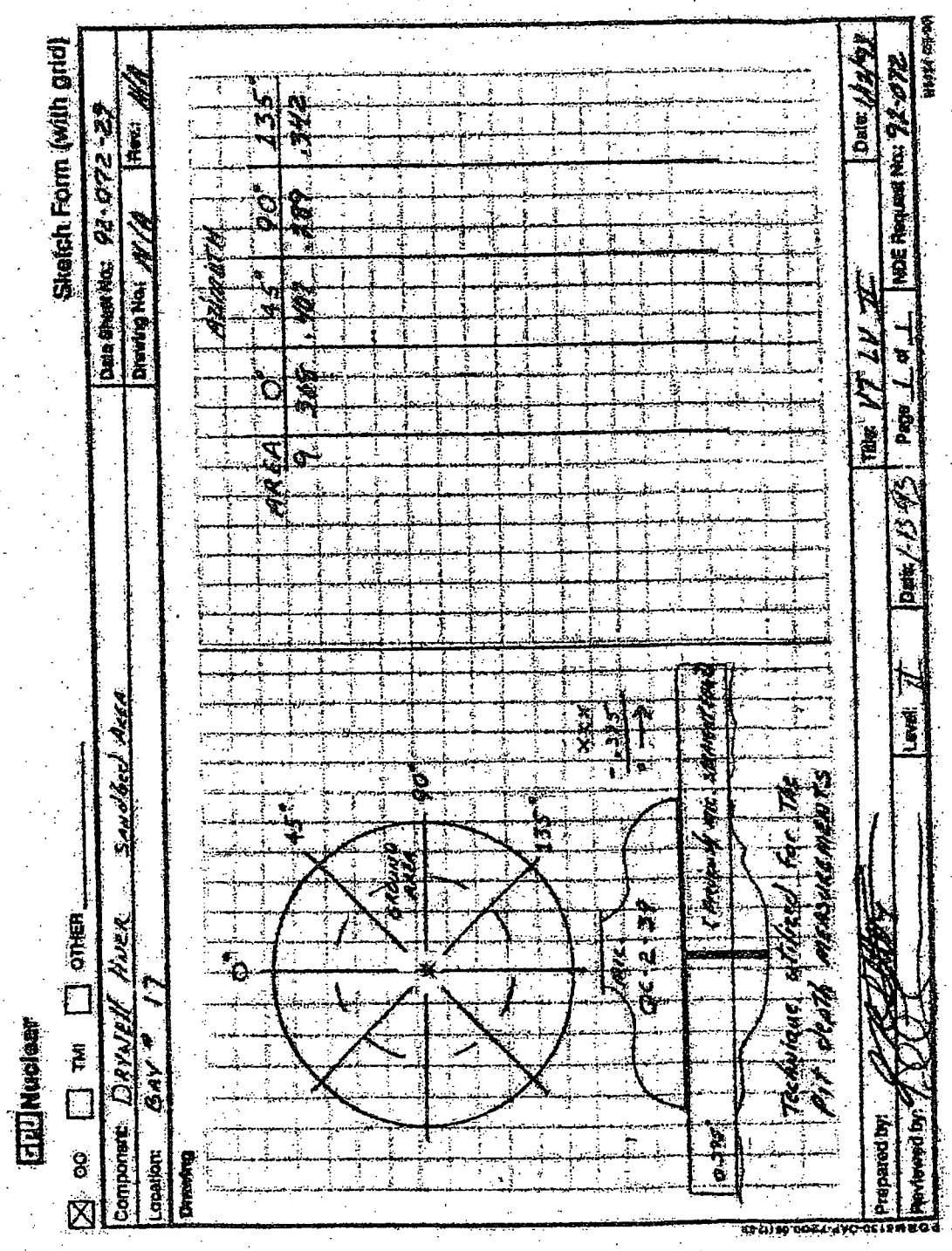
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	155 of 183
Originater	Date	Reviewed by		Date
Pete Tamburro	3/21/07			



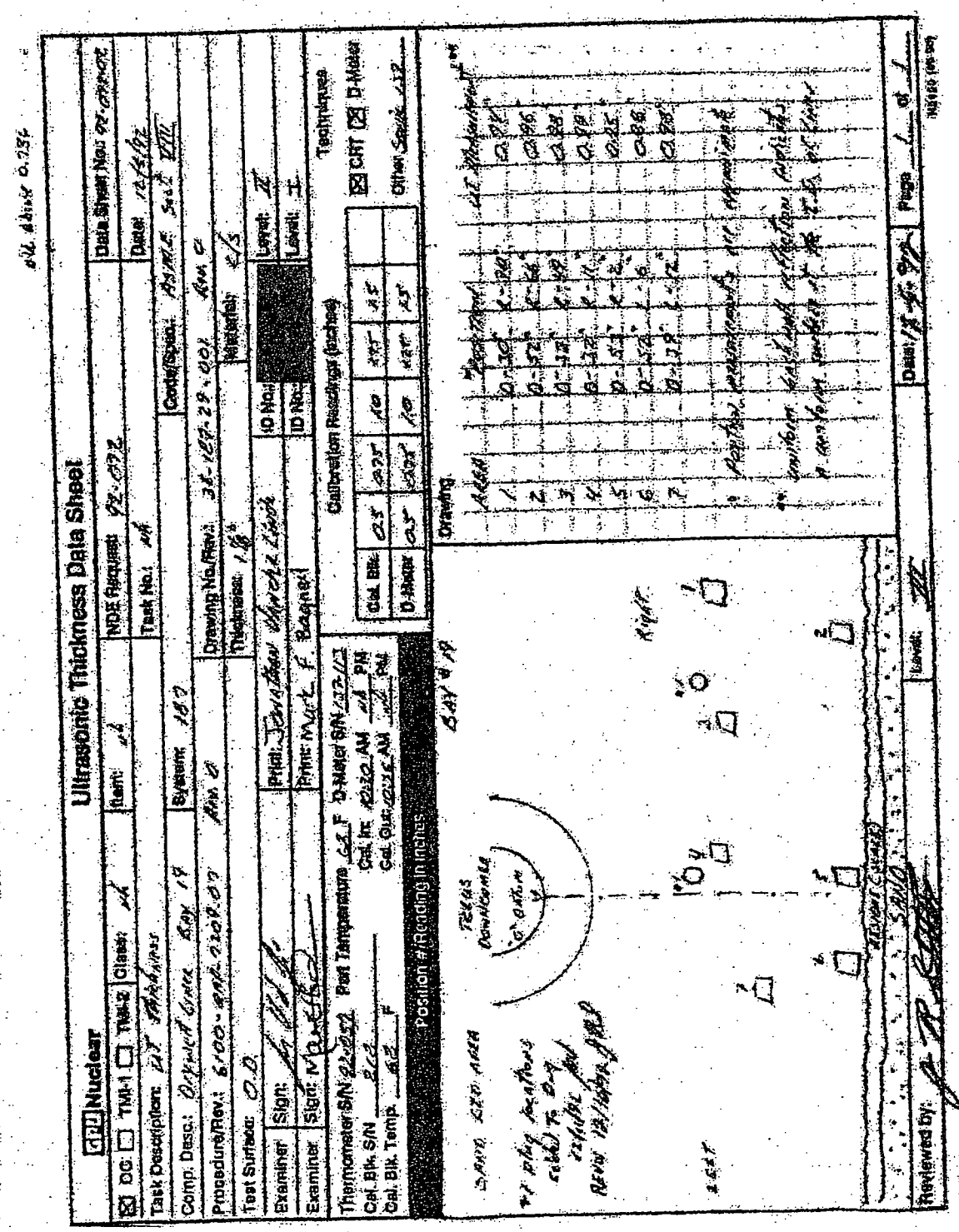
GPU Nuclear

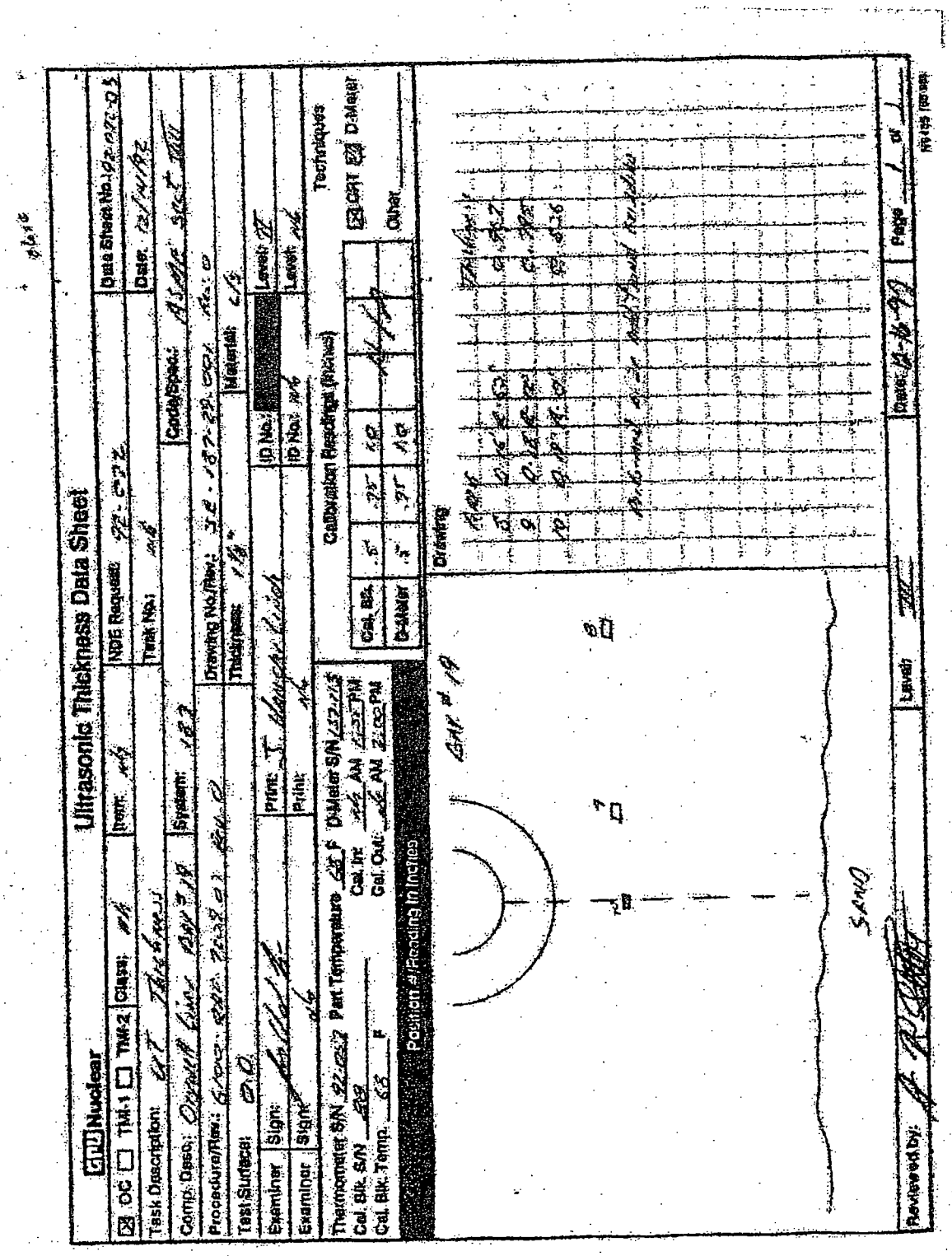
Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	156 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



GPU Nuclear

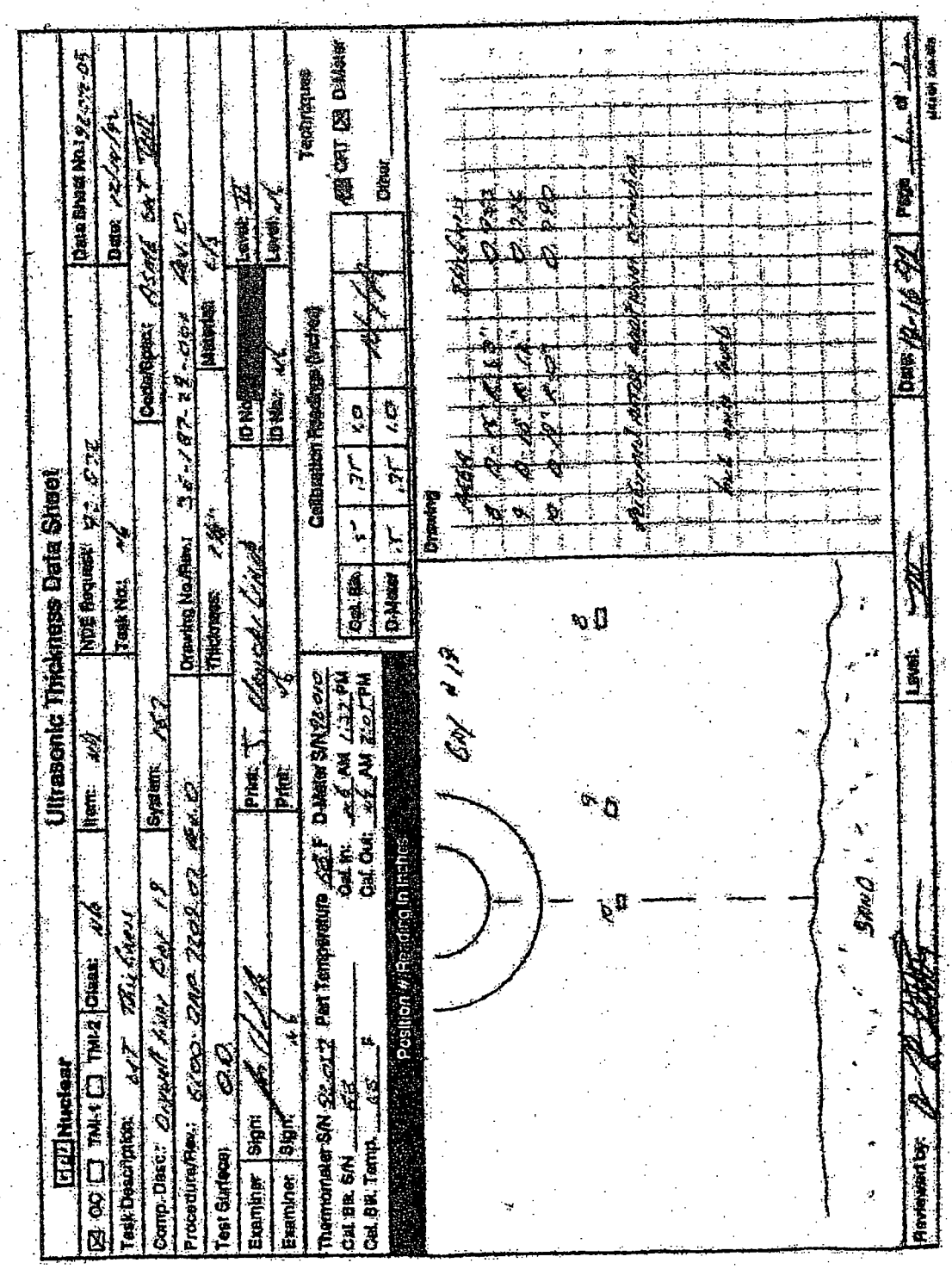
Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	157 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			




Ultrasonic Thickness Data Sheet
GPU Nuclear
Drawing
SAND

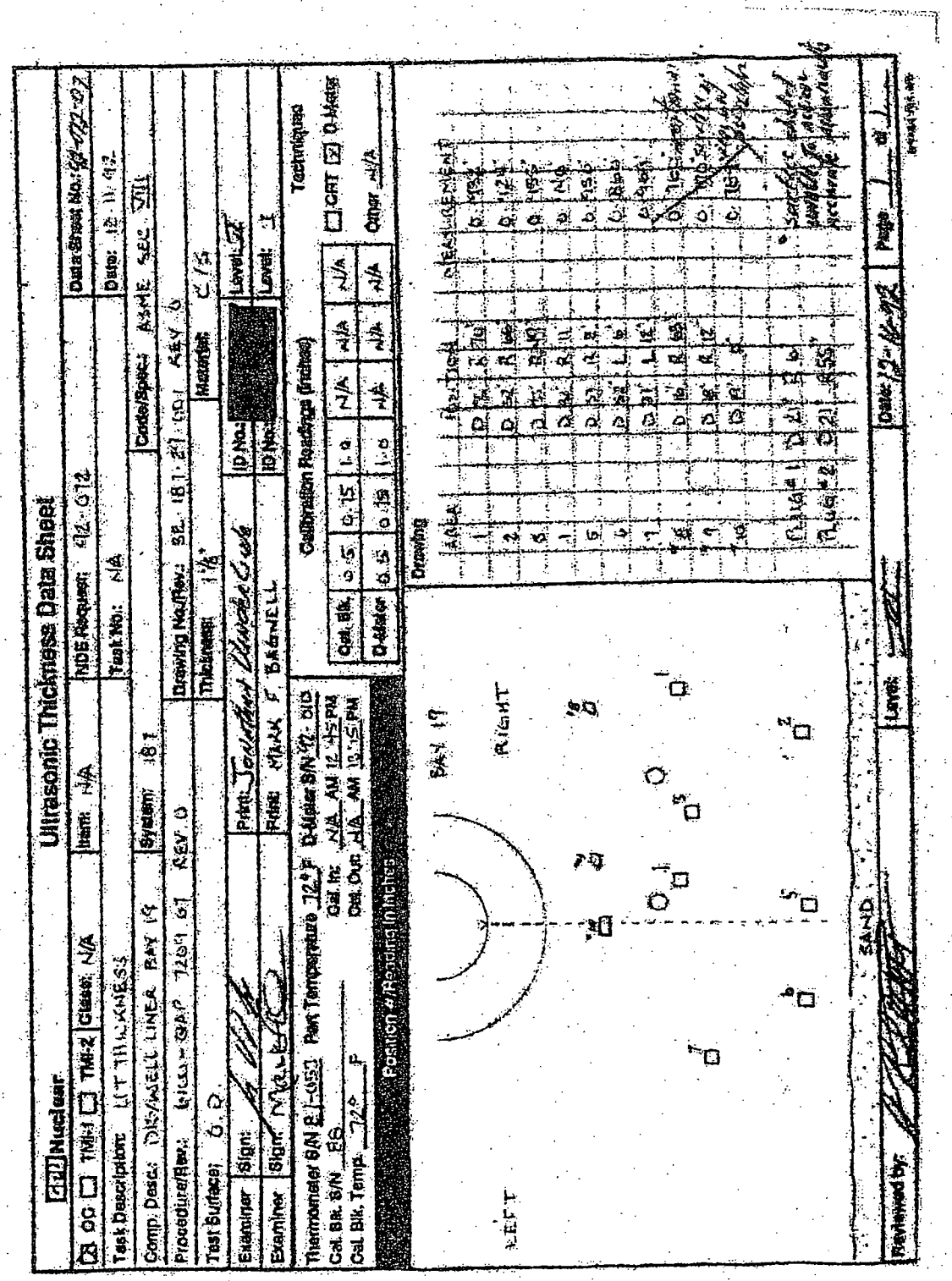
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	159 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



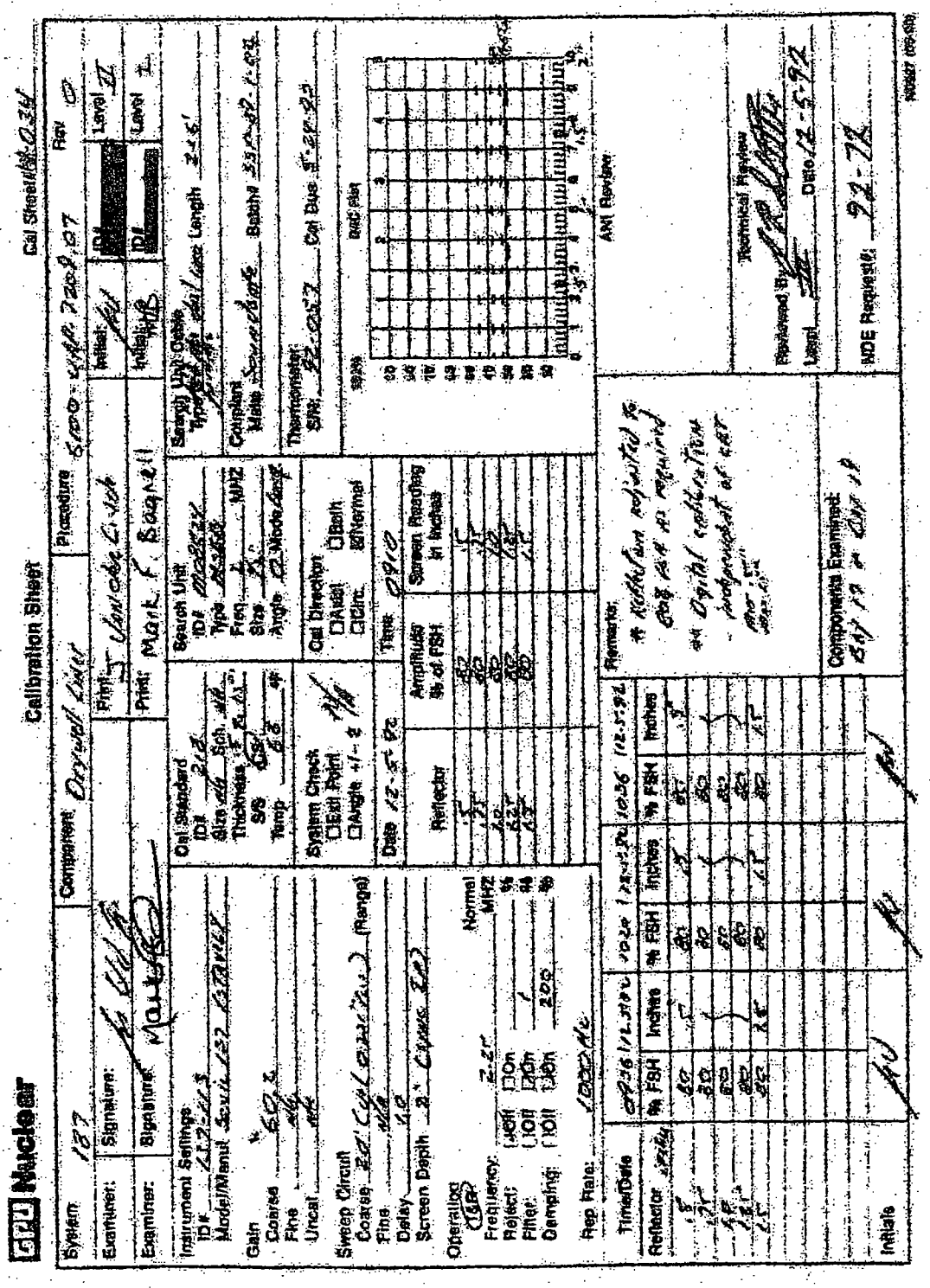
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evalution in Sandbed		C-1302-187-5320-024	3	160 of 183
Originator	Date	Reviewed by		Date
Pete Tamburro	3/21/97			



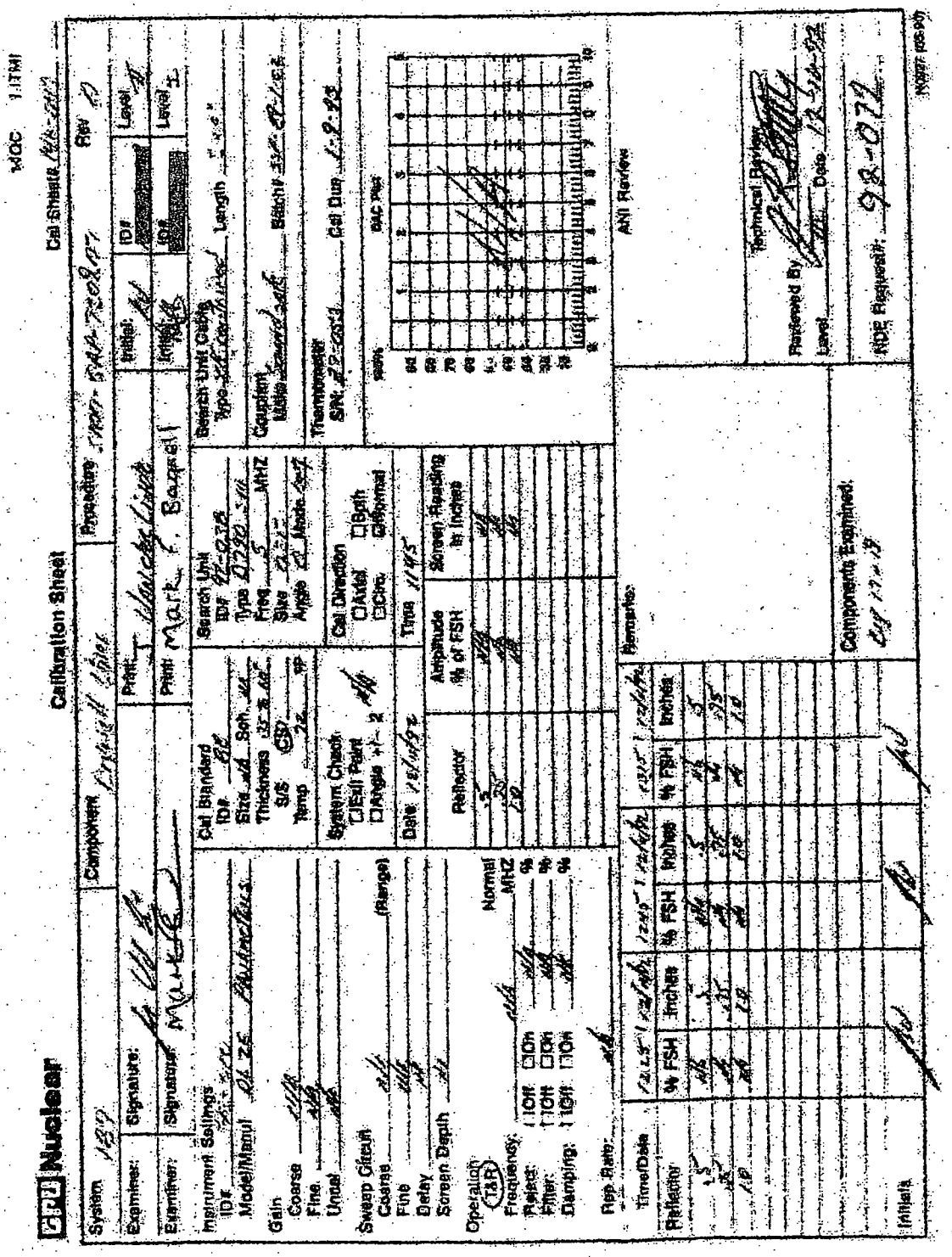
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	161 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



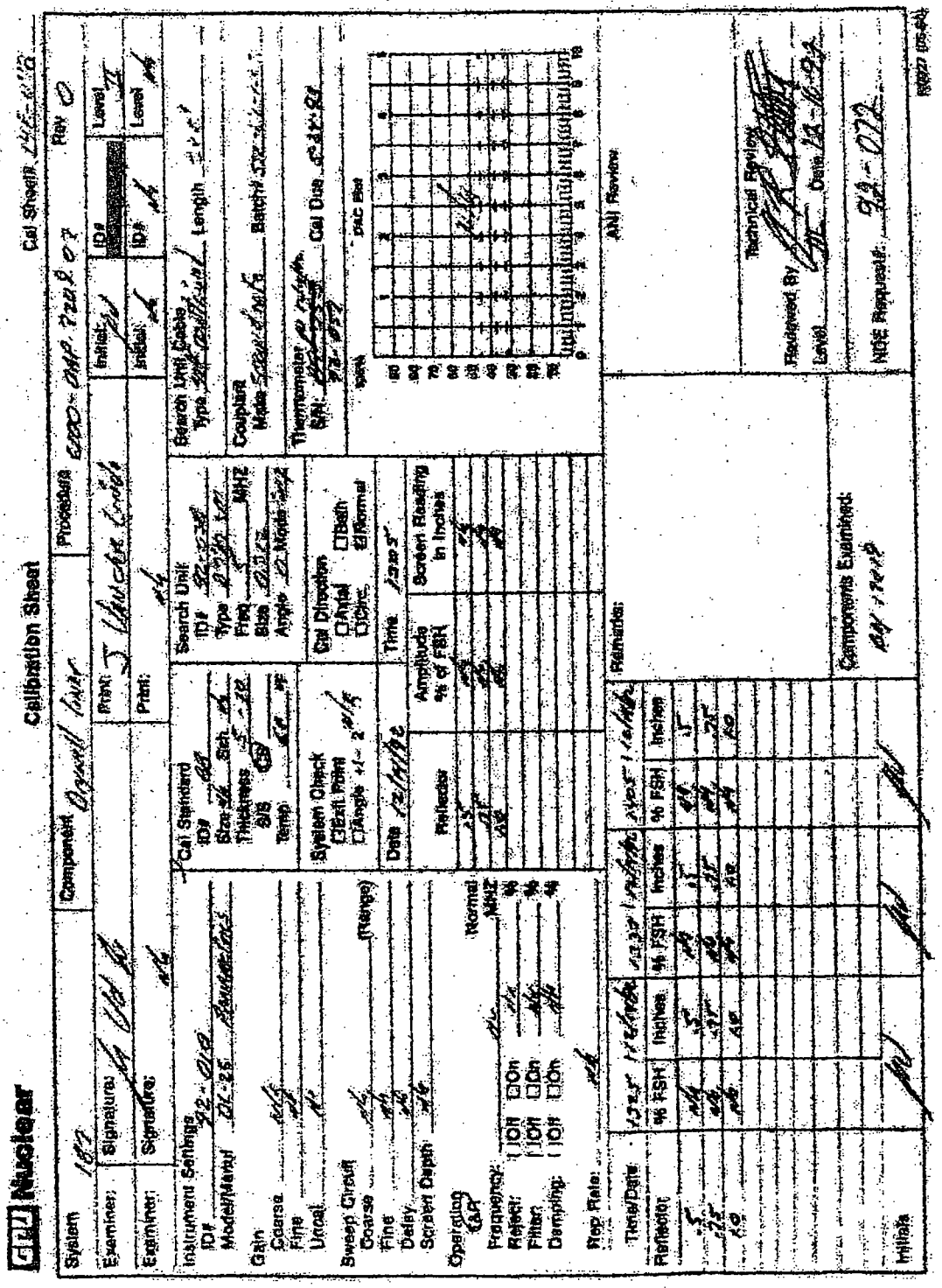
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	162 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



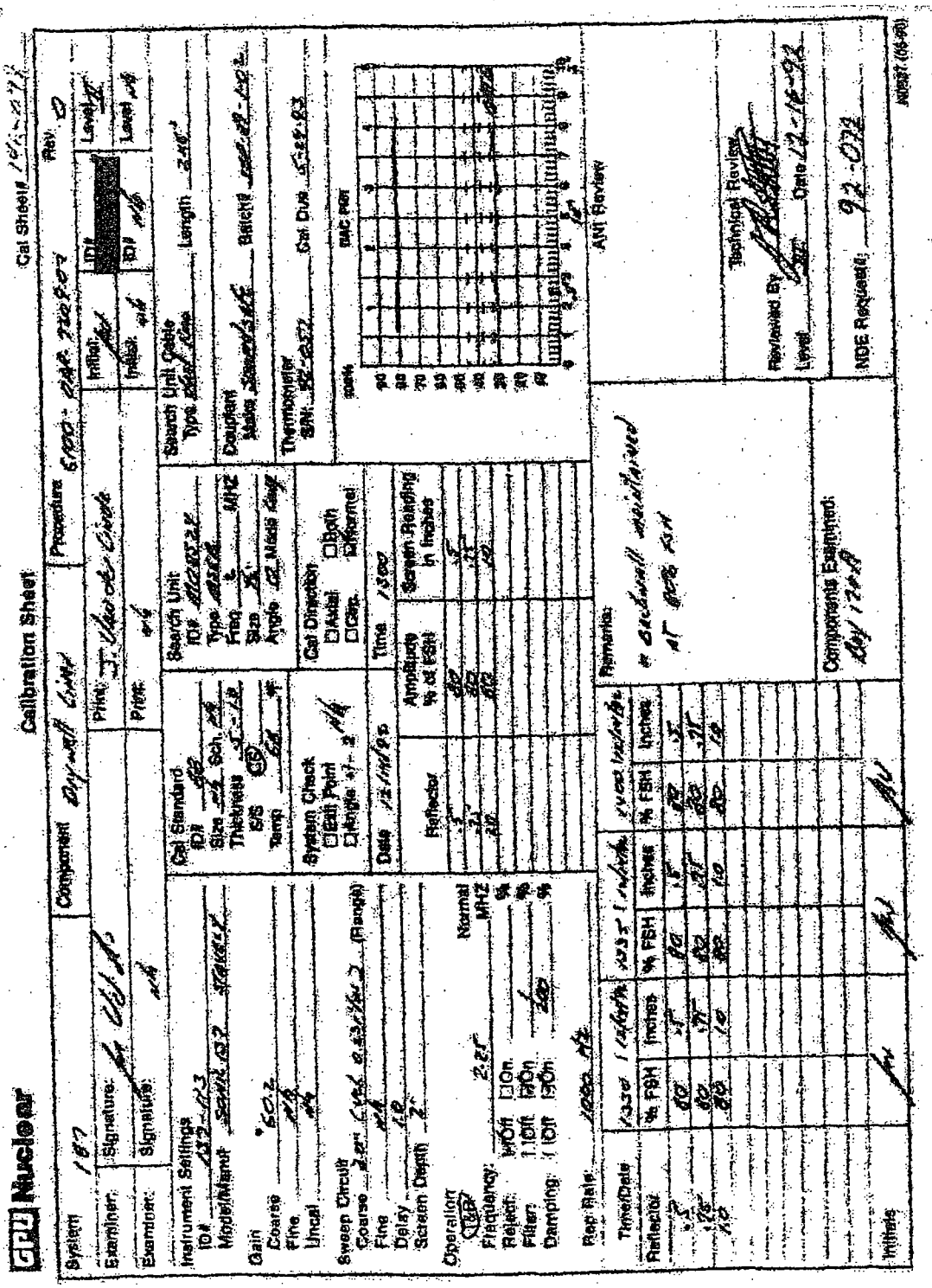
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	163 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



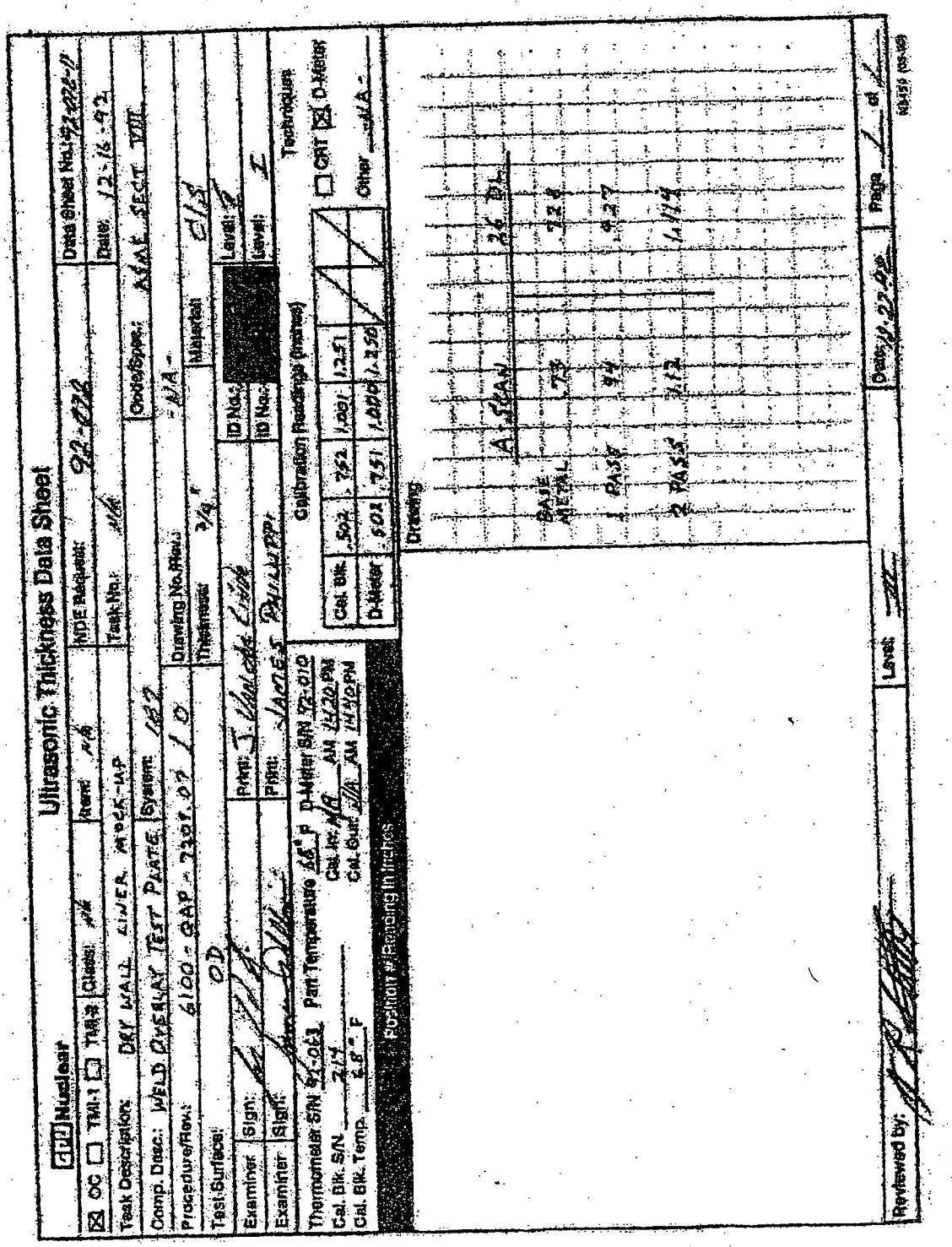
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	164 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



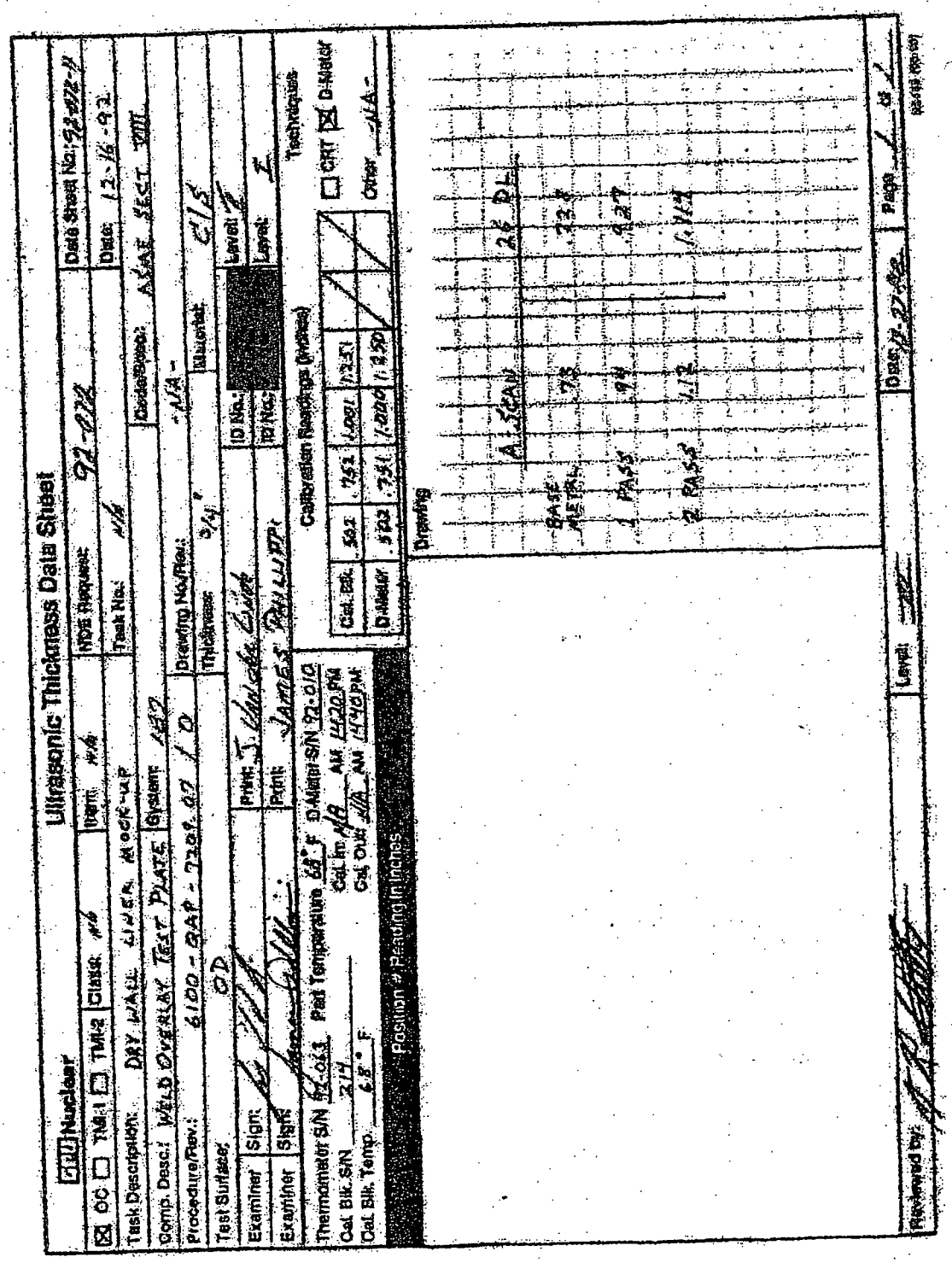
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	165 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



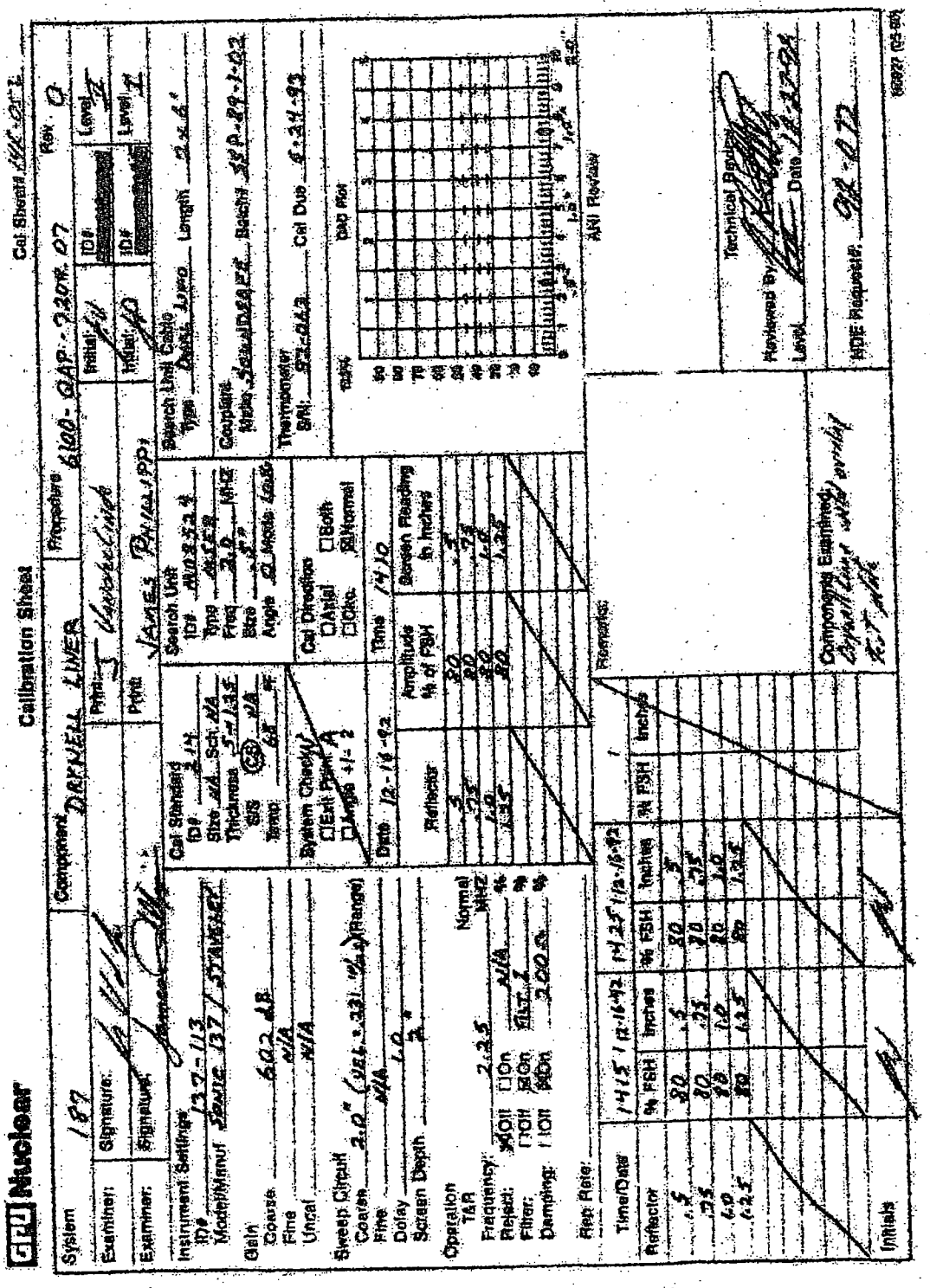
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	166 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



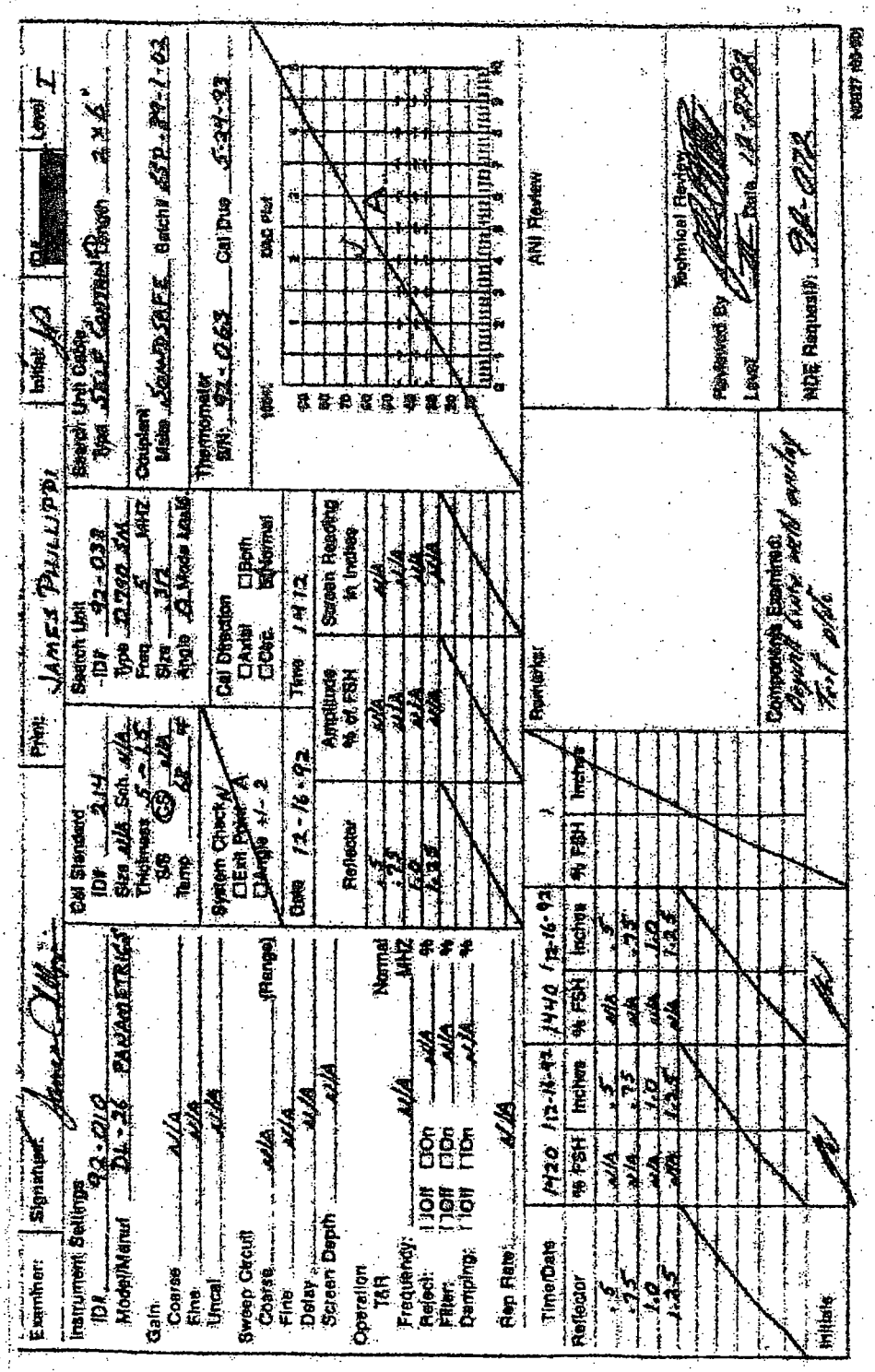
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	167 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	168 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	169 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			

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Appendix E
Bay 1 2006 UT data

BAY 1

Point	Vertical	Horizontal	1992 value	2006 Value	Comments
1	D16	R27	0.720	0.710	
2	D22	R17	0.716	0.690	
3	D23	L3	0.705	0.665	
4	D24	L33	0.760	0.738	Very Rough Surface
5	D24	L45	0.710	0.680	
6	D46	R19	0.760	0.731	
7	D39	R7	0.700	0.669	
8	D48	R0	0.805	0.783	
9	D36	L38	0.805	0.754	
10	D16	R23	0.839	0.824	
11	D23	R12	0.714	0.711	
12	D24	L5	0.724	0.722	
13	D24	L40	0.792	0.719	
14	D2	R35	1.147	1.157	
15	D8	L51	1.156	1.160	
16	D50	R40	0.796	0.795	
17	D40	R16	0.860	0.846	
18	D38	L2	0.917	0.869	
19	D38	L24	0.890	0.865	
20	D16	R13	0.965	0.912	
21	D24	R15	0.726	0.712	
22	D32	R13	0.852	0.854	
23	D48	R15	0.850	0.828	

Data obtained from
NDE Data Sheets 92-072-12 page 1 of 1
NDE Data Sheets 92-072-18 page 1 of 1
NDE Data Sheets 92-072-18 page 1 of 1
All horizonal measurements taken 13" to the right of the centerline of the reinforcement ring (Base).
All vertical measurements taken from bottom of vent nozzle at the 13" reference line.
Surface roughness prohibited characterization of all readings.

Note: Per discussion with Engineering, single point readings were taken in lieu of 8, based on surface curvature.

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Appendix E
Bay 3 2006 UT data

BAY 3

Point	Vertical	Horizontal	1992 value	2006 Value	Comments
1	D16	R63	0.785	0.795	n/a
2	D18	R48	1	0.999	
3	D17	R33	0.857	0.850	
4	D13	L5	0.898	0.803	
5	D25	L6	0.823	0.819	
6	D15	L56	0.866	0.972	
7	D29	IR4	0.826	0.810	
8	D34	IC4	0.776	0.764	

Data obtained from
NDE Data Sheets 92-072-14 page 1 of 1
Note: Per discussion with Engineering, single point readings were taken in lieu of 8, based on surface curvature.

GPU Nuclear

Subject: O.C. Drywell Ext. UT Evaluation in Sandbed	Calc No. C-1302-187-5320-024	Rev. No. 3	Sheet No. 171 of 183
Originator: Pete Tamburro	Date: 3/21/07	Reviewed by	Date

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Attachment 10-22-06

BAY 5

	Point	Vertical	Horizontal	1992 value	2006 Value	Comments
*	1	D38	R12	0.97	0.948	up .97 dn .97
*	2	D38	R7	1.04	0.955	Rough surface - up .99 dn .99
*	3	D42	R10	1.02	0.989	up 1.0 dn 1.04
*	4	D41	L7	0.97	0.948	Rough surface, also dished
*	5	D42	L11	0.89	0.88	Rough surface
**	6	D47	R5	1.06	0.981	up 1.018 dn 1.014
**	7	D48	L18	0.99	0.974	Rough surface left .99 right N/A
**	8	D46	L31	1.01	1.007	Rough surface

Note: up, dn, left & right readings were taken 1/8" from recorded 2006 value reading.
Rough surface limited taking additional readings. Reference above.
* =Vertical and horizontal measurements taken from top of coating on long seam 62" to right
** =Vertical and horizontal measurements taken from bottom of nozzle at 6 o'clock position
Reference NDE Data Sheets 92-072-16 page 1 of 1

1 - Reference off the weld 62" to the right of the centerline of the bay.
2 The original data sheet is not clear as to whether this point is to the right or left of the weld.
Therefore NDE shall verify this dimension.

Note: per discussion with Engineering, single point readings were taken in lieu of 6, based on surface curvature.

10-20-06

Appendix E
Bay 5 2006 UT data

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7041 CHI
10-26-06

Appendix E
Bay 7 2006 UT data

BAY 7

Point	Vertical	Horizontal	1992 value	2006 Value	Comments
1	D21	R39	0.82	N/A	Could not locate area
2	D21	R32	1.018	N/A	Could not locate area
3	D10	R26	0.984	0.964	up/dn ranged from 0.866 to 0.980
4	D10	R10	1.04	1.04	n/a
5	D21	L6	1.03	1.003	up/dn ranged from 1.000 to 1.049
6	D10	L23	1.045	1.023	up/dn ranged from 1.020 to 1.052
7	D21	L12	1	1.003	up/dn ranged from 1.002 to 1.028

Data obtained from
NDE Data Sheets 92-072-20 page 1 of 1
Note: up, dn readings were taken 1/8" from recorded 2006 value /reading.

GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
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Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			

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24.91 & III
10-22-06

Appendix E
Bay 9 2006 UT data

BAY 9

	Point	Vertical	Horizontal	1992 value	2006 Value	Comments
	1	D29	R32	0.96	0.968	n/a
	2	D18	R17	0.94	0.934	
	3	D20	R8	0.984	0.989	
	4	D27	R15	1.02	1.016	
	5	D35	L5	0.985	0.964	
	6	D13	L30	0.82	0.802	
	7	D16	L35	0.825	0.82	
	8	D21	L38	0.791	0.781	
	9	D20	L53	0.832	0.823	
	10	D30	L8	0.98	0.955	

Data obtained from
NDE Data Sheets 92-072-22 page 1 of 1

Note: per discussion with Engineering, single point readings were taken in lieu of 6, based on surface curvature.

GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	174 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/97			

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Appendix E
Bay 11 2006 UT data

BAY 11

Point	Vertical	Horizontal	1992 value	2006 Value	Comments
1	D20	R29	0.705	0.700	N/A
2	D25	R32	0.77	0.760	
3	D21	L4	0.832	0.830	
4	D24	L6	0.755	0.751	
5	D32	L14	0.831	0.823	
6	D27	L22	0.8	0.756	
7	D31	R20	0.831	0.817	
8	D40	R13	0.85	0.825	

Data obtained from
NDE Data Sheets 92-072-10 page 1 of 1
Note: per discussion with Engineering, single point readings were taken in lieu of 8, based on surface curvature.

ACM'd L III 10-22-06

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Appendix E
Bay 13 2006 UT data

BAY 13

Point	Vertical	Horizontal	1992 value	2006 Value	Comments
1	U1	R45	0.672	N/A	Could not locate area
2	U1	R36	0.729	N/A	Could not locate area
3	D21	R46	0.841	0.923	
4	D12	R38	0.916	0.873	
5	D21	R6	0.718	0.708	
6	D24	L9	0.665	0.658	
7	D17	L23	0.818	0.602	
8	D24	L26	0.718	0.704	
9	D28	R41	0.924	0.915	
10	D29	R12	0.728	0.741	
11	D28	L15	0.685	0.668	
12	D29	L23	0.885	0.898	
13	D18	D46	0.932	0.814	
14	D18	R8	0.868	0.876	
15	D20	L9	0.683	0.668	
16	D20	L26	0.829	0.814	
17	D9	R39	0.807	N/A	Could not locate area
18	D22	R39	0.823	N/A	Could not locate area
19	D37	R38	0.718	0.718	

Data obtained from
NDE Data Sheets 92-072-24 page 1 of 2
Note: per discussion with Engineering, single point readings were taken in lieu of 6, based on surface condition.

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	176 of 183
Originater	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			

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Appendix E
Bay 15 2006 UT data

BAY 15

Point	Vertical	Horizontal	1992 value	2006 Value	Comments
1	D12	R26	0.786	0.779	0.711 to 0.778
2	D22	R21	0.828	0.798	0.777 to 0.798
3	D33	R17	0.932	0.835	
4	D30	R7	0.785	0.791	
5	D28	L3	0.85	0.855	0.817 to 0.855
6	D6	L8	0.784	0.787	0.715 to 0.787
7	D26	L18	0.808	0.805	
8	D20	L36	0.77	0.760	
9	D36	L44	0.722	0.749	0.720 to 0.749
10	D24	L48	0.86	0.852	0.837 to 0.852
11	D24	L85	0.803	0.843	0.788 to 0.843

Data obtained from
NDE Data Sheets 92-672-21 page 1 of 1
Note: scanned 0.25" area around recorded 2006 value number - see comments for ranges.

GPU Nuclear

Subject: O.C. Drywell Ext. UT Evaluation in Sandbed	Calc No. C-1302-187-5320-024	Rev. No. 3	Sheet No. 177 of 183
Originator: Pete Tamburro	Date: 3/21/07	Reviewed by	Date

Appendix E
Bay 3 2006 UT data

BAY 17

Note: measurement from vent pipe CL to floor 60"

	Point	Vertical	Horizontal	1992 value	2006 Value	Comments
	1	D12	R50	0.916	0.909	
	2	D9	R40	1.150	0.681	up .705 dn .683
	3	D16	R26	0.898	0.894	
	4	D34	R24	0.951	0.963	
	5	D6	R20	0.913	0.822	
	6	D17	R7	0.992	0.909	
	7	D18	L14	0.970	0.970	
	8	D34	L46	0.990	0.960	
	9	D21	L29	0.720	0.970	
	10	D3	L2	0.830	0.844	
	11	N/A	N/A	N/A	N/A	

Note: Down measurements taken from bottom of boss which is 18" below vent line.
Locations 8,9, & 3 look to be un-prepped flat areas of the original surface.
All left, right measurements taken from 8" left of liner long seam
Data obtained from
NDE Data Sheets 92-072-08 page 1 of 1

Note: Per discussion with Engineering, single point readings were taken in lieu of 6, based on surface curvature.

10-19-2006

GPU Nuclear

Subject: O.C. Drywell Ext. UT Evaluation in Sandbed | Calc No. C-1302-187-5320-024 | Rev. No. 3 | Sheet No. 178 of 183

Originator | Date | Reviewed by | Date

Appendix E
Bay 19 2006 UT data

BAY 19

	Point	Vertical	Horizontal	1992 value	2006 Value	Comments
	1	D30	R60	0.932	0.904	up .897 dn .887
	2	D52	R58	0.924	0.921	up .850 dn .907
	3	D33	R40	0.955	0.932	up .894 dn .905
	4	D32	R11	0.94	N/A	Could not locate area
	5	D31	R3	0.95	0.932	up .883 dn .897
	6	D52	L65	0.86	N/A	Could not locate area
	7	D54	L10	0.969	0.891	up .821 dn .912
	8	D16	R64	0.793/0.953 ***	0.745	up .721 dn .747
	9	D18	R12	0.776	0.780	up .728 dn .745
	10	D19	R0	0.79	0.791	up .736 dn .846
	11	20D	L18	N/A	0.738	up .738 dn .712

Data obtained from
NDE Data Sheets 92-072-05 page 1 of 1
NDE Data Sheets 92-072-07 page 1 of 1
Note: Per discussion with Engineering, single point readings were taken in lieu of 6, based on surface curvature.
*** - This value is not clear form the original datasheet -NDE to verify this value.
Note: per discussion with Engineering, single point readings were taken in lieu of 6, based on surface curvature.

Matthew E Welsh 10/22/06

OCLR00030853

Appendix F

GPU Nuclear **Memorandum**

Subject: INSPECTION OF DRYWELL SAND BED REGION AND ACCESS HOLES

Date: January 28, 1993

From: K. L. Whitmore - Civil/Structural Mgr.

Location: Harris Corp. Center 5320-93-020

To: J. C. Flynn - Manager, Special Projects, Engineering Projects

As requested by you, I conducted two visual inspections of the drywell sand bed region and several of the access holes. On December 22, 1992, I entered Bays 3, 5 and 17. From inside these bays, I could see all or portions of 1, 3, 5, 7, 15, 17 and 19. On January 21, 1993, I entered Bays 13, 15 and 17. From inside these bays, I could see all or portions of Bays 11, 13, 15, 17 and 19. At the time of the first inspection, bays 1, 3, 5, 17 and 19 had been cleaned of sand and corrosion material. No concrete repair or drywell coating had begun. At the time of the second inspection, Bays 11, 13 and 15 had been cleaned of sand and corrosion material. Primer had been placed on the floor in preparation of epoxy placement. However, no concrete repairs or drywell coating had begun in those bays. Bays 17 and 19 had been completed. The epoxy floor had been installed and the drywell had been coated. Following is a summary of my observations during these two inspections:

1. Drywell Shell

The drywell shell is sound metal with no loose material, rust or laminations. There are no apparent cracks or discontinuities. The shell is characterized by a rough surface full of dimples similar to the outside surface of a golf ball. The dimples are of varying sizes, but most are less than 1/2" in diameter. The shell appears to be relatively uniform in thickness except as noted below:

(a) Above the elevation of the bottom of the holes through the concrete shield wall for the vent pipe (approximately 6" below the vent pipe reinforcement ring to drywell shell weld), corrosion is much less than below that elevation. Therefore, there is an obvious change in thickness at this elevation.

(b) There are two strips around the vessel just below the vent pipe holes described in (a) above which are slightly thinner than the general area of the shell. These strips have been described as "bathtub rings."

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J. C. Flynn - Manager, Special Projects, Engineering Projects
January 28, 1993
5320-93-020
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(c) In addition to the dimples, there are spots that appear to be thinner than the general area. The dimples in the surface occur in these thin spots to the same degree as in the rest of the corroded portion of the shell. The "thin" spots are typically a foot to 18" in diameter and probably comprise about 20% of the corroded area. In general, except in Bay 13, the thin spots are not readily apparent. Therefore, a more detailed characterization is difficult for the other Bays (see (d) below). I could not determine visually which of the thin spots are the thinnest. However, due to the small differences between the "thick" areas and the "thin" areas, and the amount of metal removed in preparation for the UT measurements, it is highly likely that the thickness readings reported in the UT measurements encompass the thinnest spots in the shell.

(d) Due to the results of the thickness measurements, a more detailed visual inspection was conducted of the drywell shell in Bay 13. The conditions observed during the inspection of Bay 13 are summarized below:

- The variation in thickness is greater in Bay 13 than in the other bays.
- The "thin" spots are about a foot to 18" in diameter and are at least 1 ft. apart (edge to edge, or 2 to 2-1/2 ft. center to center). Some spots are thinner than others. Again, I could not determine precisely which spots are the thinnest. However, due to the amount of metal removed to perform the UT measurements, the reported thicknesses in all likelihood envelop the smallest thicknesses in the shell.
- The thin spots comprise abut 20% of the total area of the corroded portion of the shell. They are spread throughout the bay but are closer together (about 1 ft. apart) in the vicinity of the vent pipe and further apart toward the frames.

All of the observations discussed above apply in general to all portions of the drywell shell in the sandbed area. However, Bay 13 has a greater variation between the "thick" and "thin" areas than any of the other observed bays. In addition, the abrupt change in thickness at the elevation described in (a) above is more pronounced in Bay 13 than in other bays which were inspected. In fact, in the other bays the thin spots are not apparent unless a concerted effort is made to locate them. Due to this, a more detailed characterization is not drawn for the other bays.

After cleaning and coating, the drywell shell is sound metal with no apparent cracks, laminations, scale or rust. The surface is dimpled, but does not have severe changes in thickness which would result in significant stress risers.

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2. Concrete Floor in the Sand Bed

The floor of the sand bed was found to be uneven and unfinished. A number of small and some large voids were found in the floor of the sand bed. In many places, the reinforcing bars placed to form the drainage channel in the floor are exposed. The deepest void observed in the floor is about 20" deep and about 3'-4' long. This void is located adjacent to the drywell shell. A number of smaller voids were also observed. A more complete and accurate recording of voids and exposed reinforcing is contained in MNCRs 92-188 and 93-062. The exposed reinforcing is generally sound with very little evident corrosion. The concrete in the floor is sound and no cracks are apparent.

After repair, the floor is sound, smooth and resilient. The configuration will lead to rapid draining of the sand bed should water enter the area. In addition, the slope provided will prevent water from standing adjacent to the drywell shell.

3. Concrete in Shield Wall, Frames and Access Holes

A number of small fissures, cracks and voids were observed in the drywell sand bed access holes. In addition, a number of voids and areas of exposed reinforcement were observed in the shield wall in the sand bed region. The voids in the sand bed area and access holes are documented in MNCR 93-062. The voids observed in the concrete comprise an insignificant percentage of the area of the shield walls. All voids are localized and isolated, and do not appear to be associated with any concrete cracking or spalling. All exposed concrete is sound and free of signs of degradation. Exposed bars appear to be sound and generally free of corrosion. In the areas where reinforcing is exposed, the reinforcing appears to be consistent with the reinforced concrete design drawings. No areas were observed which caused any concern with regard to structural adequacy of the shield wall, concrete frames or the Reactor Building.

This completes the record of observations from my inspection of the drywell sand bed region. If you have any questions or need additional information, please let me know.

K. L. Whitmore
Extension 7546

/rw

cc: A. R. Baig - Engineer, Engineering Projects
J. J. Colitz - Director, Engineering Projects
J. H. Horton - Mechanical Analysis Manager
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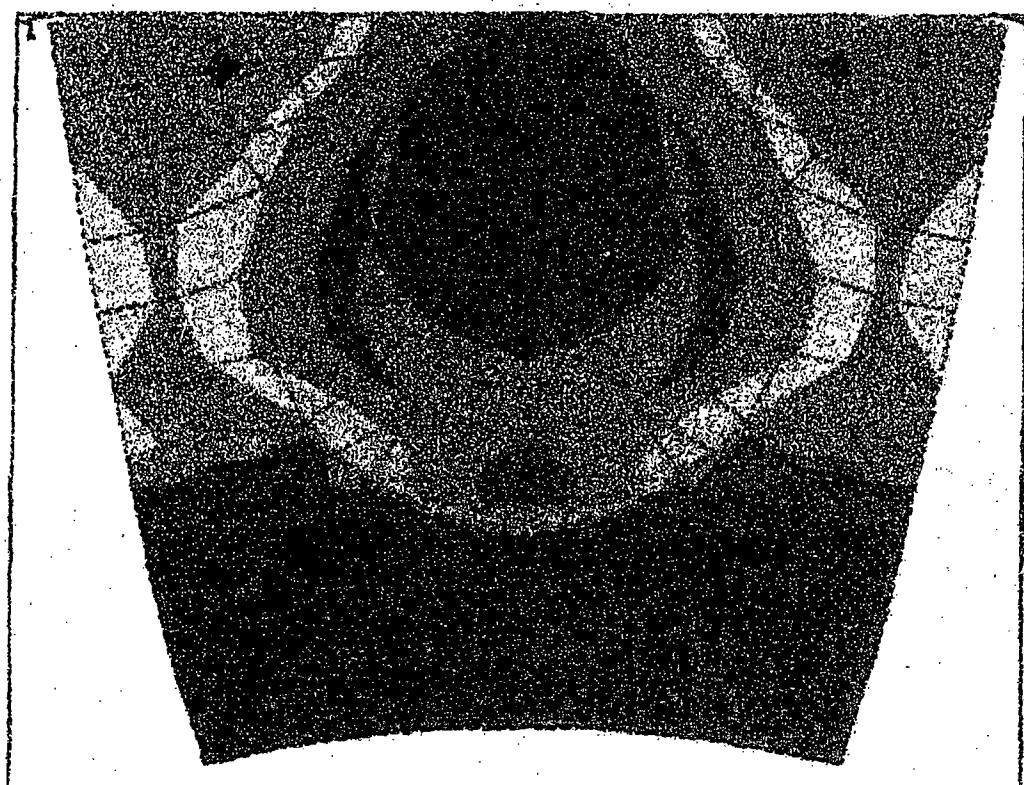

3-91

Appendix G
Figure 3-11 from reference 3.4

Figure 3-11 Lower Drywell Meridional Stresses - Refueling Case

OYSTER CREEK DRYWELL ANALYSIS - SVM-SVM, NOSAND, REFUELING

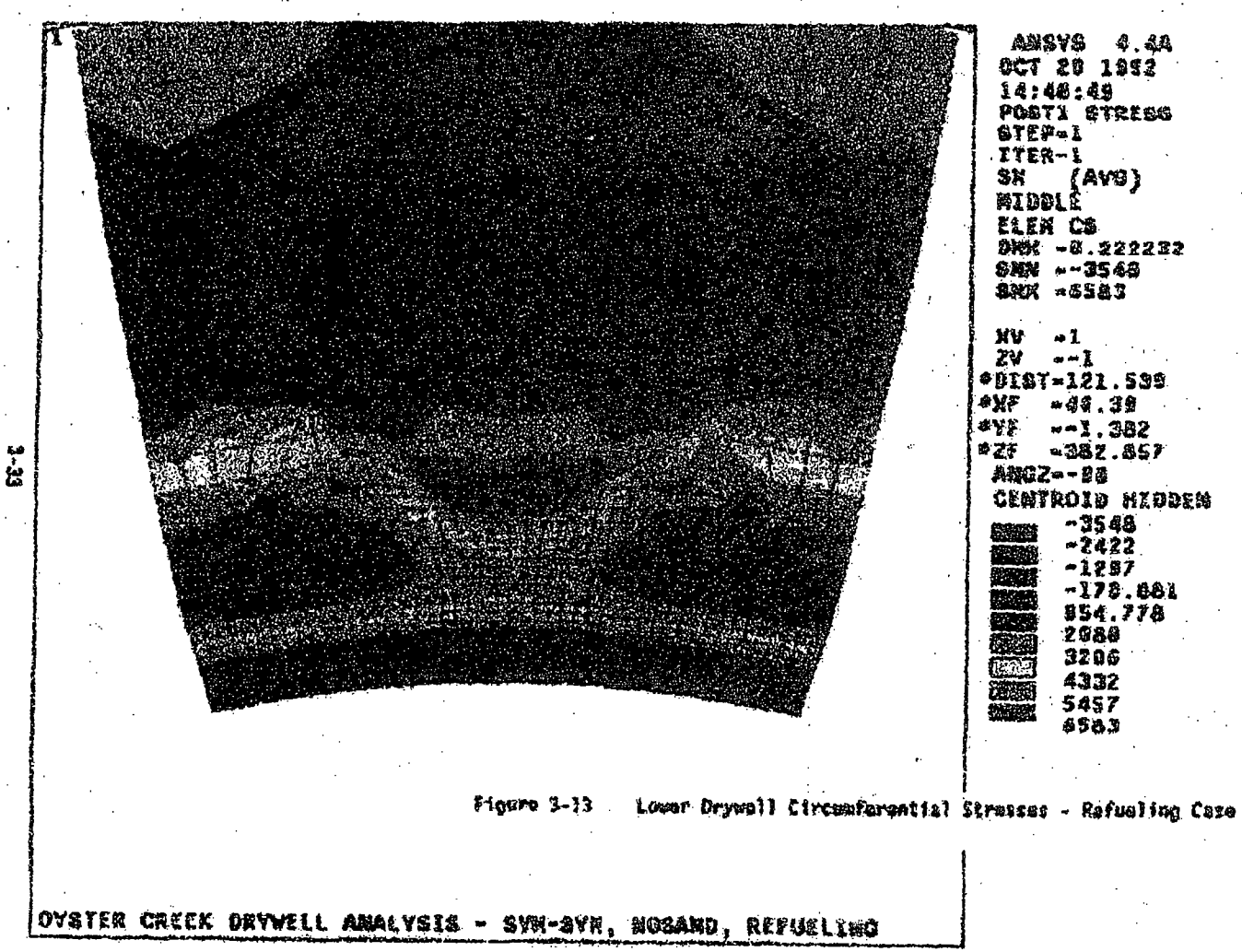

Figure 3-13 Lower Drywell Circumferential Stresses - Refueling Case