UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

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

In the Matter of:	)	July 20, 2007
AmerGen Energy Company, LLC	)	
	)	Docket No. 50-219
(License Renewal for Oyster Creek Nuclear Generating Station)	)	

AMERGEN'S PRE-FILED DIRECT TESTIMONY EXHIBITS

VOLUME 1 OF 2: EXHIBITS 1-19

APPLICANT'S EXH. 1

ENERCON SERVICES, INC.

Julien D. Abramovici, P.E.

Experience Summary

- Degreed Mechanical Engineer with over 33 years of experience
- Significant experience with ASME and ANSI codes with an emphasis on ASME Sections III, VIII, and XI, and ANSI B31.1 and 31.7
- Registered Professional Engineer, New Jersey
- Multi-discipline Root Cause Evaluator
- License Renewal
- Third party reviews
- Former member of the EPRI-MRP who has dealt with the Alloy 600 Head Penetrations
- Reactor vessel internals (BWR and PWR)
- Steam Generator support
- Performed Alloy 600 Assessments for Three Mile Island and Fort Calhoun
- New plant operating license support

Experience Description

Since joining Enercon Services in 2000, Mr. Abramovici has been assigned to the Mt. Arlington, New Jersey office where he has worked on a multitude of diversified tasks, which included: ISI relief requests for Grand Gulf, Oyster Creek Reactor Vessel Internals and Reactor Vessel weld inspections outage support, Oyster Creek CRD leakage evaluation and repair, Fort Calhoun CRDM venting investigation, Cooper ISI and IST Programs audits, Fort Calhoun Inconel 600 assessment, Pickering Travelling Screens problems investigations, Indian Point 2 projects assessment, Three Mile Island (TMI) Steam Generator evaluation and repairs, TMI CRD head penetration repairs , GSI 191 resolutions including support to French and Spanish utilities, Oyster Creek License Renewal and many others.

Over the year, Mr. Abramovici has been involved in developing operational programs(ISI, IST, RVMS, CLRT, etc.) for new plant applications, for NuStart utility consortium. Additionally, Mr. Abramovici has provided technical input for heavy loads, steam generator , leak before break, MOV reactor head inspections and many other programs as well as subject matter expertise.

Mr. Abramovici was employed as a Senior Engineer/Consulting Engineer at GPU Nuclear's Corporate Headquarters for four years and was responsible for major plant equipment such as the reactor vessel and internals (BWR) and steam generators (PWR). He provided technical expertise on various component and system issues as well as ASME and ANSI codes, with emphasis on ASME Section III, VIII and XI, and ANSI B31.1 and 31.7. He acted as responsible or independent reviewer for 50.59 type evaluations and performed third party design verifications on multi-discipline modifications. He additionally evaluated "as found" conditions for acceptability for continued operation "as is" with minimal schedule or financial impact.

Prior to this, Mr. Abramovici held the position of Mechanical Components Manager at GPU Nuclear for two years. He was responsible for analytical support of the GPU Nuclear plant mechanical components. This activity included evaluation of component degradation mechanisms such as fatigue, corrosion, and cracking, ASME code pressure boundary calculations and heat exchanger, and rotating equipment performance. He was responsible for preparation of inspection plans and specifications for major components such as reactor internals. He reviewed inspection data and dispositioned associated material nonconformance reports. He evaluated component failure events and performed associated root cause evaluations. He provided management and guidance to the staff in the identification of problems with the design or operation of the plant systems and components by technical expertise and knowledge of regulatory requirements. He provided management and guidance to the staff for the evaluation of engineering alternatives as well as life assurance and life extension. This included cost/benefit analysis, development of design criteria, and the establishment of work scope and schedules. He provided management and guidance for the design and/or procurement of mechanical components and review of plant operations, maintenance, surveillance practices and standards relative to these components. Large programs included underground piping, reactor vessel internals, steam generator related issues, and motor operated valves. He additionally chaired numerous design and constructability reviews.

Mr. Abramovici was part of a Plant Optimization and License Renewal (POLR) group that evaluated the adequacy of the GPUN plants for continued operation as well as license renewal. While part of this group, he participated in and reviewed the products of various industry-related groups, such as EPRI, and GE and B&W Owners Groups. His group was responsible for the plants thermal cycle monitoring and calculations revisions that may be necessary to assure continued licensing requirements compliance. After GPUN set up a License Renewal group, Mr. Abramovici and his group continued to provide support in this arena.

As Heat Exchanger and Pressure Vessel Manager with GPU Nuclear for nine years, Mr. Abramovici's responsibilities were the same as above, but limited to heat exchangers, feedwater heaters, pressure vessels, steam generators, pressurizers, reheaters, moisture separator pump, turbines, and material handling equipment.

Mr. Abramovici held similar responsibilities as Piping Engineering Manager with GPU Nuclear for one year, but these were limited to valves, piping, piping support, and material handling equipment.

While with GPU Nuclear, Mr. Abramovici additionally held various staff positions for six years. He was responsible for the nuclear steam supply system design and modifications. As System Engineer, he was responsible for the reactor coolant (primary) systems such as reactor coolant, make-up and purification, and building spray and decay heat system problem identification and resolution. He was responsible for programs related to sulfur removal from the primary loop, especially the pressurizer. He implemented the intergranular stress, corrosion, and cracking (IGSCC) at Three Mile Island Unit 1 Nuclear Generating Station. He additionally generated piping, heat exchangers, and piping supports procurement specifications.

Prior to this, Mr. Abramovici worked as Mechanical Engineer at General Dynamics Corporation's Electric Boat Division. In this position, he was responsible for design and evaluation of submarine components and systems.

Education and Training

B.S., Mechanical Engineering, City College of New York, 1973

M.S., Systems Management, University of Southern California, 1975

GPU Professional and Management Development Training Courses:

Principle Centered Leadership

Seven Habits of Highly Effective People

Time Management

Deming Management Methods

Teamwork and Leadership

Kepner-Tregoe Problem Solving and Decision Making

ASME Section XI Training

Professional Affiliations and Licenses

Electric Power Research Institute (EPRI):

Steam Generator Reliability Project – Technical Advisory Group

Reactor Vessel Internal Project – Repair Committee

PWR Materials Reliability Project

Registered Professional Engineer, State of New Jersey, License 24GE2674500

JON R. CAVALLO, PE, PCS

Born: Washington, D.C. - 1946

Education:
- Pomona College
- U.S. Naval Nuclear Power School
- Northeastern University, Bachelor of Science in Engineering Technology, Cum Laude
- University of Washington, Cold Regions Engineering
- University of Colorado, Engineering Project Management
- NACE, Corrosion Prevention in Oil and Gas Production
- University of New Hampshire, Finance for the Non-Financial Manager
- Fairleigh Dickinson University, Inspection, Evaluation and Rehabilitation of Highway Bridges
- The Hartford Graduate Center, Value Engineering

Professional Activities:

Registered Professional Engineer:
- Alaska, ME-5161 Connecticut, 14797
- Maine, 5549 Massachusetts, 30114
- New Hampshire, 8993 New Jersey, GE32609

Certifications:
- SSPC Protective Coatings Specialist No. 130-35-0235
- NBR Certified Nuclear Coatings Engineer No. 137

Organizational Affiliations:
- Member, American Society of Mechanical Engineers
- Member, American Society for Testing and Materials
  - Chairman Committee D-33 (2004-2008)
- Member, National Association of Corrosion Engineers
- Director and President (2006-2007), Maine Society of Professional Engineers
- Member, Order of the Engineer
- Member, Steel Structures Painting Council
  - Chairman, Northern New England Chapter (1991-1998)
  - Chairman, New England Chapter (2000 - Present)
  - Member, National Strategic Planning Committee (1995-1996)
- Member, Northeastern University Sigma Epsilon Rho Honor Society

Work Experience
- Corrosion Control Consultants & Labs, Inc. 1998 - Present (Consulting Engineering Firm)
  - Vice-President
- Independent Professional Engineer 1991 - 1998
  - Corrosion Engineering Consulting Services
- Sponge-Jet, Inc. 1991 - Present (Surface Cleaning Systems)
  - Vice-Chairman
- S.G. Pinney & Associates, Inc. 1986-1991 (Consulting Engineering Firm)
  - Northern U.S. Regional Manager (1986-1991)
- Metalweld, Inc, 1983-1986 (Industrial Coating and Lining Contractor)
  - Manager, New England Division
  - Project Manager, Seabrook Nuclear Power Station
- Stone & Webster Engineering Corporation, 1971-1983
  - Materials Engineering Division Coordinator
- United States Navy, 1965-1971
  - Viet Nam Veteran, 1965-1966
  - Naval Nuclear Power Program, 1967-1971

Scott R. Erickson
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Education: 1983 Graduate of Hutchinson Vo-Tech Institute NDE Program

Training: **EPRI Courses, Charlotte, NC**: 9/91 Level II VT1-4; 6/92: Manual Weld Overlay UT Inspection; 8/92: Manual UT Thru-Wall Sizing; 7/94 Manual UT Inspection Testing Qualification (Performance Demonstration Initiative; 12/04 Manual UT Reactor Pressure Vessel Detection Qualification;

General Electric (GE) Course: 1/07 Level III VT-1

Experience: **3/2004 to Present – Sonic Systems International**. Certified Level III in Magnetic Particle Testing (MT), Liquid Penetrant Testing (PT), Ultrasonic Testing (UT), Visual Testing (VT1-3). Job duties include Project Level III, Inservice Inspection (ISI) Coordinator, Manual PDI Piping/RPV examinations, BOP examinations (MT, PT, VT1 inspections of surfaces, VT-3 inspections of Supports, Hangers, and Snubbers (Hydraulic and Mechanical))

5/2002 to 2/2004 – Alstom Power. Certified Level II in MT, PT, UT. Job duties included performing NDE exams on refurbished/modified turbine components.

10/1997 to 4/2002 – SSI. Certified Level II in MT, PT, UT, VT1-3. Job duties included performing Inservice Inspections (ISI) / Balance of Plant (BOP) / Flow Accelerated Corrosion (FAC) examinations.

9/1992 to 10/1997 – LMT. Certified Level III in MT, PT, UT, VT1-3. Job duties included supervising and performing ISI and System Pressure Tests.

2/1992 to 2/1994 – Virginia Corporation of Richmond (VCR) (Contract Employee). Certified Level III in MT, PT, UT, Level II in VT1-3. Job duties included supervising and Performing ISI, BOP, FAC, and NSS examinations.

10/1985 to 2/1992 – VCR. Certified Level III in MT, PT, UT, Level II in VT1-3. Job duties included supervising outage work, writing and reviewing procedures, training and testing of employees, and performing ISI, BOP, FAC, and NSS examinations.

4/1985 – BESTCO (for LMT). Certified Level II in MT, PT, Level I in UT. Performed ISI examinations.

10/1984 to 4/1985 – Branch Radiographic Labs. Certified Level II in MT, PT, Level I in UT. Job duties included performing construction NDE examinations at Hope Creek.

7/1984 to 10/1984 – LeHigh Testing Labs. Certified Level II in Radiographic testing (RT), MT, PT, UT. Job duties included performing manufacturing NDE Examinations.

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Michael P. Gallagher

Professional History

1981-present Exelon

VP License Renewal Projects	2006 to present
Nuclear Review Board- PSEG	2004 to 2007
VP Engineering & Technical Support- PSEG	2004 to 2005
Director Licensing & Regulatory Affairs- Mid Atlantic	2001 to 2004
BWROG Prime Representative	2001 to 2004
Nuclear Safety Review Board Member-Exelon	2000 to 2004
Director Operations Support- Mid Atlantic Region	2000 to 2001
Plant Manager- Limerick	1998 to 2000
Director of Work Management- Peach Bottom	1996 to 1998
Director of Engineering - Limerick	1995 to 1996
Plant Engineering Manager- Limerick	1993 to 1995
Operations Support Manager- Limerick	1992 to 1993
Mechanical Design Manager- Nuclear Group	1989 to 1992
Reactor Engineering Manager- Limerick	1986 to 1989
Startup Test Engineer- Limerick	1982 to 1986
Engineer- Peach Bottom	1981 to 1982

Education

1997	INPO Senior Nuclear Plant Managers Course
1988	Masters in Business Administration, Saint Joseph's University
1981	Bachelor of Chemical Engineering, Georgia Tech

Licenses

1984-1989	Senior Licensed Operator Limerick Units 1&2
1987	Registered Professional Engineer- Pennsylvania

Exelon.

Michael P. Gallagher, PE

Position

Vice President License Renewal Projects

Profile

Gallagher, 48, is responsible for the overall implementation of the license renewal projects for Exelon Nuclear.

Professional History

Gallagher has 26 years experience in the nuclear industry and has held key leadership positions within Exelon Nuclear. Prior to his current position, Gallagher was Vice President Engineering and Technical Support at the PSEG Salem and Hope Creek stations responsible for performance improvements under the Exelon/PSEG Operating Services Agreement. From 2001 to 2004 Gallagher was the Director of Licensing and Regulatory Affairs responsible for compliance with Nuclear Regulatory Commission requirements. From 1998 to 2000 Gallagher was Plant Manager of the Limerick Generating Station. Gallagher also attained a USNRC Senior Reactor Operator license while at Limerick.

Civic Involvement

Gallagher is a member of Good Works, a Christian nonprofit organization that exists to improve the living conditions for low-income families in Chester County, PA. Since 2000, Gallagher has also participated in Habitat for Humanity blitz builds internationally and in the United States.

Education

Gallagher received his Bachelor in Chemical Engineering from Georgia Tech and Master in Business Administration from Saint Joseph's University. Gallagher is a registered professional engineer in Pennsylvania.

Family

Gallagher and his wife, Gina, have five children, Erin, Claire, Kevin, Brian and Molly.

Barry M. Gordon, P. E.

Associate

Education

MS, Metallurgy and Material Science, Carnegie Mellon University
BS, Metallurgy and Material Science, Carnegie Mellon University (First in Department)
Additional courses from MIT, University of Pittsburgh and NACE in Corrosion Science

Professional Associations and Awards

Registered Professional Engineer, State of California – Corrosion Engineering
Registered Corrosion Specialist – National Association of Corrosion Engineers (NACE), International
Member – International Cooperative Group on Environmentally Assisted Cracking (ICG-EAC)
Adjunct Professor, Colorado School of Mines
Instructor Credential, California Community Colleges
Instructor, International Atomic Energy Agency (IAEA)
Patent No. 4,950,449 – Inhibition of Radioactive Cobalt Deposition in Water-Cooled Nuclear Reactors
Patent No. 5,577,083 – Method and Apparatus for Electro-Protection of Piping Systems and Reactor Internals from Stress Corrosion Cracking
Patent No. 5,590,162 – Beta Battery
R&D Magazine's 100 award (most significant new technical products of the year) for zinc injection

Professional Experience

1998 to Present	Structural Integrity Associates, Inc., San José, CA Associate
1975 to 1998	GE Nuclear Energy, San José, CA Technical Expert – Corrosion Engineering Project Manager – Corrosion Technology Program Manager – Stress Corrosion Cracking
1969 to 1975	Westinghouse Electric – Bettis Atomic Power Laboratory, West Mifflin, PA Materials Engineer

Summary

Mr. Gordon has consulted on various LWR corrosion and material issues for over three decades with special emphasis on stress corrosion cracking (SCC). He has addressed numerous materials and corrosion problems in the LWR industry over a wide range of subjects including reactor internals, piping, fuel hardware, water chemistry transient and core flow issues, weld overlays and repairs, crack growth rate modeling, alloy selection, failure analysis, license renewal, NRC inspection relief, dry fuel storage, welding of irradiated materials, decontamination, etc.

Mr. Gordon has been the SI program manager and/or co-author of over 18 EPRI sponsored programs and reports including the landmark documents:

1. "Effects of Marine Environments on Stress Corrosion Cracking of Austenitic Stainless Steels – An Evaluation of the NISA and CRIEPI Spent Fuel Storage Canister Project"
2. "Effect of PWR Water Chemistry on PWSCC"
3. "BWR Water Chemistry Guideline – 2004 Revision"
4. "Technical Basis for Guidelines for Performing Weld Repairs to Irradiated BWR Internals.
5. "Guidelines for Performing Weld Repairs to Irradiated BWR Internals
6. "Interim Welding Guidelines for BWR Internals
7. "BWR Water Chemistry Guideline – 2000 Revision
8. "Technical Justification for the Extension of the Interval between Inspections for Weld Overlay Repairs"
9. "Technical Basis for Inspection Relief for BWR Internal Components with Hydrogen Injection"
10. "Full-System Decontamination of a BWR Using the LOMI Process,"

Mr. Gordon is also the SI project manager for the Yucca Mountain Project for both Bechtel SAIC and EPRI. He has conducted evaluations on the qualification of the waste package (WP) relative to long-term materials corrosion performance, weld residual stresses and long-term corrosion monitoring.

While at GE Nuclear Energy (GENE), Mr. Gordon was responsible for consultation, problem analysis and management of programs on BWR materials/environmental interactions. He developed and qualified the environmental BWR IGSCC mitigation technique, hydrogen water chemistry, prepared the EPRI decontamination guidelines for BWRs and qualified a process for BWR full-system decontamination. Mr. Gordon also co-patented a revolutionary method (GEZIP) of inhibiting radioactivity and mitigating IGSCC in nuclear reactors, a process that won *R&D Magazine's* 100 award as one of the most significant new technical products of the year.

Mr. Gordon managed multi-million dollar development programs on corrosion testing, field surveillance, failure analysis and design qualifications at GENE. He has lectured throughout the U.S., Mexico, Canada, Japan and Europe on corrosion phenomena to technical societies, regulatory agencies, utilities and vendors. He authored the highly acclaimed college accredited course (SUNY), "Corrosion and Corrosion Control in BWRs" and teaches an updated and greatly expanded "Corrosion and Corrosion Control in LWRs." Thirty US NRC personnel attended this class 2004.

Mr. Gordon has supervised senior level materials engineers and has consulted on a broad range of materials problems for other GE businesses. He also managed the materials technical exchange programs among GE, ABB, Hitachi and Toshiba. He has provided extensive litigation support to GE.

Mr. Gordon directed corrosion programs on steam generator materials and nuclear fuel cladding while at Westinghouse. He performed fieldwork on the nuclear aircraft carriers Enterprise and Nimitz and devised and qualified a new surface treatment for zirconium and hafnium alloys for corrosion and hydriding mitigation.

Resume: **DAVID GARY HARLOW**

Personal:

Date of birth: July 18, 1951
Place of birth: Bowling Green, Kentucky

Home address:
149 W. Langhorne Ave.
Bethlehem, PA 18017
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Business address:
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Lehigh University
19 Memorial Drive West
Bethlehem, PA 18015
(610) 758-4127 (office)
(610) 758-6224 (fax)
dgh0@lehigh.edu

Education:

B.A.: 1973 - Western Kentucky University; Mathematics and Physics
M.S.: 1976 - Cornell University; Applied Mathematics
Ph.D.: 1977 - Cornell University; Applied Probability and Stochastic Processes

Research Interests: Probability and statistical modeling of failure processes in materials, aluminum alloys, steels, and composites; Stochastic fracture mechanics; Stochastic differential equations and their numerical solutions; Mechanical and system reliability; Applications of stochastic processes; Applied probability modeling

Awards:

1973 Sigma Xi - First place; for original research at Western Kentucky University
1973 Highest honors in Mathematics
1973 Pi Mu Epsilon - National Mathematics Honorary Fraternity
1973 Sigma Pi Sigma - National Physics Honor Society
1973 Summa Cum Laude
1985 Lehigh University Award for teaching
1985 ASEE Summer Faculty Research Fellow - Naval Research Laboratory
1988 NRC Research Fellowship - Naval Postgraduate School
1992 Tau Beta Pi Teacher of the Year - Lehigh University
2006 Pi Tau Sigma Professor of the Year – Lehigh University

Professional Experience:

1992-	Professor; Mechanical Engineering and Mechanics; Lehigh University
1985-1992	Associate Professor; Mechanical Engineering and Mechanics; Lehigh University
1982-1985	Assistant Professor; Mechanical Engineering and Mechanics; Lehigh University
1979-1982	Assistant Professor; Mechanical Engineering and Mechanics; Drexel University, Philadelphia, PA
1977-1979	Research Associate; Sibley School of Mechanical and Aerospace Engineering; Cornell University, Ithaca, NY
1974-1979	Adjunct Professor; Mathematical Sciences; Tompkins-Cortland Community College, Dryden, NY

Publications:

Refereed Articles:

1. D.G. Harlow and S.L. Phoenix, The Chain-of-Bundles Probability Model for the Strength of Fibrous Materials I: Analysis and Conjectures, *Journal of Composite Materials* 12 (1978) 195-214.
2. D.G. Harlow and S.L. Phoenix, The Chain-of-Bundles Probability Model for the Strength of Fibrous Materials II: A Numerical Study of Convergence, *Journal of Composite Materials* 12 (1978) 314-334.
3. D.G. Harlow and S.L. Phoenix, Bounds on the Probability of Failure of Composite Materials, *International Journal of Fracture* 15 (1979) 321-336.
4. D.G. Harlow, Properties of the Strength Distribution for Composite Materials, *Composite Materials: Testing and Design (Fifth Conference), ASTM STP* 674, S.W. Tsai, Ed., American Society for Testing and Materials (1979) 484-501.
5. D.G. Harlow and S.L. Phoenix, Probability Distributions for the Strength of Composite Materials I: Two-Level Bounds, *International Journal of Fracture* 17 (1981) 347-372.
6. D.G. Harlow and S.L. Phoenix, Probability Distributions for the Strength of Composite Materials II: A Convergent Sequence of Tight Bounds, *International Journal of Fracture* 17 (1981) 601-630.
7. D.G. Harlow and S.L. Phoenix, Probability Distributions for the Strength of Fibrous Materials Under Local Load Sharing I: Two-Level Failure and Edge Effects, *Advances in Applied Probability* 14 (1982) 68-94.
8. D.G. Harlow, R.L. Smith, and H.M. Taylor, Lower Tail Analysis of the Distribution of the Strength of Load-Sharing Systems, *Journal of Applied Probability* 20 (1983) 358-367.
9. D.G. Harlow, Statistical Properties of Hybrid Composites I: Recursion Analysis, *Proceedings of the Royal Society of London A* 389 (1983) 67-100.
10. S.J. Fariborz, D.G. Harlow, and T.J. Delph, The Effects of Nonperiodic Void Spacing upon Intergranular Creep Cavitation, *Acta Metallurgica* 33 (1985) 1-9.
11. D.G. Harlow, The Pure Flaw Model for Chopped Fibre Composites, *Proceedings of the Royal Society of London A* 397 (1985) 211-232.
12. S.J. Fariborz, C.-L. Yang, and D.G. Harlow, The Tensile Behavior of Intraply Hybrid Composites I: Model and Simulation, *Journal of Composite Materials* 19 (1985) 334-354.
13. T.-S. Liu, R.J. Fields, D.G. Harlow, and T.J. Delph, Statistical Observations of Creep Cavitation in AISI Type 304 Stainless Steel, *Scripta Metallurgica* 19 (1985) 299-304.
14. S.J. Fariborz, D.G. Harlow, and T.J. Delph, Intergranular Creep Cavitation with Time-Discrete Stochastic Nucleation, *Acta Metallurgica* 34 (1986) 1433-1441.
15. S.H. Johnson, D.G. Harlow, and J.S. Yoon, Time Optimal Multistage Controllers for Nonlinear Continuous Processes, *Journal of Dynamic Systems and Measurement Control Transactions ASME* 108 (1986) 240-247.
16. S.J. Fariborz and D.G. Harlow, The Tensile Behavior of Intraply Hybrid Composites II: Micromechanical Model, *Journal of Composite Materials* 21 (1987) 856-875.

17. T.-S. Liu, D.G. Harlow, and T.J. Delph, Stereological Analysis of Creep Cavities on Polished Surfaces, *Metallography* **21** (1988) 55-76.

18. T.-S. Liu, R.J. Fields, S.J. Fariborz, D.G. Harlow, and T.J. Delph, Experimental Observations and Analysis of Creep Cavitation in AISI 304 Stainless Steel, *Acta Metallurgica* **36** (1988) 2481-2491.

19. D.G. Harlow, The Effect of Proof-Testing on the Weibull Distribution, *Journal of Materials Science* **24** (1989) 1467-1473.

20. R.C. Dobbyn, J. Farris, D.G. Harlow, T.J. Delph, and R.J. Fields, Insitu Imaging of Creep Cavities by Synchrotron Microradiography, *Scripta Metallurgica* **23** (1989) 623-625.

21. J.P. Farris, J.D. Lee, D.G. Harlow, and T.J. Delph, On the Scatter in Creep Rupture Times, *Metallurgical Transactions A* **21A** (1990) 345-352.

22. D.G. Harlow and S.L. Phoenix, Approximations for the Strength Distribution and Size Effect in an Idealized Lattice Model of Material Breakdown, *Journal of the Mechanics and Physics of Solids* **39** (1991) 173-200.

23. D. Xiao, D.G. Harlow, and T.J. Delph, Numerical Solutions of the Random Paris-Erdogan Equation, *Engineering Fracture Mechanics* **40** (1991) 227-231.

24. D.G. Harlow and T.J. Delph, The Numerical Solution of Random Initial-Value Problems, *Mathematics and Computers in Simulation* **33** (1991) 243-258.

25. D. Xiao, J.E. Yukich, D.G. Harlow, and T.J. Delph, A Simplified Probabilistic Model of the Growth of Creep Cavitation, *Philosophical Magazine A* **65** (1992) 71-84.

26. D.G. Harlow and T.J. Delph, Solutions of Random Initial Value Problems, *Proceedings of the International Union of Theoretical and Applied Mechanics: Symposium on Nonlinear Stochastic Mechanics* (July 1-5, 1991) Eds. Bellomo, N. and Cascatti, F., Springer-Verlag, (1992) 273-283.

27. D.G. Harlow and J.E. Yukich, Empirical Process Methods for Classical Fiber Bundles, *Stochastic Processes and Their Applications* **44** (1993) 141-158.

28. R.P. Wei and D.G. Harlow, Materials Considerations in Service Life Prediction, *Applied Mechanics Reviews* **46** (1993) 190-193; Part of *Aging of Energy Production and Distribution Systems*, edited by M.M. Carroll and P.D. Spanos, ASME Book AMR128, 1992.

29. D.G. Harlow and R.P. Wei, A Mechanistically Based Approach to Probability Modeling for Corrosion Fatigue Crack Growth, *Engineering Fracture Mechanics* **45** (1993) 79-88.

30. D.G. Harlow and R.P. Wei, Probability Approach for Prediction of Corrosion and Corrosion Fatigue Life, *AIAA Journal* **32** (1994) 2073-2079.

31. R.P. Wei, D. Masser, H. Liu, and D.G. Harlow, Probabilistic Considerations of Creep Crack Growth, *Materials Science and Engineering* **A189** (1994) 69-76.

32. J.R. Cockman, R.J. Fields, T.J. Delph, and D.G. Harlow, Spatial Statistics of Creep Cavities, *Modelling and Simulation in Materials Science and Engineering* **3** (1995) 187-200.

33. D.G. Harlow and T.J. Delph, A Computational Probabilistic Model for Creep-Damaging Solids, *Computers and Structures* **54** (1995) 161-166.

34. P.J. Laumakis and D.G. Harlow, Probability Failure Modeling of Woven Fiber Networks, *Textile Research Journal* **65** (1995) 254-264.

35. H. Liu, M. Gao, D.G. Harlow, and R.P. Wei, Grain Boundary Character, and Carbide Size and Spatial Distribution in a Ternary Nickel Alloy, *Scripta Metallurgica et Materialia* **32** (1995) 1807-1812.

36. D.G. Harlow and R.P. Wei, Probability Modeling for the Growth of Corrosion Pits, *Structural Integrity in Aging Aircraft* **AD-47** ASME (1995) 185-194.

37. P.J. Laumakis and D.G. Harlow, Asymptotic Approximations Used in Probabilistic Failure Modeling of Woven Fiber Networks, *Textile Research Journal* **65** (1995) 731-738.

38. D.G. Harlow, Reliability Modeling Based on Fatigue Crack Growth, *International Journal of Mathematical Education in Science and Technology* **27** (1996) 447-454.

39. D.G. Harlow, H.-M. Lu, J.A. Hittinger, T.J. Delph, and R.P. Wei, A Three Dimensional Model for the Probabilistic Intergranular Failure of Polycrystalline Arrays, *Modelling and Simulation in Materials Science and Engineering* **4** (1996) 261-279.

40. N.R. Cawley and D.G. Harlow, Spatial Statistics of Particles and Corrosion Pits in 2024-T3 Aluminum Alloy, *Journal of Materials Science* **31** (1996) 5127-5134.

41. M. Gao, S. Chen, D.G. Harlow, and R.P. Wei, Preferential Coarsening of γ'' Precipitates in Inconel 718 During Creep, *Metallurgical and Materials Transactions* **27A** (1996) 3391-3398.

42. P.J. Laumakis and D.G. Harlow, Designing a Model of a Platform Crane, *The Journal of Undergraduate Mathematics and Its Applications* **17** (1996) 397-414.

43. D.G. Harlow and T.J. Delph, A Probabilistic Model for Creep-Fatigue Failure, *Journal of Pressure Vessel Technology* **119** (1997) 45-51.

44. D.G. Harlow, Statistical Properties of Hybrid Composites: Asymptotic Distributions for Strain, *Reliability Engineering and System Safety* **56** (1997) 197-208.

45. J.T. Gliniak, D.G. Harlow, and T.J. Delph, A Probabilistic Model for the Growth of Creep Cracks, *Engineering Fracture Mechanics* **57** (1997) 25-40.

46. D.G. Harlow and R.P. Wei, A Probability Model for the Growth of Corrosion Pits in Aluminum Alloys Induced by Constituent Particles, *Engineering Fracture Mechanics* **59** (1998) 305-325.

47. J. Park and D.G. Harlow, Statistical Modeling of Interfacial Damage of Polymer Encapsulated Microelectronic Devices, *International Journal of Microcircuits and Electronic Packaging* **21** (1998) 171-176.

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45. D.G. Harlow, P.K. Liaw, W. Peter, G. Wang, and R.A. Buchanan, An Approach to Modeling the S-N Behavior of Bulk-Metallic Glasses, *2005 TMS Annual Meeting & Exhibition; Symposium on Bulk Metallic Glasses*, San Francisco, February 13 – 17, 2005.

46. R.P. Wei, D.G. Harlow, M.Z. Wang, R.G. Buchheit, and N. Birbilis, Modeling of Localized Corrosion and Corrosion Fatigue Damage Accumulation, *DARPA Prognosis Meeting*, Sedona, AZ, February 8 – 11, 2005.

47. D.G. Harlow, Spatial Statistics Of Particle Clusters And Modeling Of Pitting Corrosion, *Eighth U.S. National Congress on Computational Mechanics (USNCCM8)*, Austin, TX, July 25 – 27, 2005 (invited).

48. N. Birbilis, R.G. Buchheit, R.P. Wei, D.G. Harlow, and M. Wang, Predicting Corrosion and Corrosion Fatigue in AA7075-T651 used in Airframes, NACE, 2005.

49. R.P. Wei, D.G. Harlow, M.Z. Wang, R. Buchheit, and N. Birbilis, On the Need for Mechanistically Based Modeling in Life Prediction and Reliability Analysis, *EUROCORR 2005*, Lisboa, Portugal, September 4 – 8, 2005 (invited, plenary).

50. R.P. Wei, D.G. Harlow, and R. Buchheit, Mechanistically Based Probability (MBP) Modeling In Design, Fleet Management and Sustainment, *AF Aging Aircraft Technical Interchange Meeting (TIM)*, Tinker AFB, OK, October 18 – 19, 2005 (invited).

51. D.G. Harlow, Mechanics Based Probability Modeling for Minimum Life Estimation of S-N Data, *TMS 2006 135th Annual Meeting & Exhibition; A Symposium in Honor of Art McEvily's 80th Birthday*, San Antonio, March 12 – 16, 2006.

52. D.G. Harlow, Modeling Pitting Corrosion Induced by Clusters of Particles, *15th U.S. National Congress of Theoretical and Applied Mechanics*, Boulder, CO, June 25-30, 2006 (invited).

53. D.G. Harlow, M.-Z. Wang, and R.P. Wei, Probability Modeling to Reflect The Influence of Microstructure, *Materials Damage Prognosis and Life Cycle Engineering*, Snowmass, CO, July 24-28, 2006 (invited).

Technical Reports:

1. D.G. Harlow, R.L. Smith, and H.M. Taylor, The Asymptotic Distribution of Certain Long Composite Cables, Technical Report No. 384, School of Operations Research and Industrial Engineering, Cornell University, Ithaca, NY, Aug. 1978.

2. D.G. Harlow, D. Wei, and J. Keverian, Development of a Reliability, Availability, and Maintainability (RAM) System for the Narrow Strip Production (NSP) Process (proprietary), Kennecott/Chase Brass and Copper, Aug. 1982.

3. D.G. Harlow, Reliability Analysis for the F-18 Main Landing Gear (proprietary), McDonnell Douglas Technical Report, Fall 1985.

4. D.G. Harlow and E.M. Wu, Antenna Wire Reliability (proprietary), NADC Technical Report, Fall 1987.

5. D.G. Harlow, Separation of Three Populations of White Blood Cells from a Histogram (proprietary), Baker Instruments, Spring 1988.

6. D.G. Harlow, Statistical Sampling Plan for the Oyster Creek Drywell Vessel (proprietary), GPU Nuclear, Fall 1990.

7. D.G. Harlow, Reliability Functions for Composite Materials Models, USN/NPS, Report N62271-90-M-2999, Spring 1991.

8. D.G. Harlow and R.P. Wei, A Probability Approach for Prediction of Corrosion and Corrosion Fatigue Life, *Airworthiness Assurance R&D Branch - 1995 Research Accomplishments*, FAA, Atlantic City, 1995, 45-46.

9. D.G. Harlow, N.R. Cawley, and R.P. Wei, Spatial Statistics of Particles and Corrosion Pits in 2024-T3 Aluminum Alloy, *Airworthiness Assurance R&D Branch - 1995 Research Accomplishments*, FAA, Atlantic City, 1995, 47.

10. R.P. Wei and D.G. Harlow, Corrosion and Corrosion Fatigue of Airframe Materials, U.S. Department of Transportation, Federal Aviation Administration, DOT/FAA/AR-95/76, February, 1996.

11. R.P. Wei and D.G. Harlow, Corrosion and Corrosion Fatigue of Airframe Materials: Final Report, U.S. Department of Transportation, Federal Aviation Administration, DOT/FAA/AR-00/22, July, 2000.

Contracts and Grants:

Principal or Co-principal Investigator:

Water Quality of the Barren River, NSF, 1972.

A Probabilistic Model for Fibrous Materials, NSF, 1980 - 1982.

Structural Reliability Characterization of Short Fiber Reinforced Plastics, General Motors Technology Center, (with A. Wang) 1981.

Development of a Reliability, Availability, and Maintainability System for Narrow Strip Processing, Chase Brass Company, (with J. Keverian) 1981 -1982.

Practical Robot Control Laws from the Theory of Dynamical Cell-to-Cell Mappings, NSF, (with S.H. Johnson) 1984 - 1986.

Fundamentals of Automated Inference, ONR/ASEE - NRL, (with P. Mast) 1985.

Reliability of the F18 Landing Gear, McDonnell Douglas Corporation - MDRL, 1985.

Investigations of Creep Cavitation in Type 304 Stainless Steel, DOE, (with T.J. Delph) 1985 - 1986.

An Experimental and Analytical Investigation into the Statistics of Creep Rupture, NSF, (with T.J. Delph) 1986 - 1988.

Antenna Wire Reliability, NADC, (with E.M. Wu) 1987.

Reliability and Durability Analysis of Cables, NRC/ONR - NPS, (with E.M. Wu) 1988 - 1989.

Reliability without Hermeticity: Task 4.4.3 Develop Models for Reliability Predictions, MCC/USAF, (with R. Jaccodine, D. Jaffe, and many others) 1991 - 1993.

Environmental and Stochastic Aspects of Creep Crack Growth, NSF (with R.P. Wei, T.J. Delph, M. Gao, and D. Dwyer) 1991 - 1995.

Corrosion and Corrosion Fatigue of Airframe Materials, FAA (with R.P. Wei, M. Gao, and R.D. Granata) 1992 - 1999.

Corrosion and Fatigue of Aluminum Alloys: Chemistry, Micromechanics and Reliability, AFOSR (with R.P. Wei and M. Gao), 1993 - 1996.

Mechanistically Based Temperature and Relative Humidity Reliability Model, MCC, 1993 - 1994.

Study of Fundamentals of Adhesion, Manufacturing, and Reliability of Organic Chip Attachment Adhesives and Process, SRC (with R.A. Pearson and others), 1994 - 1996.

Moisture Induced Subcritical Crack Growth at Coating Interfaces, SRC (with H.F. Nied and R.A. Pearson), 1996 - 1999.

Corrosion and Fatigue of Aluminum Alloys: Chemistry, Micromechanics and Reliability, AFOSR (with R.P. Wei), 1998 - 2000.

Airworthiness Assurance Center of Excellence, FAA, participant as an affiliate member, 1997 - 1999.

Visteon – Reliability, PA Department of Community and Economic Development, (with H.F. Nied and others), 2000 – 2002.

IGERT Formal Proposal: Environmental/Mechanical Interactions and Effects on the Integrity of Structural Materials, NSF (partnership with University of Tennessee, Knoxville), 2000 - 2004.

Accelerated Insertion of Materials (AIM) – Rotor Components, DARPA/DSO (partnership with Pratt & Whitney, and others), 2001 - 2004.

Northrop Grumman Corporation, Modeling for Corrosion and Corrosion Fatigue, DARPA, 2003 – 2008.

Data Fusion and Scientifically Based Modeling, USAF, 2006.

Probability and Statistics Teaching:

- Undergraduate:
  - Statistics
  - Probability
  - Engineering Reliability
  - Advanced Mechanical Design - Mechanical Reliability
- Graduate:
  - Applied Stochastic Processes
  - Mechanical Reliability
  - Random Vibrations
  - Probability Models in Mechanics
  - Stochastic Control
  - System Identification
  - Nondeterministic Models in Engineering

Jon C. Hawkins
Non-Destructive Examination Inspector
Peach Bottom Atomic Power Station

Current Certifications

- Level III Ultrasonic Testing (UT) – 15 years
- Level III Visual Testing (VT) – 15 years
- Level III Magnetic Particle Testing (MT)
- Level III Liquid Penetrant Testing (PT)
- NDE Instructor Certified
- PDI Ultrasonic Certified in RPV, Bolting & Overlay

Previous Certifications

- Level II Radiographic Film Interpretation (RTI)
- EPRI IGSCC Ultrasonic Certified

Experience

- 1978 to 1980: NDE Level I & Level II RT film Interpreter
  - International Union of Operating Engineers: Pipeline Radiography (several company's and locations)

- 1981 to 1986: Limerick Nuclear Generating Station Unit # 1,
  - Pre Service Inspection (PSI) Level II UT, VT, MT, PT

- 1986 to 1991: Limerick Nuclear Generating Station Unit # 2,
  - Pre Service Inspection (PSI) Lead L/II UT, VT, MT, PT

- 1991 to 1992: PECO Level II NDE Inspector

- 1992 to Present: PECO / Exelon NDE Level III NDE Inspection Specialist
  - Currently- Peach Bottom Atomic Power Station NDE Level III / Project Manager
  - PBAPS NDE Project Manager since 2001

- 2006 1R21 Oyster Creek Outage: Performed and Supervised Visual and Ultrasonic thickness readings of the drywell shell.

UT and VT Training

- EPRI, Level III Visual Inspection, 160 hrs
- PECO, VT-1. VT-2, VT-3 Visual Inspection, 40 hrs
- PECO, VT-1C. VT-3C Visual Inspection (IWE/IWL), 40 hrs
- EPRI, UT of High Energy Piping, 40 hrs
- EPRI, UT IGSCC Detection, 80 hrs

- EPRI, UT IGSCC Sizing, 40 hrs
- Sperry school for NDE, UT Weld Inspection, 40 hrs
- ASNT, UT Refresher course, 40 hrs
- PECO, NDE Instructor Training, 40 hrs

RESUME

EDWIN W. HOSTERMAN, P.E.
Mechanical/Nuclear Engineer

HOME ADDRESS

45 Clearview Drive
Mertztown, PA 19539
(610) 682-4256
e-mail address: ehosterman@ceinetworks.com

BUSINESS ADDRESS

Exelon Nuclear
200 Exelon Way
Kennett Square, PA
(610) 765-5947
e-mail address: edwin.hosterman@exeloncorp.com

REGISTRATION

Professional Engineer-Pennsylvania, Certificate No. PE-031089-E

EDUCATION

Bachelor of Science, Nuclear Engineering, Pennsylvania State University, 1977
Masters of Business Administration, Temple University, 1983

PRESENT EMPLOYMENT

Exelon Nuclear , December 2000 to present
Kennett Square

Position: Senior Staff Engineer

Responsibilities Include:

Corporate subject matter expert for heat exchangers, condensers and feedwater heaters as well as Corporate Program Owner for the Generic Letter 89-13 program. Developed Standard heat exchanger testing analysis methodology for Safety Related heat Exchangers. Responsible for formulating long term asset management strategies for condensers, feedwater heaters and buried piping. Has prepared corporate standards for the maintenance and testing of Balance of Plant heat exchangers, condenser air in-leakage testing and water in-leakage testing. Prepared Corporate standard specification for replacement feedwater heaters. Has also functioned as the Corporate Thermal Performance program manager. Prepared PEPSE model of the Limerick Generating station.

PREVIOUS EMPLOYMENT

Senentec Inc., and Hosterman Engineering, Inc. January 1999 to December 2000

PECO Nuclear Co.
Limerick Generating Station

Position: Consulting Engineer

Responsibilities Include:

- Reviewed design Calculations as part of the Limerick Calculation Improvement Project
- Prepared design packages for the replacement of Service Water system valves during the 2RO5 refueling outage
- Provided installation support for the ECCS Suction Strainer modification

- Prepared room temperature analysis for various rooms at the Peach Bottom Atomic Power Station, in support of the Fire Safe Shutdown modifications
- Prepared blowdown and room pressurization analysis in support of the Limerick Reactor Water Cleanup pump replacement.

PREVIOUS EMPLOYMENT Apollo Consulting
Pa. Power and Light Co. August 1998 to Jan. 1999

Position: Consulting Engineer

Responsibilities Included:

- Prepared calculations to provide the design basis for the process flow diagrams for the HPCI, RCIC, RWCU, Core Spray, RHR and Control Rod Drive systems as part of Licensing basis project.

PREVIOUS EMPLOYMENT PECo Energy Company, March 1992 to August 1998

Position: Senior Engineer

Responsibilities Included:

- Lead Responsible Engineer for the Emergency Service Water (ESW) and Residual Heat Removal Service Water Systems (RHRSW).
- Program owner for the Generic Letter 89-13 program for both the Limerick and Peach Bottom Stations.
- Developed PECo's heat exchanger testing program and a methodology for statistically analyzing test data.
- Responsible for all hydraulic analysis to support system modifications and system flow balancing at both the Peach Bottom and Limerick Generating Stations.
- Developed transient temperature models for the ECCS pump rooms at both Limerick and Peach Bottom. These models have been used to reanalyze the effects of a DBA LOCA on room temperatures as well as evaluating the effects of pipe breaks on reactor building temperatures.
- Re-evaluated all heat loads served by the ESW and RHRSW systems and Ultimate Heat Sink for both Limerick and Peach Bottom. This re-evaluation reduced the need for testing and cleaning of heat exchangers at the stations and reduced the post accident UHS temperature at Limerick.
- Provided consulting services regarding heat exchanger repairs and maintenance instructions for both Limerick and Peach Bottom.
- Served as the Lead Engineer for several major modifications, in charge of conceptual and final designs, material procurement and installation support. Modifications included:

  a) Install crosstie lines between the ESW and RHRSW systems at Limerick to facilitate on-line lining of approximately 3000 ft of buried piping.

  b) Design and install corrosion monitoring racks to monitor the condition of the Service Water and ESW systems at Peach Bottom.

  c) Install Radiation Monitors on the High Pressure Water System at Peach Bottom.

  d) Designed and installed a heat exchanger simulator to monitor the condition of the RHR heat exchanger at Limerick. This system allowed the Limerick units to operate for a whole refueling cycle following the discovery of severe pitting in the RHR heat exchanger tube bundle. This allowed the planned replacement of the heat exchangers to be performed without requiring an extended refueling outage. The estimated savings to PECo for this modification were 85 - 87 million dollars.

e) ECCS Suction Strainer replacement for both Peach Bottom and limerick generating Stations to meet the requirements of NRC Bulletin 96-03

- BWR Owners Group representative for ECCS Suction Strainer Working group and NPSH Generic Letter.

- Electric Power Research Institute Service Water Assistance Project Co-ordinator

PREVIOUS EMPLOYMENT <u>Bechtel Power Corporation, March 1988 to March 1992</u>

<u>Major Assignment:</u>

Mechanical Group Supervisor
March 1988 to March 1992
Pottstown Regional Office
Pottstown, PA

<u>Responsibilities Included:</u>

- Mechanical Engineering Group Supervisor for the Susquehanna Steam Electric Station projects. Supervised a staff of mechanical engineers performing engineering services for Pennsylvania Power and Light Company.
    - Supporting a 5% Power Uprate Project. Support services provided include analyis of the effects of increases in service water temperatures on reactor building room temperatures, analyzing the effects of higher steam flows on existing high energy line break analysis and performing research into the design basis for other plant systems as required by PP&L.
    - Provided engineering services in support of an electrical safety system functional inspection being conducted by the NRC for the Susquehanna SES. Tasks involved analysis of fuel oil requirements and tankage capacity for the emergency diesel generators, preparing analytical models of the control structure and reactor buildings and analyzing the current HVAC capacity versus existing heat loads within the buildings, reviewing the design of the control structure chillers to determine the effects of tube plugging on HVAC performance and reviewing the emergency service water system to determine the effects of the loss of various components on plant availability.
    - Supervised and was involved in the preparation of several design basis studies of other systems at the SSES, including the Containment Vacuum Breakers, the Process Valve Leakage Collection System, and the Backdraft Isolation Dampers.

- Supervised and participating in support for the Safety System Functional Inspection of the Emergency Service Water and High Pressure Coolant Injection systems at the Peach Bottom Atomic Power Station.

- Supervised a design basis reconciliation project for the Hope Creek and Salem Generating Stations and prepared engineering modifications to the Limerick Generating Station.

PREVIOUS EMPLOYMENT Pennsylvania Power & Light Co., April 1983 to <u>March 1988</u>

<u>Major Assignment:</u>

Project Engineer
April 1983 to March 1988
Nuclear Plant Engineering Department
Allentown, PA

Responsibilities Included:

- Lead System Engineer for HPCI and RCIC systems
- Lead Mechanical System Engineer for the plant fire protection and liquid and solid radioactive waste treatment systems.
- Lead Mechanical Engineer for programmatic concerns such as high energy line break analysis, several nuclear piping and system design reviews for compliance with the ASME III piping codes, modifications to mitigate the effects of an Anticipated Transient Without Scram and personnel radiation exposure minimization.

PREVIOUS EMPLOYMENT	Bechtel Power Corporation, May 1979 to April 1983
Major Assignment:	Senior Field Engineer May 1979 to April 1983 1100 MW BWR, Limerick Generating Station Pottstown, PA
PREVIOUS EMPLOYMENT	Burns & Roe, Inc., June 1977 to April 1979
Major Assignment:	Mechanical/ Nuclear Engineer June 1977 to April 1979 Nuclear Analysis Group Oradell, N.J.

Martin McAllister
Oyster Creek Nuclear Generating Station
Route 9, Forked River, New Jersey 08731

Current Certifications

Level III Ultrasonic Testing (UT)
Level III Magnetic Particle Testing (MT)
Level III Liquid Penetrant Testing (PT)
Level III Visual Testing (VT)
NDE Instructor Certified
PDI Ultrasonic Certified

Previous Certifications

Level II Radiography Testing (RT)
AWS/CWI Visual Inspector
IGSCC Ultrasonics Certified

Experience

1978 to 1991
NDE Level II Inspector / Supervisor
Construction of Susquehanna Steam Electric Station and Limerick Generating Station

1991 to Present
Oyster Creek Nuclear Generating Station, Currently- Station NDE Level III

Specific drywell liner experience:

Performed ultrasonic thickness readings of the Drywell liner shell from 1991-1994 and supervised exams (both VT and UT) from 1994 to present.
Certified as Level III UT over 13 yrs.
Certified as Level III VT over 9 yrs.

Training - UT and VT only

A.W. Beattie Tech School – Nuclear / Metallurgy / NDE – Diploma 1978, 170 hrs NDE
AWS, CWI Visual Inspection, 40 hrs
EPRI, Level III Visual Inspection, 40 hrs
GPUN, VT-1. VT-2, VT-3 Visual Inspection, 56 hrs
EPRI, UT of High Energy Piping, 40 hrs
EPRI, UT IGSCC Detection, 40 hrs
EPRI, UT IGSCC Sizing, 40 hrs
Magnaflux, UT Weld Inspection, 40 hrs
ASNT, UT Inspection, 40 hrs
EPRI, NDE Instructor Training, 40 hrs

AHMED M. OUAOU, PE

1103 Shadow Wood Drive
Downingtown, PA 19935 **(484) 947-3765**

SUMMARY

Registered professional engineer with extensive, diversified experience in civil/structural design, stress analysis, plant and construction support, and licensing. Areas of expertise include:

License Renewal
Configuration control
Project Management
Civil/structural Design and Analysis
Dynamic Qualification of Equipment
Process and procedure development
Design Basis Documents
Design Review/Assessment
Licensing Documents Update

PROFESSIONAL EXPERIENCE

License Renewal Experience:

Three Mile Island Nuclear Station Unit 1 03/2007 – Present

- Developed ASME Section XI, Subsection IWE, IWL, IWF, and Structures Monitoring aging management programs. The documents provide technical basis for the adequacy of TMI-1 aging management activities to support the extended period of operation.
- Supported scoping of structures and development of aging management reviews on an advisory role.

Oyster Creek Generating Station License Renewal Application 11/2003 – 03/2007

- Civil/Structural lead for Oyster Creek (OC) license renewal application.
- Performed scoping, screening, and aging management reviews for OC structures
- Prepared aging management program (AMPs) basis documents and aging management review technical basis documents.
- Evaluated Oyster Creek AMPs for consistency with NUREG-1801 AMPs
- Developed Oyster Criteria for scoping of systems and structures to meet 10 CFR 54.4 (a)(2), and NRC Staff Interim Staff Guidance (ISG-09).
- Prepared civil/structural sections of the Oyster Creek license renewal application
- Prepared position papers and project level instructions for performing scoping, screening, and aging management review of systems and structures.
- Presented scoping and screening methodology of Oyster Creek structures and 10 CFR 54.4 (a)(2) scoping to the NRC scoping and screening methodology audit team.
- Supported the NRC AMP/AMR audit team and interfaced with the Staff and its consultants to resolve AMP and AMR questions and issues
- Prepared response to RAIs and interfaced with NRC Staff to resolve technical issues.
- Prepared presentation for, and supported the ACRS Subcommittee review of the OC drywell corrosion issue.
- Participated in industry review of the draft NUREG-1801 Rev. 1
- Member of NEI Civil/Structural Working Group team.
- Provided technical support to the drywell corrosion issue legal team.

Browns Ferry License Renewal Application 07/2003 – 11/2003

- Performed scoping and screening of Browns Ferry structures
- Review AMRs prepared by TVA consultants

Peach Bottom License Renewal Application 04/2001 – 06/2003

- Performed scoping, screening, and aging management reviews for Peach Bottom structures and selected mechanical systems.
- Wrote civil/structural sections of the application

- Prepared response to RAIs and interfaced with NRC Staff to resolve technical issues identified during its review of the LRA
- Participated in ACRS Subcommittee hearings and responded to ACRS member's questions related to structures.
- Reviewed and commented on NUREG-1801 Rev.0.
- Participated in industry peer review of Hatch, ANO-1, and Dresden/Quad LRAs.

Construction and Plant Support Experience

Limerick Generating Station 1998 -2001

Design and review the design of plant modifications for technical adequacy

Develop engineering strategy for resolving Thermo-Lag raceway encapsulation deficiencies identified in NRC Generic Letter 92-08

Maine Yankee Power Station

- Review open items for nuclear safety significance, equipment reliability, licensing commitments, and recommend their implementation strategy prior to restart from NRC Shutdown Order.
- Assess Maine Yankee's Corrective Action Program for compliance to 10 CFR 50 Appendix B requirements.

Peach Bottom Atomic Power Station.

Assess a pressure vessel for stress and fatigue Code requirements. Prepare a summary report for the client on the available design margin. Develop a specification to assess Motor Operated Valves for maximum thrust/torque. Design structural modifications for pump intake structures. Prepare procurement documents and installation work packages for modifications.

PECO ENERGY COMPANY, Philadelphia, PA

Site Support Engineer 1993 - 1996

Responsible for the design, procurement, and planning of plant modifications. Resolved Nonconformance Reports, and Engineering Change Requests. Resolved configuration control issues. Worked with plant operations and maintenance to improve plant equipment and systems performance.

- Designed modifications to structures, and equipment to enhance plant safety, performance, and improve productivity. These changes in conjunction with other plant initiatives reduced Power Plant refueling outage length from 120 days to 22.8 days. Set world record.
- Considered a subject matter expert on dynamic qualification and design of structures and equipment.
- Designed reactor cavity stair tower. The tower is considered a first in the US nuclear industry. Its use reduces refueling outage critical path time by 4 hours. The design was selected by the company for submittal as a candidate for 1995 Power Industry "Innovative Design Idea" Award.

Branch Manager, Processes and Procedures, Wayne, PA 1990 - 1993

Responsible for planning, developing, and implementing engineering processes, policies, directives, and procedures. Resolved configuration issues associated with Peach Bottom power plant shutdown. Managed work performed by consultants and contractors.

BECHTEL POWER CORPORATION, San Francisco, CA

Project Engineer 1989 - 1990

Responsible for scope, cost, and schedule of the $8.4 million design turnover project from the Bechtel to the client. Managed multi-discipline group activities associated with the turnover.

Site Project Manager 1988 - 1989

Responsible for establishing and staffing site project manager's office that is recognized as the focal point for all engineering requests. Coordinated engineering activities to ensure prompt support of critical construction, maintenance, and operations activities. Managed design and installation of modifications.

Resident Project Engineer 1987 - 1988

- Managed a multi-discipline engineering team responsible for Limerick construction support.

Engineering Group Supervisor 1981 - 1987

- Directed and provided technical direction for up to 60 engineers responsible for civil/structural design and assessment of Susquehanna Steam Electric Station, and Limerick Generating Nuclear Station structures and commodities.

Structutal Design Experience: 1977 - 1980

- Designed steel, reinforced concrete, and masonry wall structures for Susquehanna, Limerick, Peach Bottom, Trojan, and Midland nuclear power plants.
- Performed static and dynamic analysis using SAP, ANSYS, and STRUDL computer codes.
- Performed finite element analysis to evaluate Susquehanna Steam Electric Station, and Limerick Generating Nuclear Station Mark II containments for BWR Mark II containment hydrodynamic loads.
- Designed and evaluated structures and equipment for Design Basis Accident Loads.
- Developed test plans and evaluated dynamic testing of Category I equipment and structures.
- Developed Project Specification for assessing Seismic Category II/I Items.
- Developed masonry design criteria and standard details specific to nuclear plant structures.
- Developed response to NRC IE Bulletins 79-02, 79-14, and 80-11.

Engineer, Mining and Metals Division 1974 - 1977

Responsible for the design of concrete and steel structures for two $100 million dollar projects. Designed tanks, hoppers, conveyor towers and pipe racks. Prepared conceptual designs and plant layout for industrial project. Prepared cost estimates, and bid packages that resulted in job awards to the company.

EDUCATION

B.S. - Civil Engineering, University of Nevada at Reno
Graduate courses in Civil Engineering, University of California, Long Beach
Registered Professional Engineer, PA, CA

Resume of John F. O'Rourke

Present Position

Senior Project Manager, License Renewal, Exelon Nuclear, Kennett Square

Previous Positions

June 11, 1973
Joined the Philadelphia Electric Company as an Assistant Engineer in the Power Plant Services Section of the Mechanical Engineering Division

November 4, 1974
Transferred to Power Plant Design Section, Mechanical Engineering Division

June 5, 1976
Engineer, Power Plant Design Section

April 20, 1981
Appointed as Group Leader, Piping and Pipe Supports, Power Plant Design Section

May 26, 1984
Senior Engineer, Power Plant Design Section

June 23, 1984
Appointed as Branch Head, Plant Design and Metallurgy (formerly Fossil Steam Supply) Branch, Power Plant Design Section

March 22, 1986
Appointed as Supervising Engineer and Branch Head, Nuclear Services Branch, Power Plant Services Section

October 31, 1987
Appointed as Manager, Corporate Nuclear Quality (formerly Quality Support) Division, Nuclear Quality Assurance

December 1, 1989
Appointed as Manager, Limerick Quality Division, Nuclear Quality Assurance

May 18, 1992
Appointed as Acting Projects Division Manager, Limerick Generating Station (until Dec. 31, 1992)

April 1, 1993
Appointed Senior Manager, Design Engineering, Site Engineering, Limerick Generating Station.

November 18, 1996

Appointed Manager, Procedures Branch, Nuclear Engineering Division, Chesterbrook.

May 27, 1997

Appointed Manager, Engineering Assurance and Procedures Branch, Nuclear Engineering Division, Chesterbrook.

October 18, 1999

Appointed Manager, Mechanical Branch, Nuclear Engineering Division, Chesterbrook

October 20, 2000

Appointed Senior Manager, Mechanical Branch, Mid-Atlantic Regional Operating Group, Engineering Division, Exelon Nuclear, Kennett Square

July 28, 2003

Appointed Assistant Site Engineering Director for the Oyster Creek Generating Station

September 4, 2006

Assigned to License Renewal Project, Exelon Nuclear, Kennett Square as a Senior Project Manager for Oyster Creek and Salem/Hope Creek activities

Work Assignments

2006 – Present

Assigned to License Renewal Project for Oyster Creek to assist with completion of Oyster Creek activities including NRC Safety Evaluation Report review/comments, ACRS Meetings preparation/execution including preparing and delivering presentations to the ACRS Subcommittee and Full Committee, Re-Analysis of Oyster Creek drywell (Project Manager) and the Evaluation of the Oyster Creek Refueling Cavity Liner leakage (Project Manager). Appointed as the Senior Project Manager to manage all aspects of the Salem/Hope Creek License Renewal Project under contract to PSEG.

2003 – 2006

Responsible, along with the Director, for the management and leadership of the Engineering Department at Oyster Creek. Acts as Director, when the Director is away from the site, and as Senior Manager, Design and Plant Engineering (positions combined into Asst. Director position under Single Site Staffing Initiative). Develops and manages the Engineering Department budget. Provides the site single point of contact for Configuration Management activities and leadership and management of design and modification related activities for the site, including capital and expense projects/checkbook. Chairs the Design SubCommittee of the Plant Health Committee and the Curriculum Review Committee. Provides the site management sponsorship, interface and oversight for License Renewal technical activities (application, program and technical basis documents, audits, training, site engineering support, etc.). Acting Director from April, 2006 thru June, 2006

1999 - 2003

Responsible for high-end technical support, consultation and mentoring to the site Design Engineering and Plant Engineering organizations in the areas of accident analysis, thermal-hydraulic analysis, diesels, heat exchangers and condensers, structural/dynamic qualification, finite element analysis, HVAC/compressors, turbines and pumps. Responsible for developing strategic plans for the Regional Operating Group in the Mechanical and Structural areas. Responsible for Program management for selected programs (e.g., Dynamic Qualification). Completed transitioning TMI and Oyster Creek support from Parsippany including training and qualification of personnel, staffing and software support. Provided outage support for Limerick as the MSRV Modification "Make-It-Happen" Manager. Continuing as the lead for the Design Change Process Team as the Engineering organizations develop a process ownership approach to Engineering processes. Also, continuing as the lead for the Configuration Management strategy and as the Custodial Team Leader for the PIMS ECR Module. Provided support for MWROG with their implementation of Passport and for the implementation of PIMS at TMI and Oyster Creek.

1996 - 1999

Responsible for the common procedure activities (Administrative, Engineering, Modifications) within the Nuclear Group. This includes providing leadership for improvement initiatives and for the former Document Steering Committee. On May 27, 1997, the Engineering Assurance Branch was merged with the Procedures Branch providing the added responsibility for the technical assessment of engineering and configuration management activities throughout the Nuclear Group. This activity as well as the procedure activities directly support Nuclear Engineering Division's role as the PECON Design Authority. Outage support for the Limerick refueling outages provided via assignments as Engineering Duty Manager and MSIV and MSRV Modifications "Make-It-Happen" Manager. During the Nuclear Group Project to develop PassPort as a replacement for PIMS, acted as the Implementation Team Leader for the Engineering module which included working with British Energy counterparts to design a completely new module. Appointed as the lead for the Design Change Process Team and the lead for the Information Technology and Configuration Management strategies. Worked with TMI personnel to develop the appropriate application of technical assessment activities for TMI. Acted as a peer evaluator for an INPO Assistance visit to Fitzpatrick.

1993 - 1996

Responsible for ensuring timely, high quality, day-to-day station support for resolution of Design Engineering issues and for the design of engineering projects (small modifications, minor physical changes, design equivalent changes, etc.). Responsible for ensuring configuration control is maintained, facilitating the removal of organizational and cultural barriers impacting Design Engineering's performance, interfacing with on-site customers and Peach Bottom and Chesterbrook counterparts. Outage support for Limerick refueling outages provided via assignments as the Shift Outage Director, Engineering Duty Manager and MSIV Modification "Make-It-Happen" Manager.

1992

Responsible for managing activities within the Limerick Projects Division which included the Outage Section, Materials Management, Regulatory and the Modifications Group. Responsibilities included business planning and cost control (Both Projects Division and Limerick Quality Division under budget in 1992)

1989 - 1993

Responsible for the independent oversight (i.e. Single point accountability) of all Quality activities at Limerick Generating Station. Activities include auditing, inspections, surveillances, monitoring and reviews. Significant activities included reduction in contractor personnel, initiation of formal divisional self-assessment activities, budget compliance, and "customer" interface.

1987-1989

Responsible for the independent oversight of Corporate Nuclear Group organizations (i.e., Single point accountability for oversight of Nuclear Engineering and Nuclear Services Departments quality activities) for work performed under the PBAPS and LGS Operational Quality Assurance

Plans. Also responsible for all vendor audit/surveillance activities, security screening auditing, QATTS technical support, PBAPS/LGS FSAR (Chapter 17) and Quality Assurance Plans preparation/revision and NQA Procedure and Budget coordination. Served as the Acting PBAPS Quality Manager in 1989 during the absence for training purposes of the current Quality Manager. This assignment included heavy HR and OD interface as well as training in MARC, Interaction Management and Managing Organizational Change. Also, changing culture in the Nuclear Group and in NQA and downsizing of NQA required significant management attention.

1986-1987

Responsible for design activities associated with various systems that support nuclear plant operations, i.e., Diesel generators, Air and Nitrogen Systems, Gaseous Radwaste Systems, PASS, CAC, Containment, etc. This required interfacing with the plant staffs as the "customer" focal point for resolution of system operating problems. Also served as ERDP (Engineering & Research Department Procedures) Task Force Chairman during this period which required extensive interface with the Quality Assurance organizations.

1975-1986

Responsible for piping and pipe support design activities. This required working closely with plant staff personnel during the investigation and resolution of piping/pipe support problems. It also included reviewing operating data to identify plant conditions that might have caused the problems. Frequent plant inspections were made during this period.

Appointed as Group leader for all piping and pipe support design activities for nuclear and fossil plants in April, 1981. Appointed as Branch head, Plant Design and Metallurgy Branch (formerly Fossil Steam Supply Branch) in June, 1984 responsible for nuclear and fossil piping and pipe support design activities, nuclear and fossil valve design activities and fossil steam supply systems.

Significant activities performed during this period included:

- Project Manager, Peach Bottom Unit 2 Recirculation/RHR Piping Replacement. The majority of the management of the field activities was done via full time site presence working in close concert with the contractor and the plant technical/outage staff.
- Project Engineer, Eddystone Unit 1 main steam piping replacement.
- Project Engineer, Peach Bottom torus attached piping modifications associated with Mark I containment program. These activities required frequent on-site presence.
- Project Engineer, I.E. Bulletin 79-14 field inspections and modifications.

1974-1979

Responsible for the design of modifications related to the Offgas Systems at the Peach Bottom Atomic Power Station. This included the review/investigation of operating difficulties with the System which required plant staff interface and field inspections.

1973-1974

Responsible for various fossil plant projects, such as equipment replacements and preparation of waste water permits.

Educational Background

Bachelor of Science in Mechanical Engineering, Drexel University, 1973, *cum laude*

Master of Science in Mechanical Engineering, Drexel University, 1975

Master of Science in Engineering Management, Drexel University, 1983

Professional Engineer, Commonwealth of Pennsylvania, 1976

Penn State Executive Management Program, 1989

PECO Quality Management Training, 1991, 1992, 1993

Senior Reactor Operators (SRO) Certification at Limerick, 1991

Three Mile Island Unit 1 Systems Training, 1999

Professional Activities

American Society of Mechanical Engineers, Philadelphia Section

Member 1974 to 1997, held various committee chairmanships and officer positions, Section Chairman 1983-1984

American Nuclear Society, Delaware valley Section

Member 1977 to 1993

American Society for Quality Control

Member 1988 to 1993

Delaware Valley Engineers' Week Committee

Vice-Chairman 1985-88, Secretary 1988-89, Chairman, Engineer of the Year Election Committee 1989

Edison Electric Institute Quality Assurance Committee

Alternate Philadelphia Electric representative for the NQA General Manager and Vice-Chairman of the Nuclear Sub-Committee, 1988 to 1993

Institute of Nuclear Power Operations (INPO) Peer Evaluator, 1997

Updated 4/4/07

Fred Polaski
License Renewal Manager, Exelon Nuclear
200 Exelon Way
Kennett Square, Pennsylvania 19348

Experience

- Over 36 years experience in engineering and management with Philadelphia Electric, PECO and Exelon
- 1971-1996: Held various positions in nuclear engineering and management, mostly at Peach Bottom Atomic Power Station:
    - System Engineer
    - Maintenance Engineer
    - Lead Reactor Engineer
    - Outage Manager
    - Assistant Superintendent Operations during Peach Bottom restart
    - Senior Project Manager
    - Manager Independent Safety Engineering Group
- 1978: Earned Senior Reactor Operator's License on Peach Bottom Atomic Power Station
- 1996: PECO project manager for the NEI/NRC/Utility Demonstration Project on Implementation of NEI 95-10 and Part 54.
- 1996 to 2005: Member and Vice Chair of the Electric Power Research Instutute (EPRI) LCM Subcommittee, Chair of BWROG License Renewal Committee
- 1996 to present: Member of NEI License Renewal Task Force and License Renewal Working Group
- 1998: Project Director for Peach Bottom License Renewal project
- 2000-present: Exelon License Renewal Manager responsible for
    - Peach Bottom License Renewal Project - new license issued, May 2003
    - Dresden – Quad Cities License Renewal Project – new license issued, October 2004
    - Oyster Creek License Renewal Project
    - TMI 1 License Renewal Project
    - Planning for future license renewal projects within Exelon
    - Participant in Peer Reviews for several license renewal applications
    - Member of the License Renewal Assessment Board for Beaver Valley Nuclear Power Station application.

- Member various other industry groups on license renewal and LCM: EPRI MRP committee on Environmentally Assisted Fatigue, Member of the License Renewal Assessment Board for the Beaver Valley License Renewal Application, NEI License Renewal Electrical and Mechanical Working Groups, Westinghouse Owner's Group License Renewal Committee.

Education

- University of Delaware 1971 Bachelor's of Mechanical Engineering, with High Honors

Francis H. Ray
Engineering Programs Manager

Oyster Creek Nuclear Generating Station
Route 9, Forked River, NJ 08731

Experience

Over 26 years of experience in the Nuclear Industry.

December 2006-Present: Oyster Creek Nuclear Generating Station: Manager, Engineering Programs.

- Responsible for the day-day supervision of the program owners who implement the Regulatory driven Engineering Programs, which include the ASME In-Service Inspection (ISI) and drywell monitoring programs.
- Responsible for overseeing implementation of all license renewal commitments including those associated with the drywell shell integrity and inspection program.

January 2004 – December 2006: Oyster Creek Nuclear Generating Station: Manager, Mechanical / Structural Design

- Responsible for the day-to-day supervision of the Mechanical / Structural Design Engineering Branch whose primary activities included support of plant operations, configuration control, margin management, proactively defend the plant design and licensing basis, modifications, and ownership of a number of Aging Management Programs associated with the Oyster Creek Nuclear Generating Station License Renewal Application, including the drywell shell and related inspections and commitments.
- Supported NRC license renewal audits and inspections at the Oyster Creek Nuclear Generating Station in 2006.

June 1999 – January 2004: PECO / Exelon Nuclear at the Limerick Generating Station: Senior Mechanical / Structural Design Engineer

- Subject matter expert for piping and support design, structural bolting, ASME Code and Code Case interpretations associated with evaluations of ASME piping flaws due to corrosion.

September 1980 – June 1999: Stone and Webster Engineering Corporation (SWEC), Cherry Hill, NJ

- Over 18 years of extensive design experience in the civil and mechanical engineering disciplines associated with numerous nuclear power plants under construction (*e.g.* Nine Mile Point 2, RiverBend, Comanche Peak, Fermi 2, and Shoreham) and several licensed Operating plants (*e.g.* Peach Bottom Atomic Power Station, Limerick Generating Station, Three Mile

Island, RiverBend, Nine Mile Point 2, and Browns Ferry Nuclear Plant - Unit 2).

- Received extensive training in all aspects of design in BWR and PWR power plant design, construction, and maintenance.

Publication

"Cost Effective In Situ Small Bore Piping Qualification for Vintage Power Plants", ASME Pressure Vessel and Piping Division Conference, San Diego, Ca. (TP No. 91-50)

Education

Bachelor of Science, Civil Engineering, University of Pittsburgh, 1980

Peter Tamburro

Programs Engineer
Oyster Creek Nuclear Generating Station

Office Phone: (609) 971-4141

EXPERIENCE

2007 to present - **Programs Engineer,** AmerGen LLC, Oyster Creek Nuclear Generating Station, Forked River, NJ 08731. Maintain the following Oyster Creek Programs: Drywell Material Condition Program, Open Cycle Cooling Water Piping, and the Underground Piping Program. The purpose of these programs is to ensure that these systems will perform their function.

1999 to 2006 - **Mechanical Design Engineer,** AmerGen LLC, Oyster Creek Nuclear Generating Station, Forked River, NJ 08731

Responsibilities included: designing and managing modifications; resolving construction problems related to modifications; evaluating component failures; analyzing and correcting problems related to system and equipment degradation; and support engineering activities during scheduled and unscheduled outages.

Activities include developing: design criteria, installation and procurement specifications, construction sketches, and overseeing development of construction drawings. Examples of modification completed successfully are: installation of the 2004 DBT security systems, installation of various large piping systems such ESW, Service Water and Fuel Oil Transfer Lines.

Provided engineering support to troubleshoot and modify plant equipment, to avoid or recover from unscheduled outages. Performed and documented evaluations that support continued plant operation. Provided input to management with regard to economic justification for funding future projects and modifications.

Responsible to ensure that UT inspection were performed in the upper drywell regions and visual inspections were performed in the sandbed region per plant commitments.

1991 to 1999 - **Mechanical Engineer,** GPU Nuclear Corporation (GPUNC), Oyster Creek Nuclear Generating Station, Forked River, NJ 08731

Responsibilities included: to support engineering activities during scheduled and unscheduled outages and to serve as an interface between plant and corporate engineering.

Activities include developing: design criteria, installation and procurement specifications, construction sketches, and overseeing development of construction drawings. This also includes following successful modifications in the field and disposition of field changes: replacement of a 2000 GPM fire protection pumphouse; rerouting of large bore piping and valves; installing HVAC equipment and process chillers; excavations to repair leaking underground Service Water lines; and installing temperature, pressure, flow and radiation instrumentation.

Provided engineering support to trouble shoot and modify plant equipment, to avoid or recover from unscheduled outages. Performed and documented evaluations that support continued plant operation. Developed heat exchanger monitoring programs. Provided input to management with regard to economic justification for funding future projects and modifications.

Also involved in a cross-disciplinary committee which "re-engineered" the project management process at GPUNC. Key person in specifying software for the new process.

1986 to 1991 - **Mechanical System Engineer,** GPUNC, 100 Interpace Parkway, Parsippany, NJ 07054

Member of the corporate engineering staff: responsibilities for both the Oyster Creek and Three Mile Island Unit #1 Nuclear Power Plants included: evaluating system problems and component failures; monitoring system parameters; analyzing, defining, and correcting problems related to system degradation; and design of plant modifications.

Performed and documented evaluations that supported regulatory Technical Specification revisions, and justifications for continued plant operation. This included calculations, technical reports, and responses to audits. Performed numerous studies and reviews related to system and component heat transfer capabilities and plant capacity improvements, including overall effects on plant heat rates. Member of the GPUNC Thermal Performance Committee whose purpose was to overview lost capacity issues and pursue corrective actions. Designed plant modifications for both plants and then followed construction in the field.

Major contributor to the Oyster Creek drywell corrosion abatement program. Responsibilities included defining requirements for an inspection program of the drywell pressure vessel. Coordinated inspection data reduction, performed and documented analysis, and reported results to upper management and the Nuclear Regulatory Commission.

1982 to 1988 - **Plant Analysis Engineer,** GPUNC, Parsippany, 100 Interpace Parkway, NJ 07054

Responsibilities involved developing and maintaining the Plant Thermal Performance and Availability Monitoring Programs for both the Oyster Creek and Three Mile Island Unit #1 Nuclear Power Plants. This involved developing and refining calculations, procedures, and methods for determining plant inefficiencies and loss generation. Developed thermal performance code models of both plants. These models have been a foundation for GPUNC thermal performance monitoring programs at both plants. Model outputs were used for the development of replica simulators of both plants.

Another responsibility was to review, for applicability to GPUNC plants, descriptions of adverse events which occurred in the nuclear industry. If applicable, it was my responsibility to implement action that would reduce the possibility for the events from occurring at GPUNC.

It was also my responsibility was to assist in the development of a SCRAM Frequency Reduction Program for GPUNC. The program established methods which reduced the number of unnecessary reactor trips at Oyster Creek. Participated for GPUNC on a nuclear industry committee which exchanged lessons learned.

1980 to 1982 - **Mechanical Test Engineer,** Newport News Shipbuilding & Drydock Company, Newport News, Virginia

Mechanical system testing of two A4W type nuclear power plants on the CVN-70 aircraft carrier.

EDUCATION

B.S. in Chemical Engineering from Clarkson University, Potsdam, NY (May 1980).
M.S. in Computer Science from Fairleigh Dickinson University, Teaneck, NJ (October 1986).
Professional Engineer, State of New Jersey, 1986.

APPLICANT'S EXH. 2

AmerGen℠
An Exelon Company

AmerGen Energy Company, LLC
200 Exelon Way
Kennett Square, PA 19348

www.exeloncorp.com

10 CFR 50
10 CFR 51
10 CFR 54

2130-05-20159

July 26, 2005

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Oyster Creek Generating Station
Facility Operating License No. DPR-16
NRC Docket No. 50-219

Subject: Application for Renewed Operating License – Reformatted CD-ROM

References: Letter from C. N. Swenson (AmerGen Energy Company, LLC) to U. S. NRC "Application for Renewed Operating License" dated July 22, 2005

AmerGen Energy Company, LLC (AmerGen) submitted an application for the renewal of the operating license for the Oyster Creek Generating Station (OCGS) pursuant to U. S. Nuclear Regulatory Commission (NRC) regulations 10 CFR 50, 51 and 54 in the above referenced letter.

For clarity, the enclosed CD-ROM is being provided in a revised electronic file format that is intended to resolve issues with image resolution and embedded fonts. It is solely an administrative reformatting. Specifically, Enclosure 2 is a single compact disc (CD), formatted in a manner that is consistent with "Guidance for Electronic Submissions to the Commission", referenced in the *Federal Register* on October 10, 2003 (68 FR 58826). This CD contains files suitable for entry into the NRC's record retrieval system, ADAMS.

It is not practicable to provide fully text searchable files for Appendices B, C, D and E of the Environmental Report since they contain copies of documents and graphics that must be scanned as image files. Thus, AmerGen also is providing a paper copy of the complete Oyster Creek Generating Station "Application for Renewed Operating License" in Enclosure 3 (four volumes).

Inasmuch as this submittal only involves administrative changes to the electronic formatting, the Application for Renewed Operating License submitted by letter dated July 22, 2005, remains operative.

If you have any questions, please contact Fred Polaski, Manager License Renewal, at 610-765-5935.

A114

Respectfully,

Pamela B. Cowan
Director – Licensing and Regulatory Affairs
AmerGen Energy Company, LLC

Enclosures:
1. Affidavit
2. CD-ROM labeled "Oyster Creek Generating Station, License Renewal Application, July 2005, Reformatted CD-ROM "
3. Oyster Creek Generating Station, License Renewal Application (four volume paper copy)

cc:
Regional Administrator, USNRC Region I, without enclosures
NRC Project Manager, NRR – License Renewal, Safety, without enclosures
NRC Project Manager, NRR – License Renewal, Environmental, without enclosures
USNRC Senior Resident Inspector, OCGS, without enclosures
Bureau of Nuclear Engineering, New Jersey Department of Environmental Protection, without enclosures
File No. 05040

STATE OF PENNSYLVANIA)

CHESTER COUNTY)

IN THE MATTER OF:)

AMERGEN ENERGY COMPANY (AmerGen), LLC) Docket Number

Oyster Creek Generating Station) 50-219

SUBJECT: Application for Renewed Operating License – Reformatted CD-ROM

AFFIDAVIT

I affirm that the content of this transmittal is true and correct to the best of my knowledge, information, and belief.

Pamela B. Cowan
Director – Licensing and Regulatory Affairs
AmerGen Energy Company, LLC

Subscribed and sworn to before me, a Notary Public in and

for the State above named, this 26th day of

July, 2005

Notary Public

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Vivia V. Gallimore, Notary Public
Kennett Square Boro, Chester County
My Commission Expires Oct. 6, 2007
Member, Pennsylvania Association Of Notaries

Enclosure 2 consists of one CD-ROM labeled "Oyster Creek Generating Station, License Renewal Application, July 2005, Reformatted CD-ROM" containing the following 3 files:

01-LRA.pdf; 5,025 KB; publicly available
02-ER(TOC-Chap9).pdf; 14,027 KB; publicly available
03-ER(Appendix A-F).pdf; 40,194 KB; publicly available

LICENSE RENEWAL APPLICATION

OYSTER CREEK GENERATING STATION

DOCKET No. 50-219

Facility Operating License No. DPR-16

2.4.1 Primary Containment

System Purpose

The Primary Containment Structure is comprised of the primary containment, containment penetrations, and internal structures. The structure is enclosed by the Reactor Building, which provides secondary containment, structural support, shielding, shelter, and protection, to the containment and components housed within, against external design basis events.

The primary containment is a General Electric Mark I design and consists of a drywell, a pressure suppression chamber, and a vent system connecting the drywell and the suppression chamber. It is designed, fabricated, inspected, and tested in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, and Nuclear Code Cases1270N-5, 1271N and 1272N-5. The containment is safety related, classified Seismic Class 1 structure.

The drywell is a steel pressure vessel, in the shape of an inverted light bulb, with a spherical lower section and a cylindrical upper section. The lower spherical section is embedded externally in the reinforced concrete foundation and covered internally by a fill slab at the bottom of the drywell. The top portion of the drywell vessel consists of a steel head that is removed during refueling operations. The head is bolted to the drywell flange and is sealed with a double seal arrangement. Access into the drywell is through a personnel airlock/equipment hatch, with two mechanically interlocked doors, and other access hatches. The drywell houses the reactor pressure vessel, the reactor coolant recirculation system, safety relief valves, electromatic relief valves (EMRVs), branch connections of the reactor primary system, containment drywell spray header, and internal structures discussed below. The drywell shell and the enclosing reactor building concrete are separated by an air gap to allow for differential thermal expansion between the shell and the concrete during any mode of plant operation.

The pressure suppression chamber is a toroidal shaped, steel pressure vessel encircling the base of drywell. The suppression chamber, commonly called the torus, is partially filled with demineralized water and includes internal steel framing, and access hatches. The suppression chamber is mounted on support structures that transmit loads to the reactor building foundation. Major components inside the suppression chamber include Emergency Core Cooling Systems (ECCS) suction strainers, which are connected to the ECCS suction header located outside the chamber, torus spray header, and Y-Quenchers.

The vent system consists of ten circular vent lines, which form a connection between the drywell and the pressure suppression chamber. The lines enter the suppression chamber through penetrations provided with expansion bellows and join into a common header contained within the air space of the suppression chamber. The header discharge is through 120 downcomer pipes, which terminate below the water level in the torus. The header and the downcomer pipes are supported from the suppression chamber shell.

The primary containment is provided with a vacuum breaker system to equalize the pressure between the drywell and the suppression chamber, and between the suppression chamber and the reactor building. The vacuum breaker system assures that the external design pressure limits of the two chambers are not exceeded.

The primary containment is penetrated at several locations by piping, instrument lines, ventilation ducts, and electric leads. The penetrations consist of sleeves welded to drywell vessel or suppression chamber and are of two general types. Those required to accommodate thermal movements; and those, which experience relatively little thermal stress. Penetrations required to accommodate thermal movements are provided with expansion bellows.

Internal structures consist of a fill slab, reactor pedestal, biological shield wall and its lateral support, and structural steel. The fill slab is reinforced concrete placed in the bottom of the drywell to provide a working base for supporting the reactor pedestal and other structures and components inside the drywell.

The reactor pedestal is a reinforced concrete cylinder with an outside diameter of 26 feet. The pedestal provides structural support to the reactor pressure vessel, the biological shield wall, and floor framing. The biological shield wall extends above the reactor pedestal and is a composite steel, concrete cylinder with an inside diameter of approximately 21 feet. The wall is framed with steel columns covered with steel plate on each face and filled partly with normal density concrete and partly with high-density concrete. The top of the wall is capped with a steel plate and laterally braced to the drywell vessel.

Structural steel includes floor framing steel for the platforms inside the drywell, and a catwalk inside the suppression chamber. It also includes miscellaneous steel inside the containment such as grating, ladders, connection plates; electrical cable trays, and electrical conduits.

The purpose of the primary containment is to accommodate, with a minimum of leakage, the pressures and temperatures resulting from the break of any enclosed process pipe; and thereby, to limit the release of radioactive fission products to values, which will insure offsite dose rates well below 10CFR100 guideline limits. It also provides a source of water for ECCS and for pressure suppression in the event of a loss-of-coolant accident. The primary containment and internal structures also provide structural support to the reactor pressure vessel, the reactor coolant systems, and other safety and nonsafety related systems, structures, and components housed within. The biological shield wall provides the added function of radiation shielding to maintain drywell environment within equipment qualification parameters.

Included in the evaluation boundary of the Primary Containment are the drywell, drywell head, suppression chamber, vent lines, downcomers, drywell and suppression chamber penetrations, vent line bellows, drywell penetration bellows, personnel air lock/equipment and other hatches, pressure retaining bolting, thermowells, and internal structures listed above.

Not included in the evaluation boundary of the Primary Containment are safety relief valves and EMRVs, EMRV discharge lines, Y-Quenchers, drywell and torus spray headers, vacuum breakers, ECCS suction strainers and header, downcomer bracing, suppression chamber (torus) supports, and other component supports. These components are separately evaluated with their respective license renewal systems. That is, safety relief valves, EMRVs, EMRV discharge lines, and Y-Quenchers are evaluated with Main Steam System. Drywell and torus spray headers, and ECCS suction strainers and header are evaluated with the Containment Spray System. Vacuum breakers are evaluated with the Containment Vacuum Breakers System. Downcomer bracing, suppression chamber supports, and other component supports are evaluated with the Component Supports Commodity Group.

For more detailed information, see UFSAR Sections 3.8 and 6.2

Reason for Scope Determination

The Primary Containment meets the scoping requirements of 10 CFR 54.4(a)(1) because it is a safety-related structure which is relied upon to remain functional during and following design basis events. It meets 10 CFR 54.4(a)(2) because failure of nonsafety related portions of the structure could prevent satisfactory accomplishment of function(s) identified for 10 CFR 54.4(a)(1). It also meets 10 CFR 54.4(a)(3) because it is relied upon in the safety analyses and plant evaluations to perform a function that demonstrates compliance with the Commission's regulations for fire protection (10 CFR 50.48), ATWS (10 CFR 50.62), and Environmental Qualification (10 CFR 50.49). The Primary Containment is not relied upon in the safety analyses and plant evaluations to perform a function that demonstrates compliance with Station Blackout (10 CFR 50.63).

System Intended Functions

1. Controls the release of fission products to the secondary containment in the event of design basis loss-of-coolant accidents (LOCA) so that off site consequences are within acceptable limits. (10 CFR 54.4(a)(1))
2. Provides sufficient air and water volumes to absorb the energy released to the containment in the event of design basis event so that pressure is within acceptable limits. (10 CFR 54.4(a)(1))
3. Provides a source of water for core spray, containment spray, and condensate transfer systems. (10 CFR 54.4(a)(1))
4. Provides physical support, shelter, and protection for safety related systems, structures, and components (SSCs). 10 CFR 54.4(a)(1)
5. Provides physical support, shelter, and protection for nonsafety related systems, structures, and components (SSCs) whose failure could prevent satisfactory accomplishment of function(s) identified for 10 CFR 54.4(a)(1). 10 CFR 54.4(a)(2)
6. Relied upon in safety analyses or plant evaluations to perform a function that demonstrates compliance with the commission's regulations for Anticipated Transients without Scram (10 CFR 50.62). 10 CFR 54.4(a)(3)
7. Relied upon in safety analyses or plant evaluations to perform a function that demonstrates compliance with the commission's regulations for Fire Protection (10 CFR 50.48). 10 CFR 54.4(a)(3)
8. Relied upon in safety analyses or plant evaluations to perform a function that demonstrates compliance with the commission's regulations for Environmental Qualification (10 CFR 50.49). 10 CFR 54.4(a)(3)

UFSAR References

3.8
6.2

License Renewal Boundary Drawings

LR-JC-19702

Table 2.4.1 Primary Containment
Components Subject to Aging Management Review

Component Type	Intended Functions
Access Hatch Covers	Pressure Boundary
Beam Seats	Structural Support
Biological Shield Wall - Concrete	Shielding
Biological Shield Wall - Lateral Support	Structural Support
Biological Shield Wall - Liner Plate	Structural Support
Biological Shield Wall - Structural Steel	Structural Support
Cable Tray	Structural Support
Class MC Pressure Retaining Bolting	Pressure Boundary
Concrete embedment	Structural Support
Conduits	Enclosure Protection
	Structural Support
Downcomers	Pressure Boundary
Drywell Head	Pressure Boundary
	Structural Support
Drywell Penetration Bellows	Pressure Boundary
Drywell Penetration Sleeves	Pressure Boundary
	Structural Support
Drywell Shell	Pressure Boundary
	Structural Support
Drywell Support Skirt	Structural Support
Liner (Sump)	Leakage Boundary
Locks, Hinges, and Closure Mechanisms	Pressure Boundary
	Structural Support
Miscellaneous Steel (catwalks, handrails, ladders, platforms, grating, and associated supports)	Structural Support
Panels and Enclosures	Enclosure Protection
	Structural Support
Penetration Closure Plates and Caps (spare penetrations)	Pressure Boundary
Personnel Airlock/Equipment Hatch	Pressure Boundary
Reactor Pedestal	Structural Support
Reinforced Concrete Floor Slab (fill slab)	Enclosure Protection
	Structural Support
Seals, Gaskets, and O-rings	Pressure Boundary
Shielding Blocks and Plates	Shielding
Structural Bolting	Structural Support
Structural Steel (radial beams, posts, bracing, plate, connections, etc.)	Structural Support
Suppression Chamber Penetrations	Pressure Boundary
	Structural Support
Suppression Chamber Ring Girders	Structural Support
Suppression Chamber Shell	Pressure Boundary

Suppression Chamber Shell	Structural Support
Suppression Chamber Shell Hoop Straps	Structural Support
Thermowells	Pressure Boundary
Vent Header Deflector	HELB Shielding
Vent Jet Deflectors	HELB Shielding
Vent line bellows	Pressure Boundary
Vent line, and Vent Header	Pressure Boundary

The aging management review results for these components are provided in
Table 3.5.2.1.1 Primary Containment
-Summary of Aging Management Evaluation

Table 3.0-2 – Oyster Creek External Service Environments

Oyster Creek Environment	Description	Equivalent NUREG-1801 Environment
Adverse localized Environment	Environment, which could exist in limited plant areas caused by heat, radiation, moisture or voltage in the presence of oxygen. Used for electrical insulation only.	Adverse Localized Environment
Aggressive Environment[1]	Ground water and raw water environments are considered aggressive if pH < 5.5, or chlorides > 500 ppm, or sulfates > 1500 ppm.	Aggressive Environment
Boiler Treated Water[2]	Demineralized water subject to chemistry controls recommended by the boiler manufacturer. Water chemistry controls are implemented through plant procedures.	Treated Water
Closed Cooling Water	Treated water subject to water chemistry controls recommended in EPRI TR-107396, "Closed Cooling Water Chemistry Guidelines." Closed Cooling Water includes Reactor Building Closed Cooling Water (RBCCW), and Turbine Building Closed Cooling Water (TBCCW).	Closed cycle cooling water
Closed Cooling Water < 140°F[3]	Closed cooling water below the temperature threshold for SCC in austenitic stainless steel components.	Closed cycle cooling water
Concrete	Embedded or Encased in concrete	Concrete

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[1] This environment is not an exact match of aggressive environment defined in NUREG-1801, Table IX.D. However it is an exact match of the aggressive environment used in NUREG-1801 AMR tables, for example line Item III.A3-4 (T-05).

[2] This environment is not an exact match of the environment defined in NUREG-1801 because water chemistry is controlled to different guidelines. However for aging management review considerations it is considered equivalent.

[3] This environment is not an exact match of environments defined in NUREG-1801; however it is bounded by the listed equivalent NUREG-1801 environment

Table 3.0-2 – Oyster Creek External Service Environments

Oyster Creek Environment	Description	Equivalent NUREG-1801 Environment
Containment Atmosphere	This environment is inert with nitrogen to render the atmosphere non-flammable by maintaining the oxygen content below 4% by volume. The average normal temperature inside the drywell is 139°F, with a humidity range of 20-40%. The upper elevations (above elev. 95') of the drywell could be exposed to higher temperatures, up to 256°F. For bolting this environment includes potential leakage of treated water, steam, or raw water.	Air – Indoor Uncontrolled Air with Reactor Coolant Leakage Air with Steam or Water Leakage
Dry Gas	Nitrogen	Gas Air, Dry
Encased	Applies to components encapsulated in steel, or aluminum. Encased components are inaccessible, and not exposed to air, water, or other environments.	Environment not in NUREG-1801
Fuel Oil	Diesel oil used for the combustion engines and heating boilers.	Fuel Oil
Indoor Air	Air in a sheltered environment, other than containment atmosphere. Air temperature range is 65°F - 140°F and the humidity is 100% maximum. For bolting this environment includes potential leakage of treated water, steam, sodium pentaborate, or raw water.	Air – indoor Uncontrolled Air with Reactor Coolant Leakage Air with Steam or Water Leakage
Lubricating Oil	Low to medium viscosity hydrocarbons used for lubrication of rotating equipment.	Lubricating Oil
Outdoor Air	Outdoor air environment is subject to local weather conditions. The mean temperature range is 23.7°F - 84°F and the average annual precipitation is approximately 42 inches.	Air - Outdoor

Table 3.0-2 – Oyster Creek External Service Environments

Oyster Creek Environment	Description	Equivalent NUREG-1801 Environment
Raw Water – Fresh Water	Fresh raw water is drawn from either a deep well or from the Fire Pond Dam. Water taken from the deep wells is processed in the pretreatment facility and used for domestic water or treated further and used as Demineralized water and for make up to the condensate storage and transfer system. Fresh water drawn from the Fire Pond Dam is untreated and is used for fire suppression and to the circulating water and service water pumps seals, and dilution pump oil coolers. Recent chemistry results show that the pH = 4.8, chlorides = 12 ppm, and sulfates = 6 ppm.	Raw Water
Raw Water – Salt Water	Raw salt water is drawn from Barnegat Bay, which receives salt water from the Atlantic Ocean and fresh water runoff from streams, which border it on the western shore, including Oyster Creek and Forked River. Recent tests of water samples taken at the Intake Structure and Canal showed that the pH = 7.9, Chlorides =14659 ppm, and Sulfates 1419 ppm. The average monthly water temperature range is 37°F in the winter and 80°F in summer.	
Soil	External environment for structures and components buried in soil. Buried structures and components may be exposed to groundwater if they are located below the local ground water elevation. Site groundwater has been tested and determined non-aggressive to concrete.	Soil
Steam	Steam that is subject to BWR water chemistry controls	Steam

Table 3.0-2 – Oyster Creek External Service Environments

Oyster Creek Environment	Description	Equivalent NUREG-1801 Environment
Treated Water	Treated water is demineralized water and is the base water for all clean systems. Depending on the system, this demineralized water may require additional processing. Treated water can be deaerated, include corrosion inhibitors, biocides, or some combination of these treatments. Treated water is subject to BWR water chemistry controls. Treated water includes reactor grade water, spent fuel pool water, torus water, and demineralized water.	Treated water
Treated Water < 140°F[1]	Treated Water below the temperature threshold for SCC in austenitic stainless steel components.	Treated water
Treated Water > 482°F	Treated water above thermal embrittlement threshold for CASS components.	Treated water > 482°F
Water – flowing	Water that is refreshed, thus having larger impact on leaching of calcium hydroxide from concrete structures.	Water - flowing
Water - standing	Water that is stagnant and un-refreshed, thus possibly resulting in increased ionic strength of solution up to saturation	Water - standing

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[1] This environment is not an exact match of environments defined in NUREG-1801; however it is bounded by the listed equivalent NUREG-1801 environment

APPLICANT'S EXH. 3

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10 CFR 50
10 CFR 51
10 CFR 54

2130-06-20437

December 8, 2006

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555
Attention: Mr. Michael A. Junge
Mail Stop: T2E26

Oyster Creek Generating Station
Facility Operating License No. DPR-16
NRC Docket No. 50-219

Subject: Submittal of Information to ACRS Plant License Renewal Subcommittee Related to AmerGen's Application for Renewed Operating License for Oyster Creek Generating Station (TAC No. MC7624)

Reference: AmerGen Letter to NRC, "Change to Timing for Submittal of Information to ACRS Plant License Renewal Subcommittee Related to AmerGen's Application for Renewed Operating License for Oyster Creek Generating Station (TAC No. MC7624)," dated November 1, 2006

In accordance with the Reference letter, AmerGen hereby submits information to the Advisory Committee on Reactor Safeguards (ACRS) Plant License Renewal Subcommittee related to AmerGen's application for renewal of the Oyster Creek Generating Station (OCGS) operating license. This information is intended to assist the Subcommittee in its preparation for a meeting being scheduled for January 2007 between the Subcommittee, the NRC Staff and AmerGen.

Contained within the Enclosure is a detailed discussion of the primary containment drywell corrosion issue history, which includes information learned during the October 2006 refueling outage. Numerous source documents are referenced in the discussion, and these are provided as part of the Enclosure.

If you have any questions regarding this information, please contact Fred Polaski at 610-765-5935.

Respectfully,

Michael P. Gallagher

Michael P. Gallagher
Vice President, License Renewal
AmerGen Energy Company, LLC

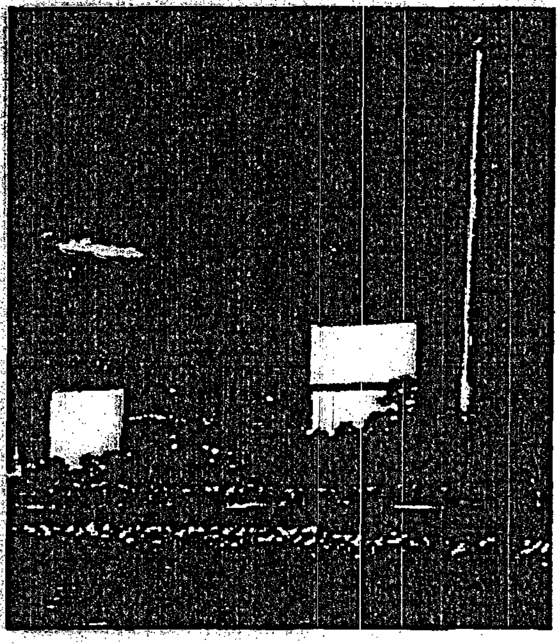
A114

Enclosure: Oyster Creek License Renewal Project, Drywell Monitoring Program – Information for ACRS Subcommittee

cc: NRC Director (Acting), License Renewal, w/o Enclosure
Regional Administrator, USNRC Region I, w/o Enclosure
NRC Project Manager, NRR - License Renewal, Safety, w/Enclosure
ACRS Staff Lead – Cayetano Santos, w/Enclosure (15 copies)
NRC Project Manager, NRR - License Renewal, Environmental, w/o Enclosure
NRC Project Manager, OCGS, Part 50, w/o Enclosure
NRC Senior Resident Inspector, OCGS, w/o Enclosure
New Jersey Bureau of Nuclear Engineering, w/o Enclosure
Oyster Creek File No. 05040

Oyster Creek License Renewal Project

Drywell Monitoring Program



Information for ACRS Subcommittee

December 8, 2006

Enclosure - Table of Contents

This package of historical information and 2006 outage information is being provided to the ACRS Subcommittee reviewing the License Renewal Application for Oyster Creek. The purpose of the information is to respond to questions that were raised at the ACRS Subcommittee meeting on October 3, 2006 concerning the corrosion of the drywell shell and to update the Subcommittee on the results of recent inspection activities. This package is meant to help the ACRS members understand the information that the NRC staff has already reviewed over the course of weeks of audits and inspections. As such, the information set forth in this package consists of documents and responses to questions that were available to the NRC staff during the NRR AMR and AMP audits in January and February 2006, during the NRC Region 1 Inspection in March 2006, in response to NRC RAIs during the review of the Oyster Creek License Renewal Application, in docketed correspondence between GPUN or AmerGen and the NRC, and in documents reviewed by NRC Region 1 during the 2006 refueling outage. The information provided also includes some historical information that serves as the basis or support for documents that were reviewed by the NRC.

Although the information included in this package has been available to the NRC, AmerGen has in many cases formatted the information differently in order to address some of the questions asked by ACRS members. For example, the NRC staff may have reviewed numerical data on drywell shell corrosion provided in a table. In this document, however, AmerGen prepared a graphical representation of the data to show how the drywell shell corrosion rate has changed with time up to and including data obtained during the 2006 refueling outage and including the margin that is available.

The information being provided by AmerGen is organized into the following five primary areas of interest dealing with the corrosion on the surfaces of the Oyster Creek drywell shell:

- Leakage of water onto the drywell shell external surface during refueling outages. (Section 4)
    - Includes a summary of significant events related to water leakage, information on the historic identification and evaluation of reactor cavity liner defects, historic troubleshooting and repairs to the reactor cavity trough area, and actions in place to minimize, detect and assess the impact of any leakage going forward.
- The Upper Regions of the drywell. (Section 5)
    - Includes information on periodic UT measurements taken from the inside of the drywell, the process to determine the locations monitored, and the random sampling confirmation of the monitored locations.
- The Sandbed Region. (Section 6)
    - This includes information on historical and recent UT thickness readings, the early 1990s General Electric buckling analysis, and early 1990s preparing and coating of the external surface of the drywell shell.

- The embedded part of the drywell shell exterior. (Section 7)
    - Includes information on environmental conditions for the embedded part of the shell located below the sandbed region.
- The embedded part of the drywell shell interior. (Section 8)
    - Includes information on construction, required shell thicknesses and environmental conditions for the embedded part of the shell that is inside the drywell

Information in each topic area is presented somewhat differently. Topics 1, 4 and 5 are generally narrative in nature presenting historical and technical information, with references to supporting documents. Topics 2 and 3 provide both a narrative presentation of the topic, and include UT measurement data that support AmerGen's understanding of and position on corrosion of the outer surface of the drywell shell.

The information on each of the five topics references many source documents, all of which are included in this package. Some of the references include the detailed inspection results.

In addition to these 5 topics, the package also includes a timeline that shows the sequence of relevant events, starting with the first discovery of water in the sand bed drains in 1980 up to and including the inspections performed during the refueling outage in October 2006. Also, the package includes a section on the general description of the Oyster Creek drywell, with associated drawings and figures.

1969	Begin Oyster Creek plant operation.
1980	Water identified coming from sand bed drains.
1980, 83, 86, and 89	Investigation into source of water leaking from sandbed drains, and the leakage path.
1986	• 2 trenches excavated in the floor inside the containment to gain access to the inside of the drywell shell at an elevation corresponding to a lower portion of the sandbed region (Bays 5 & 17).
1986 to 89	• Corrosion monitoring of the drywell shell from the inside to establish and characterize the extent of corrosion. • 19 grid locations inside the drywell at Elev. 11' 3" established for monitoring corrosion in the sandbed region with UT measurements. • Approximately 1,000 UT points taken circumferentially around the inside of the drywell shell. • 12 representative grid locations selected from the 1,000 points for continued monitoring of the upper drywell area. • Core samples taken at 9 locations of the drywell shell.
1988	• Cathodic protection system installed on drywell shell. • Sand removal from the sandbed region started. • Repairs made to reactor cavity concrete trough to improve drainage. • Visual and UT inspections in trenches.
1990	UT thickness measurements of the drywell shell taken at 57 randomly selected locations to confirm the 12 grid locations identified previously for monitoring were representative of the leading corrosion locations. One additional location added to the original 12.
1992	• Cathodic protection system removed because it was not effective in preventing corrosion. • Sand removal from the sandbed regions completed. • External surface of the drywell shell in the sand bed region cleaned. • 125 UT readings taken to confirm minimum thickness locations from the external surface. • Epoxy coating applied to the external surface of the drywell shell in the sandbed region. • Surface of the concrete floor in the sandbed regions finished with epoxy and sealed against the drywell shell. • UT of the sandbed region from inside the drywell at 19 grid locations at Elevation 11'-3". • UT readings from the inside of the drywell shell at the 13 grid locations in the upper elevations.
1994	• UT of the sand bed region from inside the drywell at 19 grid locations at Elevation 11'-3". • Visual inspection of epoxy coating on outside of drywell in the sand bed region (Bays 3 & 11). • UT readings from the inside of the drywell shell at the 13 grid locations in the upper elevations.
1996	• UT of the sand bed region from inside the drywell at 19 grid locations at Elevation 11'-3", but some data appeared anomalous. • Visual inspection of epoxy coating on outside of drywell in the sand bed region (Bays 11 & 17).

	• UT readings from the inside of the drywell shell at the 13 grid locations in the upper elevations.
2000	• Visual inspection of epoxy coating on outside of drywell in the sand bed region (Bays 1 & 13). • UT readings from the inside of the drywell shell at the 13 grid locations in the upper elevations.
2004	• Visual inspection of epoxy coating on outside of drywell in the sand bed region (Bays 1 & 13). • UT readings from the inside of the drywell shell at the 13 grid locations in the upper elevations.
2005	Oyster Creek License Renewal Application submitted to the NRC on July 22, 2005.
2006	• Visual inspection of epoxy coating on outside of drywell in the sand bed region in all 10 bays. • Visual inspection of the caulk seal at the junction between the sand bed region floor and the drywell shell in all 10 bays. • UT readings at 19 grid locations in the sand bed region from inside the drywell at Elevation 11'-3". • UT readings at 106 locally thinned areas (previously inspected in 1992) from outside the drywell in the sand bed region. • Visual inspections and UT readings of the drywell shell in the two trenches inside the drywell including additional excavation in the Bay 5 trench. • UT readings at two grid locations each at two transition plate locations from inside the drywell (Elevations 23'-6" and 71'-6"). • UT readings from the inside of the drywell shell at the 13 grid locations in the upper elevations to confirm low corrosion rates or no observable corrosion. • Boroscopic examination of reactor cavity trough drain line and all 5 sand bed drain lines. • Monitored the Sandbed Regions drains for leakage. • Monitored the Reactor cavity trough drain for leakage. • Repaired/modified areas internal to the drywell to minimize the potential for water intrusion into the area between the embedded. drywell shell and the drywell concrete floor.

The Oyster Creek primary containment is a General Electric Mark I design, with a drywell, suppression chamber, and a vent system connecting the drywell and the suppression chamber. It is designed, fabricated, inspected, and tested in accordance with the requirements of the ASME Boiler and Pressure Vessel Code, Section VIII, and Nuclear Code Cases 1270N-5, 1271N, and 1272N-5.

The drywell is a steel pressure vessel, in the shape of an inverted light bulb, with a spherical section and a cylindrical section (See Figures 1 thru 4) located inside the Reactor Building. The Reactor Building Foundation floor is a 10 ft thick reinforced concrete mat. The bottom elevation of the mat is minus 29' 6" and its top elevation is minus 19' 6" (See Figure 4). There is a waterproof membrane at the bottom of the mat that extends up the outside of the exterior walls to an Elevation of 5' 0". The concrete pedestal that supports the drywell is located at the center of the mat. The Torus Room completely surrounds this concrete pedestal with a floor elevation of minus 19' 6" (top of mat). The drywell shell has a bottom elevation of 2' 3".

The spherical section of the drywell was supported on a 39-foot diameter continuous steel skirt during construction (See Figures 4 & 7). The area within the skirt was filled with concrete and the floor inside the bottom of the sphere (drywell floor) was poured up to elevation 10' 3". The reactor support structure (pedestal) sits on top of the drywell floor (See Figure 5). The area within the reactor pedestal provides access for Control Rod Drive exchanges and is typically referred to as the Sub-Pile Room. The room also contains the drywell sump and a drainage trough that collects any leakage within the drywell. The Sub-Pile Room floor is raised at the center and slopes toward the drainage trough. Leakage outside the Sub-Pile Room, in the drywell, is directed to the drainage trough through 4 holes in the reactor pedestal equally spaced around the circumference. A concrete curb is installed around the perimeter of the drywell floor (See Figure 4 & 5) to prevent any water that collects on the floor from coming in contact with the drywell shell. The curb is removed in two locations where two trenches (Figure 3) were excavated in the floor in 1986 to allow UT thickness measurements to be taken below the floor. A moisture barrier was added at the junction of the curb and the drywell shell and inside the trenches during the 2006 refueling outage to prevent water and moisture intrusion into the embedded drywell shell.

Outside the drywell support skirt and the spherical section, concrete was poured in contact with the sphere up to elevation 8' 11". At this point, the concrete was stepped back 15" radially up to elevation 12' 3" and later filled with sand (sandbed region), refer to Figures 5 & 7 for details. The purpose of the sandbed was to provide a cushion to smooth the transition of the shell plate from a condition of fully embedded between two concrete masses to a free standing condition. The sandbed region was provided with five drains designed to allow drainage of any water that may enter the region.

Above the sandbed region, the drywell shell is closer to the reactor building concrete shield wall. The outer surface of the drywell shell and the shield wall are separated by a gap filled with compressible material. After construction completion, this material was compressed by heating and pressurizing the drywell to provide the gap required for free expansion of the drywell under design basis loads and postulated events.

At the top of the Reactor Building concrete shield wall, a concrete trough is located below the reactor cavity seal to collect any water that might leak from the reactor cavity during refueling outages. This trough is equipped with a drain line designed to direct any leakage to the Reactor Building equipment drain tank and prevent it from entering the gap between the drywell shell and the Reactor Building concrete shield wall (See Figure 6).

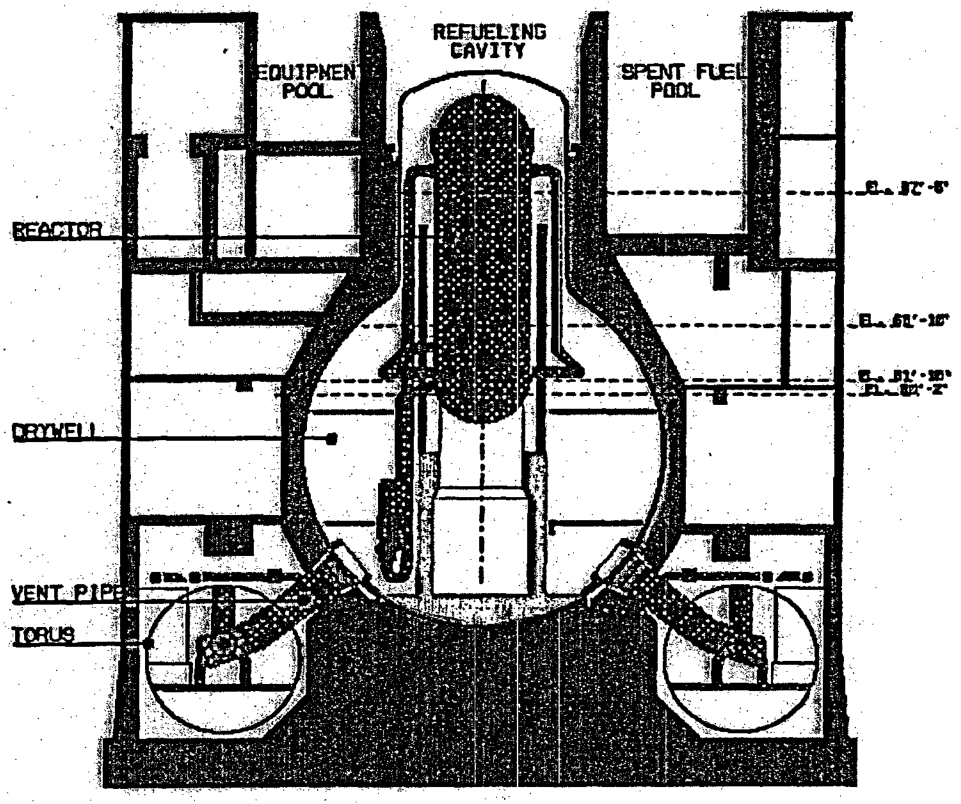
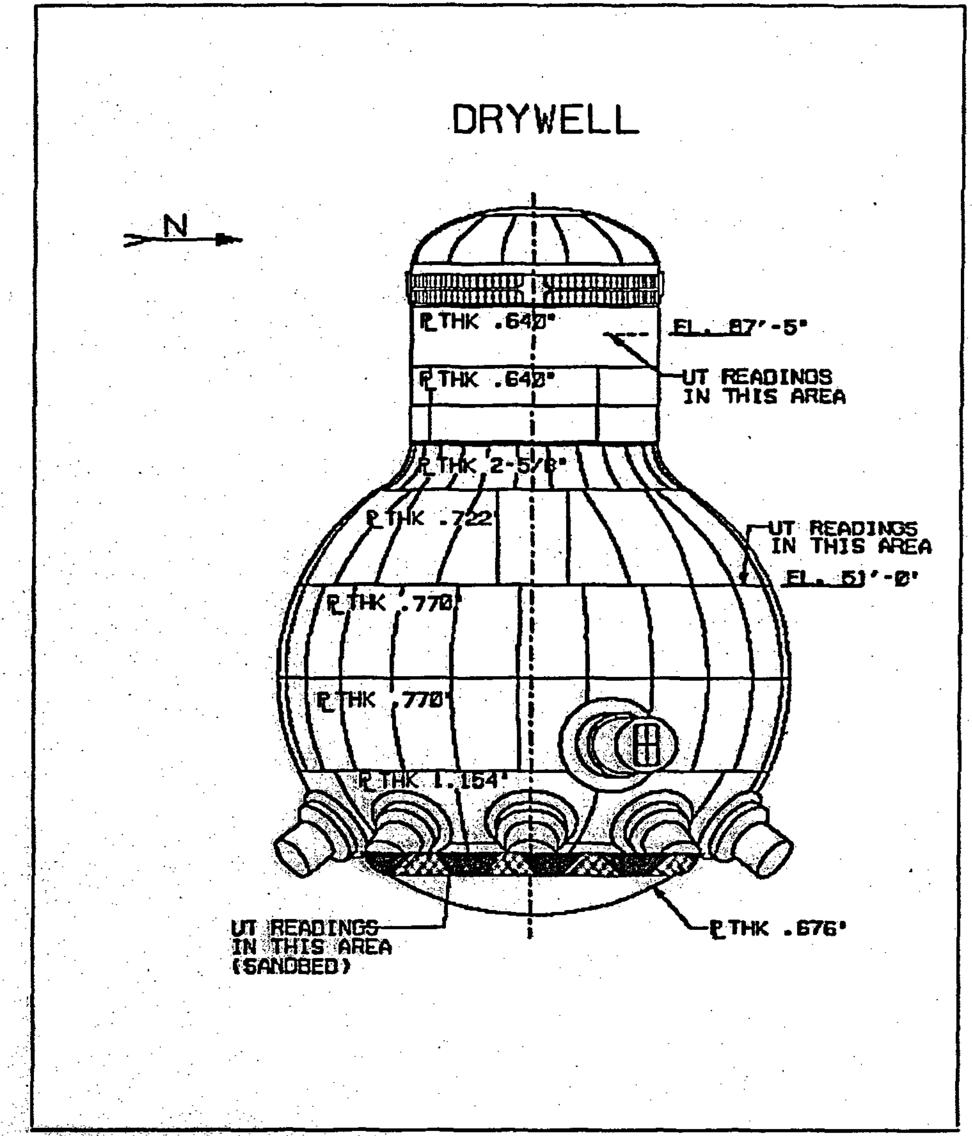


FIGURE 1 – PRIMARY CONTAINMENT CROSS-SECTION



PL THK = DESIGN NOMINAL THICKNESS

FIGURE 2 – DRYWELL ELEVATION

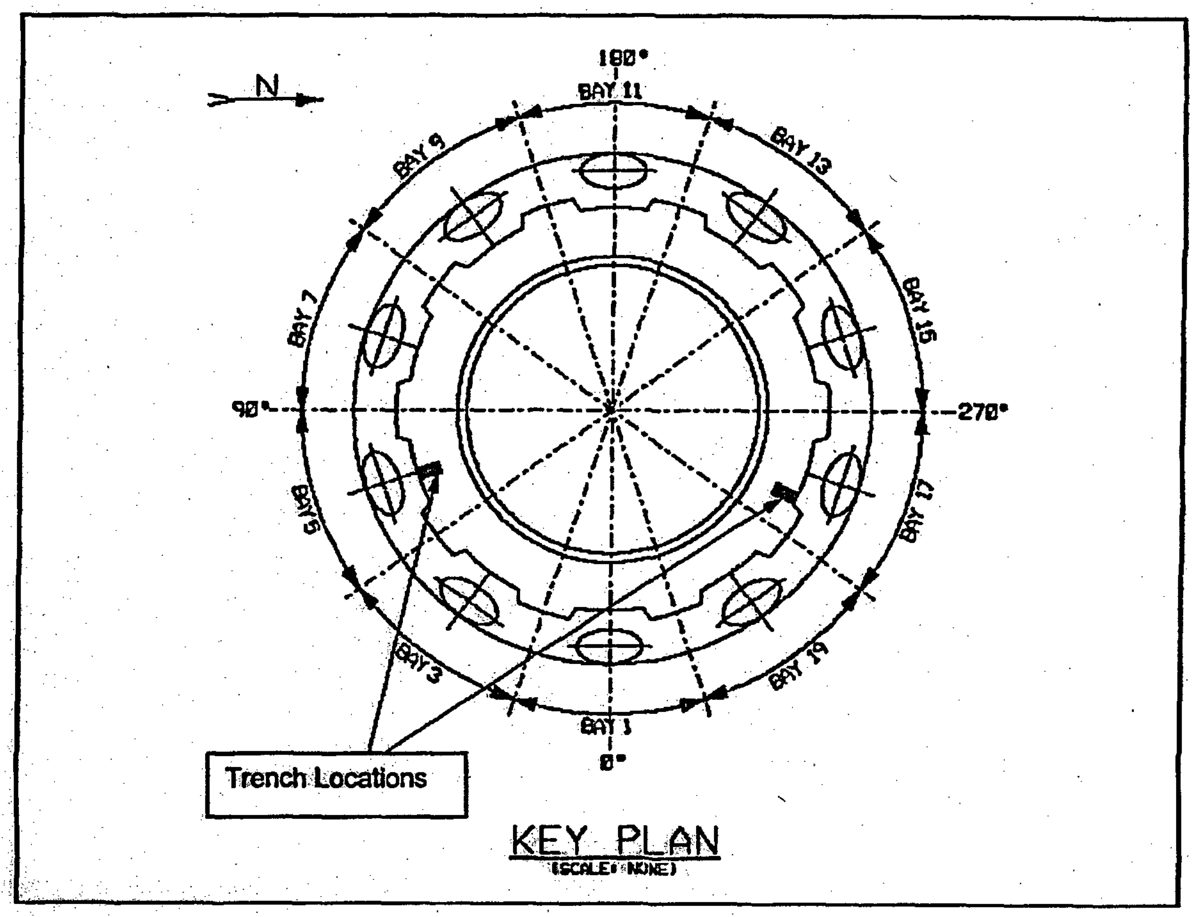
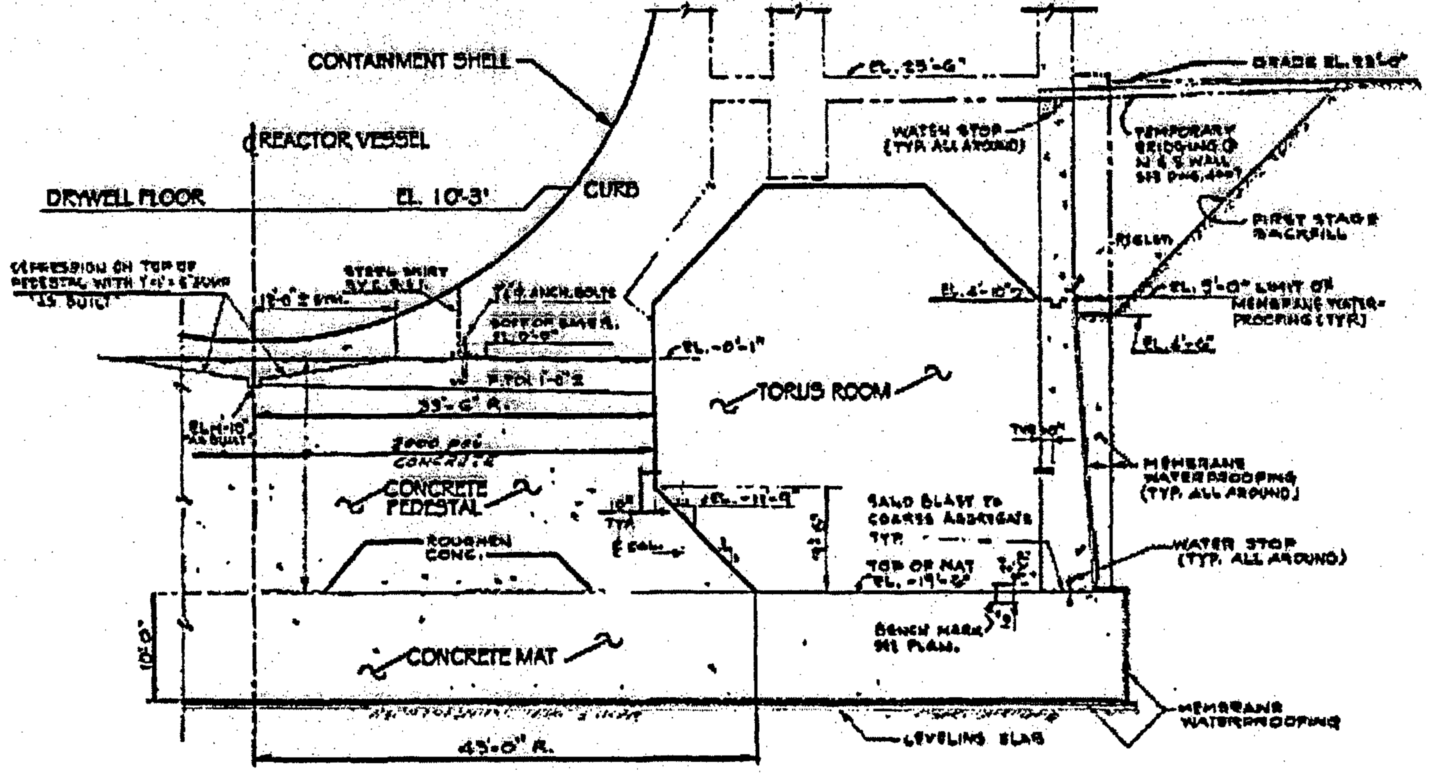


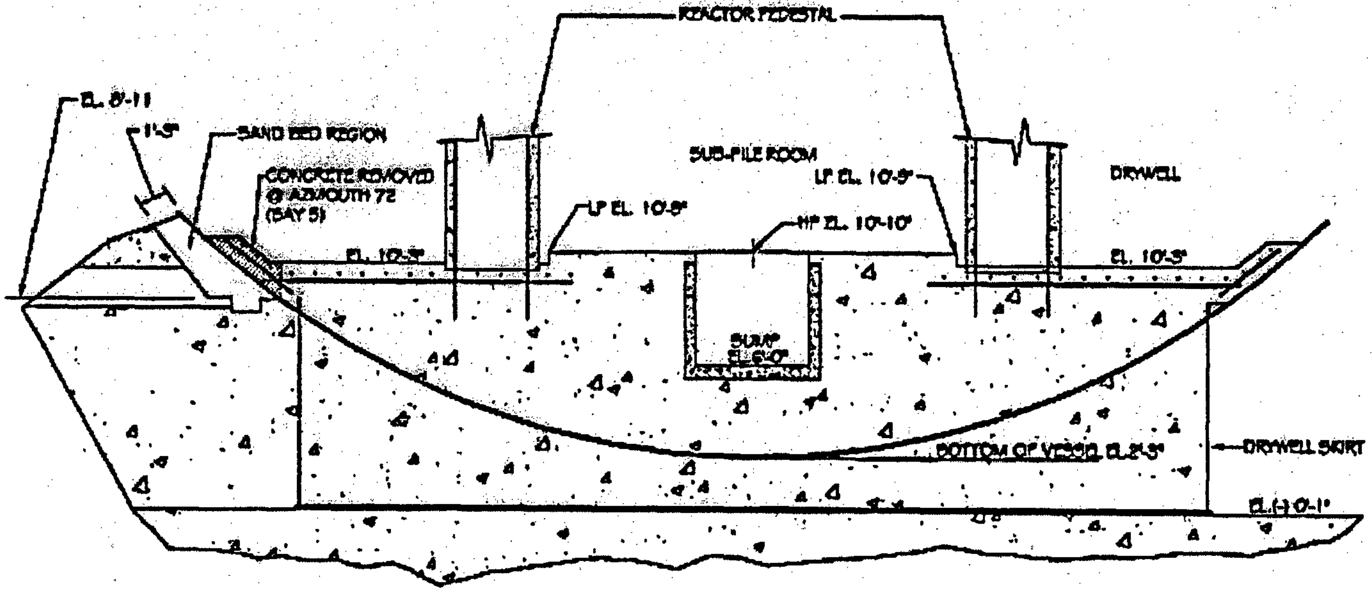
FIGURE 3 – DRYWELL BAYS

REACTOR BUILDING, DRYWELL SUPPORT STRUCTURE



ELEVATION
FIGURE 4

LOWER DRYWELL-
SANDBED, TRENCH & SUMP



ELEVATION LOOKING WEST
FIGURE 5

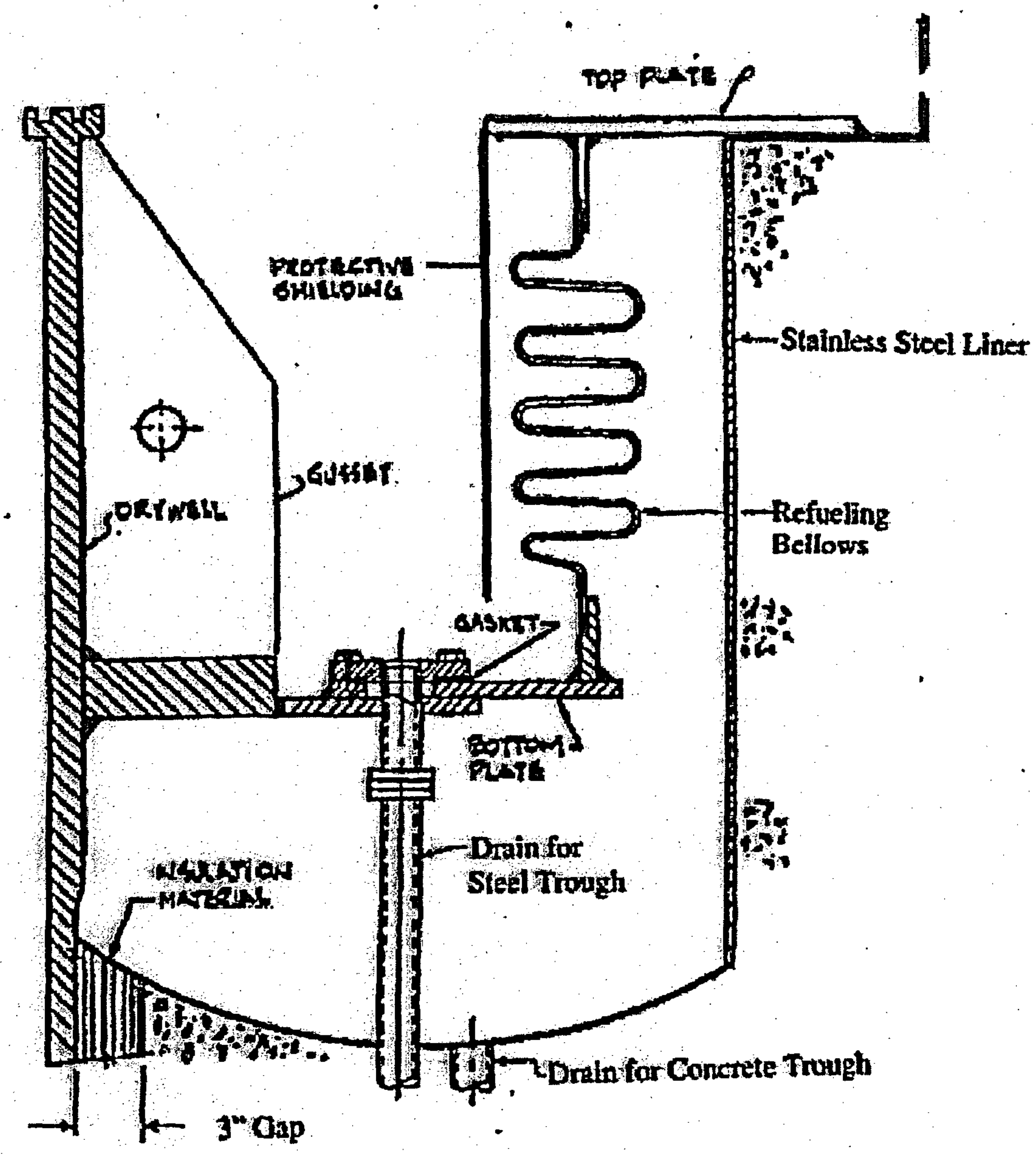
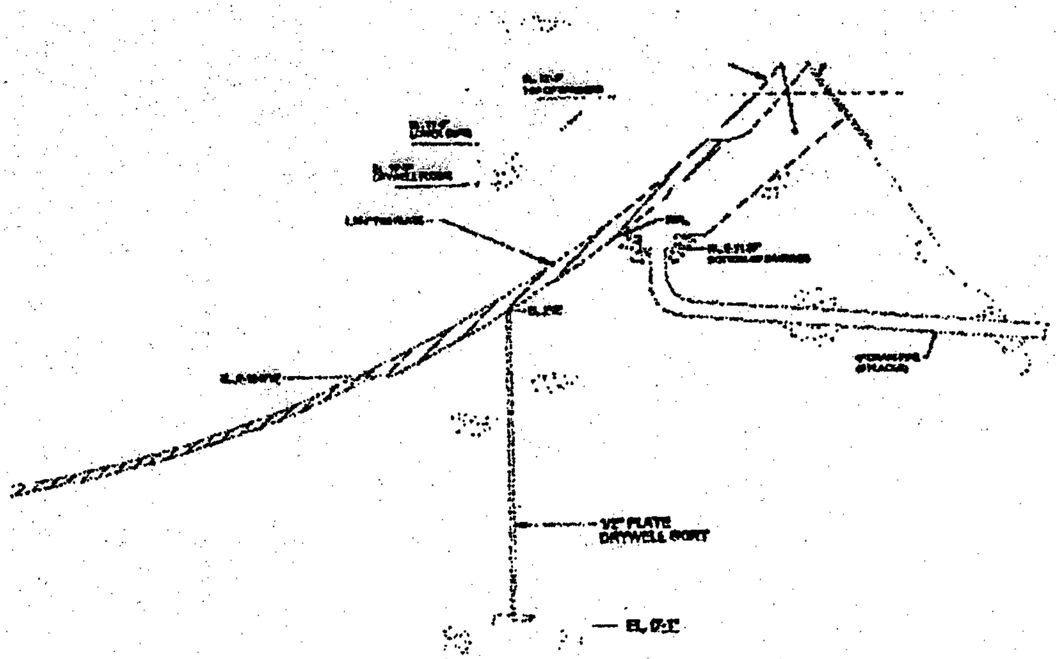


FIGURE 6 – REACTOR CAVITY TROUGH DRAIN



SECTIONAL VIEW OF SAND BED REGION

FIGURE 7

The following discussion addresses water leakage onto the exterior surface of the Oyster Creek drywell shell. Part I, below, provides a historic overview of information about water leakage prior to the October 2006 outage. The discussion in Part II summarizes prior commitments made by AmerGen aimed at preventing leakage onto the shell, monitoring for such leakage and performing corrective actions if leakage occurs. Part III sets forth information discovered and analyzed as a result of the October 2006 outage. Overall conclusions about the drywell, AmerGen's performance of associated commitments, and continued drywell operability during the proposed twenty-year renewal term are summarized in Part IV.

I. Historical Background

Water leakage onto the exterior of the Oyster Creek drywell shell over a period of years, in combination with an historically degraded sand bed region drainage system, created a condition that was conducive to corrosion of the exterior surface of the drywell shell. The previous owner/operator of Oyster Creek conducted extensive troubleshooting and repairs to determine and address the leakage and the corrosive effects of that leakage onto the drywell shell. As part of its license renewal activities, AmerGen has reviewed previous actions and instituted new measures (see Section II below) to ensure that leakage will be minimized and monitored, and that corrective actions will be implemented to ensure the drywell continues to perform its intended functions throughout the proposed twenty-year period of extended plant operation.

In addition, drywell commitments for license renewal are embedded in a formal AmerGen tracking system that includes specific work tasks, thereby ensuring timely implementation of the commitments and effective management oversight. Therefore, AmerGen is confident that the measures put into place to prevent and monitor leakage, in conjunction with the implementation of drywell shell visual and ultrasonic testing aging management program activities, will protect the shell such that it continues to perform its intended functions throughout the proposed period of extended operation.

A. Chronology of Significant Events (Also see Timeline, Section 2)

- 1980 – Water was observed coming from the sand bed drains. As part of the original design, these drains had been filled with sand during plant construction. The sand was restrained at the outlet with a 100-mesh stainless steel screen (0.006 inch opening). The intent was to prevent loss of sand from the sand bed region through the drain lines, yet allow drainage of water.
- 1980, 1983 and 1986 refueling outages - Extensive investigations were performed to identify the source of water and the leakage path. Results of the investigations indicated that:
    - Leakage was observed (from the sand bed drains) during refueling outages;

  - Leakage was not attributed to the reactor cavity metal trough drain line gasket or the refueling bellows seal (See Figure 6 of Section 3 of this Enclosure).

    The reactor cavity metal trough drain line gasket leak was ruled out as the primary source of water observed in the sand bed drains because there was no clear leakage path to the gap between the drywell shell and reactor building concrete shield wall (i.e., drywell expansion gap). Any gasket leakage would be minor and would be collected in the concrete trough below the gasket. Also, inspections concluded that the refueling bellows (seals) were not the source of water leakage. The bellows were repeatedly tested using helium (external) and air (internal) without any indication of leakage. Furthermore, any minor leakage from the refueling bellows would be collected in the same concrete trough as would collect water from the gasket. The concrete trough is equipped with a drain line that would direct any leakage to the reactor building equipment drain tank and prevent it from entering the drywell expansion gap (Ref [13], Attachment III).

  - Leakage was attributed to through-wall cracks in the reactor cavity liner attributed to mechanical damage and to fatigue (Ref [13], Attachment III); and

  - The leakage path was from the reactor cavity, to the concrete trough (later found to have been degraded – see Section C below) and through the drywell expansion gap down to the sandbed region within the reactor building (See Figure 6 of Section 3 of this Enclosure).

- Between 1988 and 1993, multiple mitigating actions were taken to address the corrosion problem. These actions included (Ref [32], page 9):

  - Cleared the former sand bed region drains of sand and corrosion products to improve drainage.

  - Replaced reactor cavity metal trough drain gasket, which was found to be leaking (See Figure 6 of Section 3 of this Enclosure).

  - Removed water from the sand bed region.

  - Installed a cathodic protection system in bays with greatest wall thinning. Subsequent UT thickness measurements in these bays showed that the system was not effective in reducing the rate of corrosion and the system was removed from service in 1992.

  - Removed sand from the sand bed region to break up the galvanic cell (Ref [46]).

  - Removed corrosion products from the external side of the drywell shell in the sand bed region.

- Upon sand removal, the sand bed concrete floor was found to be cratered and unfinished. The concrete floor was repaired, finished and coated to permit proper drainage of the sand bed region (Refer to Section 7 of this Enclosure for details).
- Applied an epoxy caulk seal at the junction of the drywell shell and the sand bed concrete floor to prevent intrusion of moisture into the drywell shell embedded in concrete (Refer to Section 6 of this Enclosure for details).
- Applied a multi-layered epoxy protective coating to the exterior surfaces of the drywell shell in the sand bed region (i.e., one pre-primer coat, and two top coats). (Refer to Section 6 of this Enclosure for details).
- Applied stainless steel type tape and strippable coating to the reactor cavity during refueling outages to seal cracks in the stainless steel liner, in order to limit leakage from the reactor cavity. (Note that the steel tape was applied to larger cavity liner cracks and then the strippable coating was applied over the entire liner surface that would be (otherwise) wetted.)
- Confirmed that the reactor cavity concrete trough drain line was not clogged (See Figure 6 of Section 3 of this Enclosure)

B. Discovery and Evaluation of Cavity Liner Defects

In 1987, defects in the reactor cavity liner were documented and evaluated in material nonconformance report MNCR 87-240 (Ref [49]). These defects consisted of through-wall and surface indications detected by non-destructive examination of the liner near weld joints. The purpose of the cavity liner is to facilitate filling the reactor cavity with water for refueling activities.

The defects do not pose problems except when the reactor cavity is filled with water during refueling outages. If no preventive action is taken, the defects allow water to leak behind the liner and run down into the reactor cavity concrete trough. If the flow rate exceeds the capacity of the two-inch trough drain, then water would back up into the drywell expansion gap and drain onto the outside of the drywell shell.

Safety Evaluation 328257-002 was generated in 1988 with the purpose of addressing the adequacy of the design and the safety impact of installation of a temporary barrier on the OC Reactor Cavity Pool to prevent leakage of water during refueling operation (Ref 6, pages 7 - 13). In it, two major options were considered – weld repair of the liner and a temporary barrier over the entire cavity liner. The weld repair option had the following drawbacks: (a) there were too many defects in the liner, (b) weld repair of these defects would produce large residual stresses and warping of the liner, and (c) if weld repairs were implemented, the repair areas would eventually fail due to the same mechanism, in the future. Therefore, the temporary barrier option of metal tape and strippable coating was chosen for the repair (Ref [6], page 6).

C. Reactor Cavity Concrete Trough Area Testing and Repairs

As a result of observations of water leaking from concrete biological shield penetrations and sand bed drain lines during refueling outages in the early 1980s, numerous troubleshooting and repair activities were implemented over several years. These included:

- Air and helium leak testing of the bellows seal in the bottom of the reactor cavity (no leakage detected) and cavity drain line (no significant leakage found),
- Leak testing and some minor repairs to reactor cavity liner welds,
- Further pressure testing of the bellows (no leakage detected) at a later outage,
- Liquid penetrant testing of the cavity "steps" upon which the cavity shield plugs are placed (no indications detected), and
- Air purge testing of the drain line that channels refueling cavity leakage away from the gap between the drywell shell and concrete drywell shield wall (drain line did not appear to be restricted).

During the 1986 refueling outage, the drain line from the refueling cavity metal trough was inspected and the drain line gasket was found to have leaks, and was replaced. Additional leak tests were performed on the bellows during the 1986 outage and no leaks were detected (Ref [1], Attachment 2, pages 2-1 and 2-2).

During the 1986 refueling outage, camera inspections identified that the lip of the reactor cavity concrete trough was not sufficient to assure that water would not enter the area between the concrete shield wall and drywell shell. (Ref [5], page 3). Prior to reactor cavity flooding for the 1988 refueling outage, repairs were made to the concrete trough to rectify the condition. These repairs were determined to be effective based on visual inspections for leakage during the 1988 outage.

As noted previously, the mitigating features described above were implemented between 1988 and 1993. For the strippable coating, a latex coating was used at first. This latex coating had (a) stringent surface preparation requirements; (b) long curing time; and (c) lack of strength to absorb mechanical abuse during refueling. Accordingly, it was not applied during the 1994 and 1996 refueling outages. Discontinuation was also prompted by the fact that sand had been removed from the sand bed region and drainage in the area was improved during the 1994 outage. However, the observed water leakage during the 1996 outage prompted investigation and use of a more durable barrier. InstaCote ML-2 coating barrier was effectively used on the reactor cavity during the 1998 outage. (Ref [28], page 6). Strippable coating has also been applied to the reactor cavity in all refueling outages since 1998.

II. Summary of IWE Program Elements Related to Water Leakage

The following is a summary of Oyster Creek's commitments related to preventing and monitoring for water leakage onto the exterior surface of the drywell shell. These are captured within the ASME Section XI, Subsection IWE Aging Management Program. These committed actions were performed during the 2006 refueling outage and will be performed during refueling outages in the future, including during the period of extended operation. For further details on these commitments, see Ref [39], Enclosure 2.

- Strippable coating, as discussed above in Section C, is applied to the reactor cavity liner surface prior to filling the reactor cavity with water for refueling activities.
- Periodic verification (once per refueling cycle) that the reactor cavity trough drain is functional (clear).
- Periodic monitoring (when reactor cavity is flooded) of reactor cavity trough drain for leakage.
- Daily visual monitoring of drywell sand bed drains for leakage during refueling outages when the reactor cavity is flooded. If leakage is detected, AmerGen will determine the source of leakage and investigate and address the impact of leakage on the drywell shell, including verification of the condition of the drywell shell coating and moisture barrier (seal) in the sand bed region and performance of UT examinations of the shell in the upper regions. UTs will also be performed on any areas in the sand bed region where visual inspection indicates the coating is damaged and corrosion has occurred. UT results will be evaluated per the existing program. Any degraded coating or moisture barrier will be repaired. These actions will be completed prior to exiting the associated outage.
- Quarterly visual monitoring of the sand bed drains for leakage during plant power operation. If leakage is identified, then the source of water will be investigated, corrective actions taken or planned as appropriate. In addition, if leakage is detected, the following items will be performed during the next refueling outage:
    - Inspection of the drywell shell coating and moisture barrier (seal) in the affected bays in the sand bed region
    - UTs of the upper drywell region consistent with the existing program
    - UTs will be performed on any areas in the sand bed region where visual inspection indicates the coating is damaged and corrosion has occurred
    - UT results will be evaluated per the existing program

Any degraded coating or moisture barrier will be repaired.

- When the sand bed region drywell shell coating inspection is performed, the seal at the junction between the sand bed region concrete and the embedded drywell shell will be inspected per the Protective Coatings Program.

Through these commitments, AmerGen will minimize any water leakage through the reactor cavity liner that may occur during refueling outages, and prevent or minimize water from reaching the external surface of the drywell shell. These commitments were made with the expectation that corrosion of the external surface of the drywell shell will be minimized, thus maximizing the margin remaining above the design-required thicknesses of the drywell shell.

III. Findings and Analysis from the 2006 Outage

During the 1R21 (October 2006) refueling outage, AmerGen implemented its commitments related to preventing water from reaching the outer surface of the drywell shell and monitoring for evidence of water leakage. The results of these activities were successful. Based on daily observations of sandbed drain water collection bottles and upon numerous visual reports from the sand bed region, no water leakage onto the exterior surface of the drywell shell during 1R21 was evident and no corrective actions related to water leakage onto the shell were required (Ref [47]).

The reactor cavity was coated with a strippable coating prior to flooding the cavity for refueling activities. A small amount of leakage (approximately 1 gallon per minute (GPM)) was observed coming from the cavity trough drain line during the time period when the refueling cavity was flooded. Daily observations of the cavity trough drainage confirmed a steady stream of approximately 1 GPM during this period. Because this small amount of leakage did not exceed the drainage capacity of the trough, no water would have leaked onto the exterior surface of the drywell shell. The minor leakage was discharged to the plant's radwaste system as designed.

Specifically, AmerGen performed the following actions during the October 2006 refueling outage to prevent or minimize water leakage onto the exterior of the drywell shell. These activities are consistent with commitments made in AmerGen Letter 2130-06-20358 (Ref [39]).

- Applied a strippable coating to the reactor cavity liner prior to flooding the cavity for refueling activities.

- Verified that the reactor cavity trough drain was clear prior to flooding the reactor cavity for refueling activities.

- Monitored the trough drain for leakage daily while the cavity was flooded with water. Documented results identified only a steady "pencil stream" of water coming from the trough drain, indicating, as expected, that the leakage was being handled by the cavity trough drain system, keeping water away from the drywell shell.

- Inspected the five sand bed drain lines to verify they were clear; removed some debris from two of the drain lines.
- Inspected the five poly collection bottles associated with the sand bed drains on a daily basis. Documented results identified no leakage observed coming from the sand bed drains.
- Verified no water on the concrete floor in any of the ten bays of the sand bed region through visual inspection.
- Inspected the seal at the junction between the sand bed region floor and drywell shell in all 10 bays. The inspection revealed the seal at this junction to be in good condition with no repairs required.

IV. Conclusion

Oyster Creek historically experienced water leakage onto the external surface of the drywell shell as described in Section I above. Various investigative and corrective activities have been performed to understand the issue and prevent water from continuing to drain onto the shell during refueling activities.

As part of the License Renewal process, AmerGen has established specific commitments within the formal Exelon Passport commitment tracking system to ensure license renewal commitments, including those addressing water leakage onto the drywell shell external surface (described in Section II above), are implemented. In addition, the recurring tasks, preventive maintenance activities, and surveillance procedures that are used to implement these commitments are annotated such that it is clear from looking at them that the subject actions are associated with commitments made to the NRC. In this way, there are formal controls to ensure awareness and oversight of the activities and to ensure that commitments are implemented.

The inspections performed during the 2006 refueling outage (1R21) confirm that the license renewal-related committed actions for leakage prevention and monitoring prevented water from reaching the external surface of the drywell shell. AmerGen has committed to perform these preventive/monitoring actions in future refueling outages, with the objective of preventing water leakage onto the drywell shell exterior. In addition, commitments are in place to investigate and address any leakage onto the shell exterior, should it occur.

This set of actions, aimed at preventing water from reaching the external surface of the drywell shell, serve as an additional level of assurance beyond that provided by performing and trending drywell shell thickness measurements and conducting visual inspections of the epoxy coating in the sand bed region (also part of the IWE Aging Management Program), that corrosion is not impacting the ability of the drywell to perform its design functions.

The following discussion addresses upper drywell corrosion at the Oyster Creek Generating Station. Part I, below, provides an overview of information pre-dating the October 2006 outage. The discussion in Part II sets forth information discovered and analyzed as a result of the October 2006 outage. Overall conclusions about the upper drywell, and its continued operation during the proposed twenty-year renewal term, are summarized in Part III.

I. Historic Summary and Past Findings

Outer drywell shell corrosion was first identified at Oyster Creek in the late 1980's. As explained in the Section 4 of this Enclosure, water intrusion into the gap between the drywell shell and the drywell shield wall was determined to be the source of the water, which created the corrosive environment. Corrective actions have been taken to mitigate corrosion in the upper region of the outer drywell shell. These actions have effectively reduced the rate of corrosion to a negligible amount in the upper region as demonstrated by UT thickness measurements (Ref [32], Table 1). In 1991, Oyster Creek and its consultants performed stress and buckling analyses considering all design basis loads and load combinations (Ref [15], Ref [16]). The results of these analyses indicate that the minimum measured drywell shell thickness satisfies ASME Section III Requirements.

A. Original Inspection Plan (1986 – 1992)

Inspections using UT thickness measurements were conducted during refueling outages and outages of opportunity between 1986 and 1989 to establish and characterize the extent of corrosion of the outer drywell shell. The initial UT measurements were not based on a sampling process. Instead the measurements were taken in areas that correspond to locations where water leakage was observed from the sand bed region drains. The UT measurements were then expanded around the drywell perimeter and vertically into the upper drywell to establish locations affected by corrosion. Approximately 1000 ultrasonic (UT) thickness measurements were taken at various elevations to access extent/scope of corrosion around the drywell perimeter and vertically to establish locations affected by corrosion and to identify the thinnest areas (Ref [4b], Ref [4c], Ref [4d]). Based on the results of the above-mentioned 1000 UT measurements, Oyster Creek continued to monitor 12 grid locations at elevations 50' 2", and 87' 5", that would be representative of the upper drywell shell condition. In addition, core samples of the drywell shell were taken at upper drywell region locations, believed to be representative of general corrosion, to confirm UT results (Ref [7]).

In addition to the above mentioned core samples of the drywell shell, the impact of Firebar-D on the drywell shell corrosion was discussed in a General Electric report (Ref [3]). Section 2.1.3.2 of the GE report discusses the material and Section 6.2.1 discusses the impact. The report concluded that the lack of γ-Fe_2O_3 in the oxide on the core plug surface/crust, the relative low amount of Mg in the sand samples and the absence of corrosion at the 51' elevation level suggest that the role of Firebar-D in the degradation of the OC drywell corrosion phenomena is not significant.

In 1990, a third elevation, 51' 10", was added to the scope of inspection after it was determined that the supplied plate thickness is slightly less than the adjacent 50' 2" plate. For each of the three elevations, sets of 49 UT measurements, spaced approximately 1" apart within a 6"x6" area, were taken from inside the drywell around the entire perimeter of each elevation. The 6"x6" area with one inch spacing results in a 7x7 grid of points located on one inch centers. These are identified as 49 point UT grid locations.

Engineering evaluation of the UT results concluded that monitoring of 12 upper drywell grid locations within these three elevations would represent the outer drywell shell condition and provide reasonable assurance that significant corrosion would be detected prior to a loss of an intended function. This is because the 12 grid locations were selected considering the degree of drywell shell thinning and the minimum required thickness to satisfy ASME stress requirements. Seven of the locations are at elevation 50' 2", three locations are at elevation 87' 5", and two locations are at elevation 51' 10" (Ref [31]). These locations are inspected from the inside of the drywell shell on a frequency of every other refueling outage.

B. Sampling Plan Justification and Confirmation - Augmented Inspection Plan (1990 - 1995)

In response to an NRC Staff concern regarding whether the inspected locations represent the condition of the entire drywell, in 1990 a new random UT inspection plan (also know as the augmented inspection) was prepared (Ref [11]). The plan was based on a non-parametric statistical approach using attribute sampling that assumes no prior knowledge of the distribution of corrosion above the sand bed region (Ref [12]). The plan consisted of random UT testing of 60 drywell shell plates. 57 plates were included in the inspection plan because three plates were inaccessible for inspection. On each plate, 49 point UT measurements were made on one 6"x6" area. Acceptance criteria were that the mean and local thickness of the shell equal or exceed the required minimum thickness plus a corrosion allowance necessary in order to reach the next inspection.

Inspection results using the new random inspection plan confirmed that previously monitored locations bound the condition of the drywell above the sand bed region; except one location at elevation 60' 10". This elevation was added to elevations 50' 2", 51' 10", and 87' 5" and all four elevations have been monitored on the frequency of every other refueling outage since 1992 (Ref [31], Ref [32]).

The augmented inspection plan, the original inspection plan, and justification for sampling techniques and statistical methodology were submitted to the NRC on November 26, 1990 (Ref [14]). In its Safety Evaluation dated November 1, 1995, the Staff noted that the licensee provided a table of UT measurement results from the Fall 1994, 15th refueling outage inspection. This table shows the locations of the measurements, the nominal as-constructed thickness, the minimum as-measured thickness, the ASME Code required thickness and the corrosion margin available at the time. The Staff found the current program based on the submitted information acceptable.

The current ongoing inspection plan is described in Oyster Creek specification IS-328227-004 (Ref [41]). The current inspection results are provided in Tables 1 and 2.

II. Confirmatory Actions During the October 2006 Outage

During the 2006 refueling outage (1R21), UT thickness measurements were taken at the 4 elevations (50' 2", 51' 10", 60' 10", and 87' 5") discussed above in accordance with the Oyster Creek ASME Section XI, Subsection IWE aging management program. The results of the UT thickness measurements indicated that no statistically observable corrosion is occurring at elevations 51' 10", 60' 10" and 87' 5". A single grid location (Bay 15 –23) of the elevation 50 '2" continues to experience minor corrosion at a rate of 0.66 mils/yr. The corrosion rate for the elevation 87' 5" is now statistically insignificant and this elevation can be considered as no longer undergoing statistically observable corrosion (Ref [47]), however it will continue to be monitored.

In addition, UT measurements were taken on 2 locations (bay #15 and bay #17) at elevation 23' 6" where the circumferential weld joins the bottom spherical plates and the middle spherical plates. This weld joins plates that are 1.154" thick to the plates that are 0.770" thick. These two bays were selected because they are among those that have historically experienced the most corrosion in the sandbed region. At each location, 49 UTs over a 6"x6" area grid were taken above the weld on the 0.770" thick plate and 49 UTs over a 6"x6" area grid were taken below the weld on the 1.154" thick plate. The minimum average thickness measured on the 0.770" thick plate is 0.766" and 1.160" on the 1.154" thick plate. The minimum measured local thickness on the 0.770" thick plate is 0.628" and on the 1.154" thick plate is 0.867". The minimum measured general and local thickness on each plate meets the minimum thickness required to satisfy ASME stress requirements with an adequate margin (Ref [47]).

UT measurements were also taken on 2 locations (bay #15 and bay #19) at elevation 71' 6" where the circumferential weld joins the transition plates (referred to as the knuckle plates) between the cylinder and the sphere. This weld joins the knuckle plates (2.625" thick) to the cylinder plates (0.640" thick). These two bays were selected because they also have historically experienced the most corrosion in the sandbed region. At each location 49 UTs over a 6"x6" area grid were taken above the weld on the 0.640" thick plate and 49 UTs over a 6"x6" area grid were taken below the weld on the 2.625" thick plate. The minimum measured average thickness on the 0.640" thick plate is 0.624" and 2.530" on the 2.625" thick plate. The minimum measured local thickness on the 0.640" thick plate is 0.449" and 2.428" on the 2.625" thick plate. The minimum measured general and local thickness on each plate meets the minimum thickness required to satisfy ASME stress requirements with an adequate margin (Ref [47]).

The above information identified during the recent outage has confirmed the condition of the upper drywell as described in previous submittals. AmerGen thus concluded that outer drywell shell corrosion at Oyster Creek is being effectively managed both during the current and proposed renewed terms of plant operation. The monitored locations under the current term were subject to extensive UT measurements conducted over several years. NRC Staff found the sampling methodology to identify these locations, and the results of inspections, acceptable for the current term.

III. Conclusion

In conclusion, Oyster Creek has conducted extensive examinations of the OCNGS upper drywell to identify the cause of drywell corrosion, employed a sampling process, quantified the extent of outer drywell shell thinning due to corrosion, and assessed its impact on the drywell structural integrity. Inspection results for the upper region are provided in Table 2. A summary of the upper region outer drywell shell corrosion rates and margins and the associated reference source documents are provided on Table 1. A summary of corrosion rates of UT measurements taken in the upper drywell every 4 years through year 2006 is provided below:

- There is no statistically observable ongoing general corrosion at three elevations (51' 10", 60' 10", and 87' 5")
- Based on statistical analysis, one location at elevation 50' 2" is undergoing a minor general corrosion rate of 0.66 mils per year
- The drywell corrosion inspection program will ensure sufficient margin will be maintained through 2029

Therefore, AmerGen has concluded that upper drywell corrosion at Oyster Creek is effectively managed, both during the current and proposed renewed term of plant operation. The upper drywell region is not experiencing statistically observable corrosion, except a single location that continues to experience minor corrosion at a rate of 0.66 mils/yr. When this monitored corrosion rate is projected through the year 2029, sufficient margin exists to acceptance criteria.

Table 1

Drywell Shell Thickness and Minimum Available Thickness Margins are provided below:

Drywell Region (Elevation monitored)	Nominal Design Thickness, mils (Ref [40])	Minimum Measured Thickness, mils (Ref [21], Ref [25], Ref [31], Ref [47])	Minimum Required Thickness, mils Acceptance Criteria (Ref [43], Ref [15])	Minimum Available Thickness margin, mils
Cylindrical (87' 5")	640	604	452	152
Upper Sphere (51' 10", 60' 10")	722	676	518	158
Middle Sphere (50' 2")	770	678	541	137

Conclusions:

Summary of Corrosion Rates of UT measurements taken every 4 years through year 2006 (Ref [47])

- There is no statistically observable ongoing general corrosion at three elevation (51' 10", 60' 10", and 87' 5")
- Based on statistical analysis, one location at elevation 50' 2" is undergoing a minor general corrosion rate of 0.66 mils per year
- The drywell corrosion inspection program will ensure sufficient margin will be maintained through 2029

For illustrations of the margins of monitored locations in upper drywell see attached Key Plan and Graphs 1-13.

Table 2

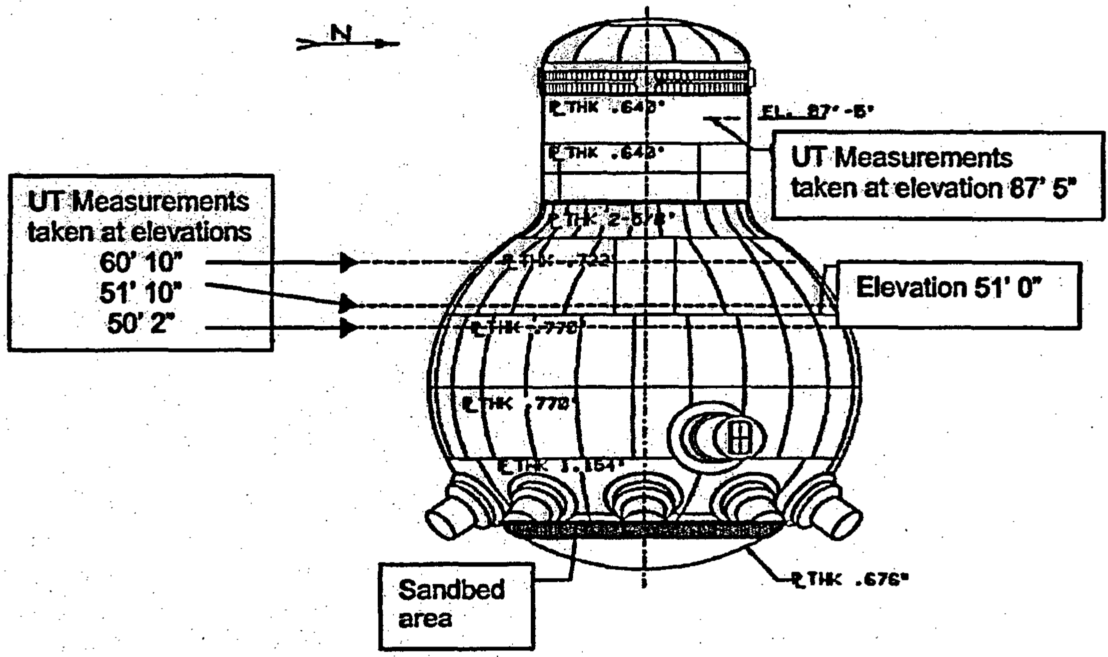
Monitored Elevation	Location	Minimum Required Thickness, inches [5]	Average Measured Thickness [1,2,4], inches												Projected Thickness in 2029
			1987	1988	1989	1990	1991	1992	1993 [3]	1994	1996	2000	2004	2006	
Elevation 50' 2"		0.541"													
	Bay 5–D12					0.743 0.745 0.746	0.742 0.745 0.748	0.747 0.747		0.741	0.748	0.741	0.743	0.747	No Observable Ongoing Corrosion
	Bay 5– 5H					0.761 0.761	0.755 0.758 0.760	0.759 0.759		0.754	0.757	0.754	0.756	0.760	No Observable Ongoing Corrosion
	Bay 5– 5L					0.706 0.703	0.703 0.705 0.706	0.703 0.702		0.702	0.705	0.706	0.701	0.705	No Observable Ongoing Corrosion
	Bay 13–31H					0.762 0.779	0.760 0.758 0.765	0.765 0.763		0.759	0.766	0.762	0.758	0.762	No Observable Ongoing Corrosion
	Bay 13–31L					0.687 0.684	0.689 0.678 0.688	0.685 0.688		0.683	0.690	0.682	0.693	0.678	No Observable Ongoing Corrosion
	Bay 15–23H					0.758 0.764	0.762 0.762 0.765	0.767 0.763		0.758	0.760	0.758	0.757	0.749	0.720
	Bay 15–23L					0.726 0.728	0.726 0.729 0.725	0.726 0.724		0.728	0.724	0.729	0.727		

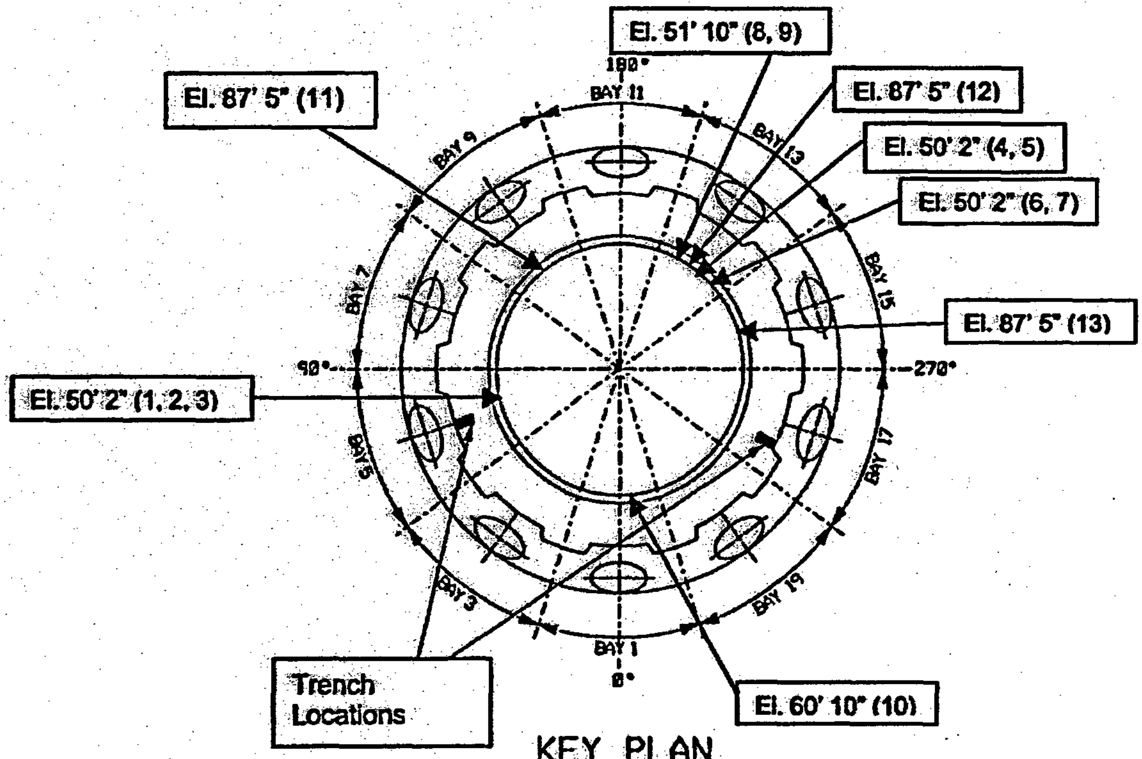
Monitored Elevation	Location	Minimum Required Thickness, Inches [5]	Average Measured Thickness [1,2,4], inches												Projected Thickness in 2029
			1987	1988	1989	1990	1991	1992	1993 [3]	1994	1996	2000	2004	2006	
Elevation 51' 10"		0.518" (6)													
	Bay 13–32H					0.716	0.715 0.715 0.720	0.717 0.717		0.714	0.715	0.715	0.713	0.715	No Observable Ongoing Corrosion
	Bay 13–32L					0.686	0.683 0.683 0.682	0.683 0.676		0.680	0.684	0.679	0.687	0.685	No Observable Ongoing Corrosion
Elevation 60' 10"		0.518"													
	Bay 1–50-22								0.693	0.711	0.693	0.689	0.693	0.691	No Observable Ongoing Corrosion
Elevation 87' 5"		0.452"													
	Bay 9–20		0.619	0.622 0.620	0.619	0.620	0.614 0.612	0.629 0.614		0.613	0.613	0.604	0.612	0.617	No Observable Ongoing Corrosion
	Bay 13–28		0.643	0.641 0.642	0.645	0.643	0.635 0.629	0.641 0.637		0.640	0.636	0.635	0.640	0.642	No Observable Ongoing Corrosion
	Bay 15–31		0.638	0.636 0.636	0.638	0.642	0.628 0.627	0.631 0.630		0.633	0.632	0.628	0.630	0.633	No Observable Ongoing Corrosion

Notes:

1. The average thickness is based on 49 Ultrasonic Testing (UT) measurements performed at each location
2. Multiple inspections were performed in the years 1988, 1990, 1991, and 1992.
3. The 1993 elevation 60' 10" Bay 5-22 inspection was performed on January 6, 1993. All other locations were inspected in December 1992.
4. Accuracy of Ultrasonic Testing Equipment is plus or minus 0.010 inches.
5. Reference SE-000243-002 (Ref [26]).

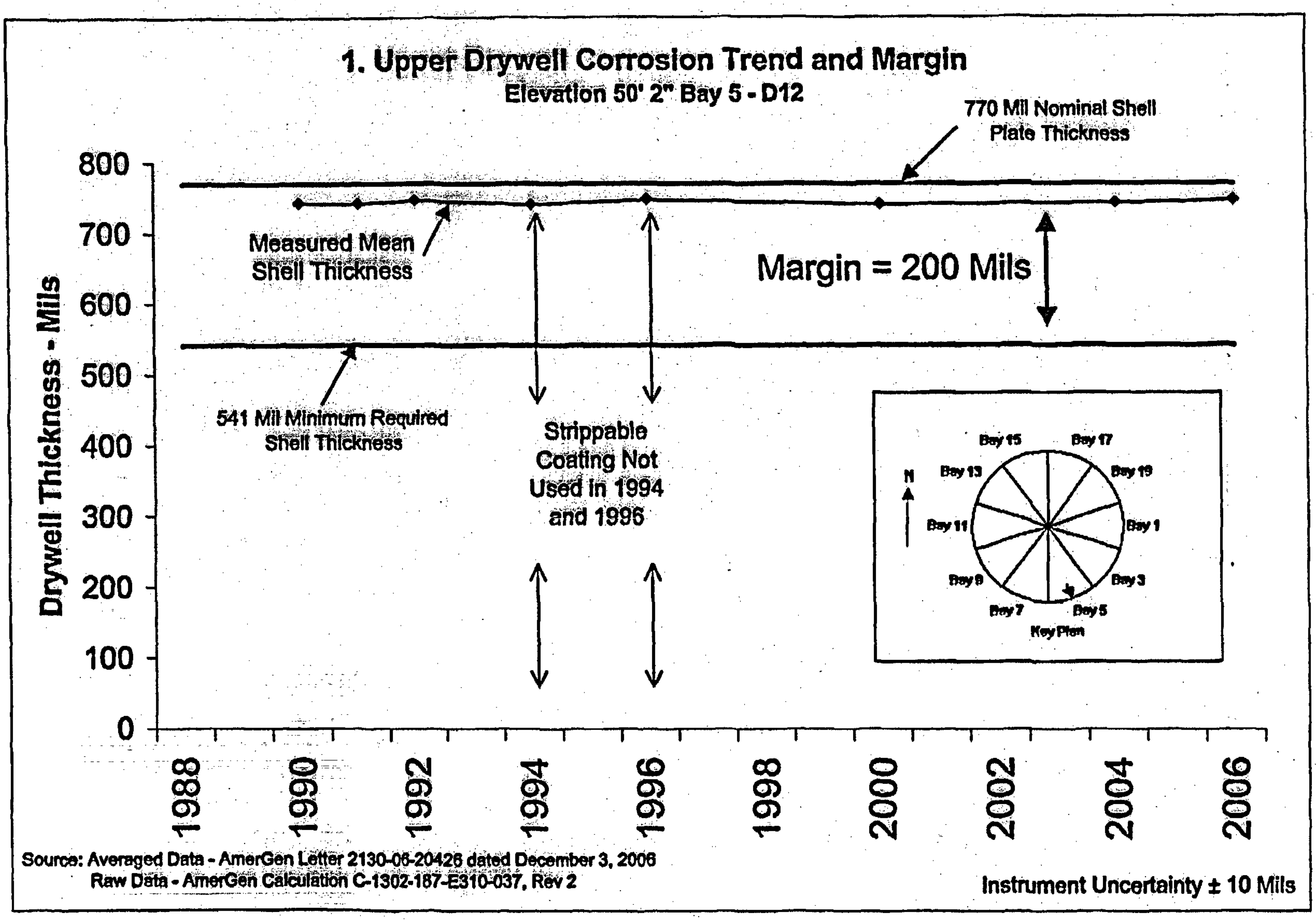
Ongoing Upper Drywell Thickness Monitoring
UT Measurement Locations





KEY PLAN
(SCALE: NONE)

Numbers in parentheses refer to the attached Graph identification numbers.



1. Upper Drywell Corrosion Trend and Margin

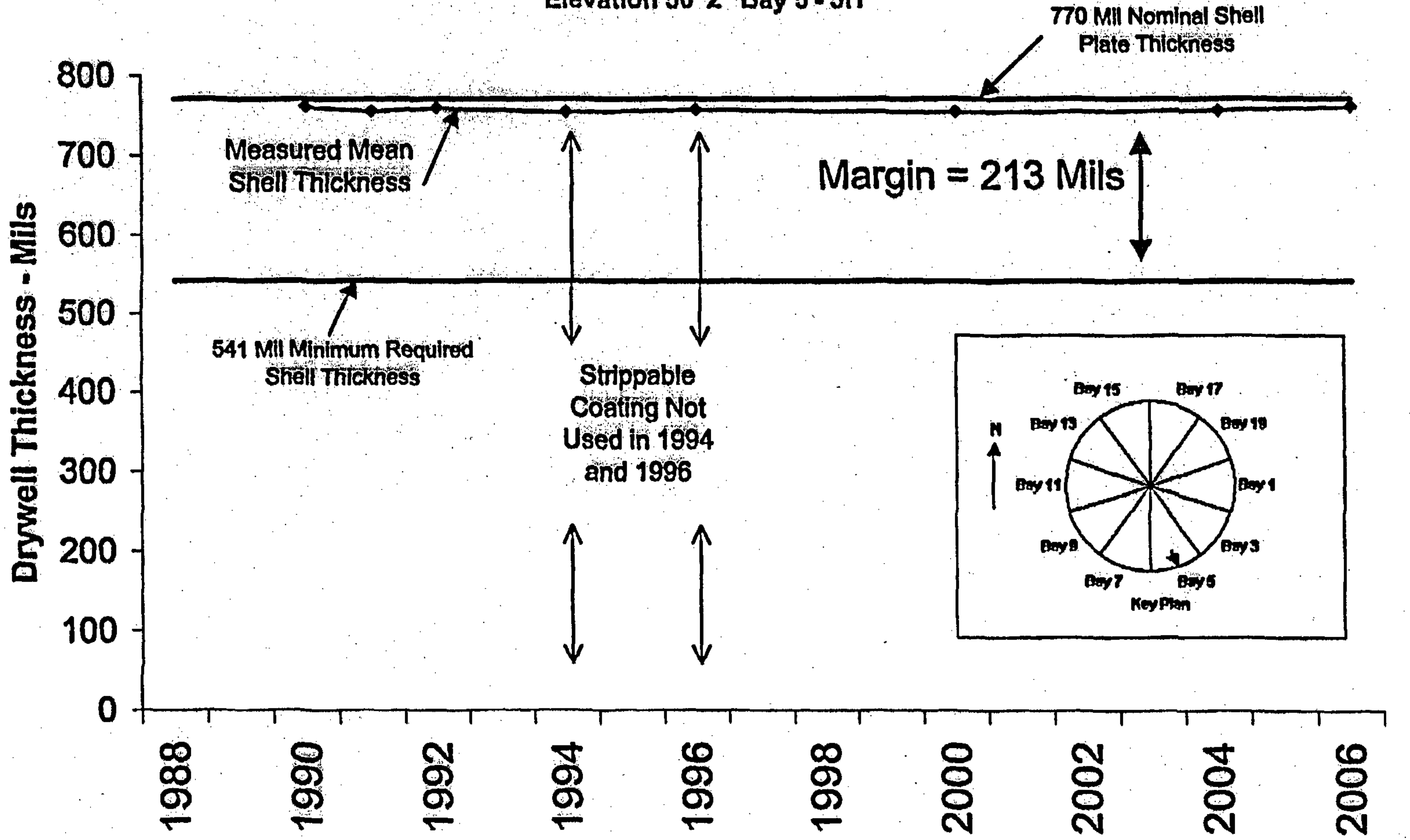
Elevation 50' 2" Bay 5 - D12

Source: Averaged Data - AmerGen Letter 2130-06-20426 dated December 3, 2006
Raw Data - AmerGen Calculation C-1302-187-E310-037, Rev 2

Instrument Uncertainty ± 10 Mils

2. Upper Drywell Corrosion Trend and Margin

Elevation 50' 2" Bay 5 - 5H



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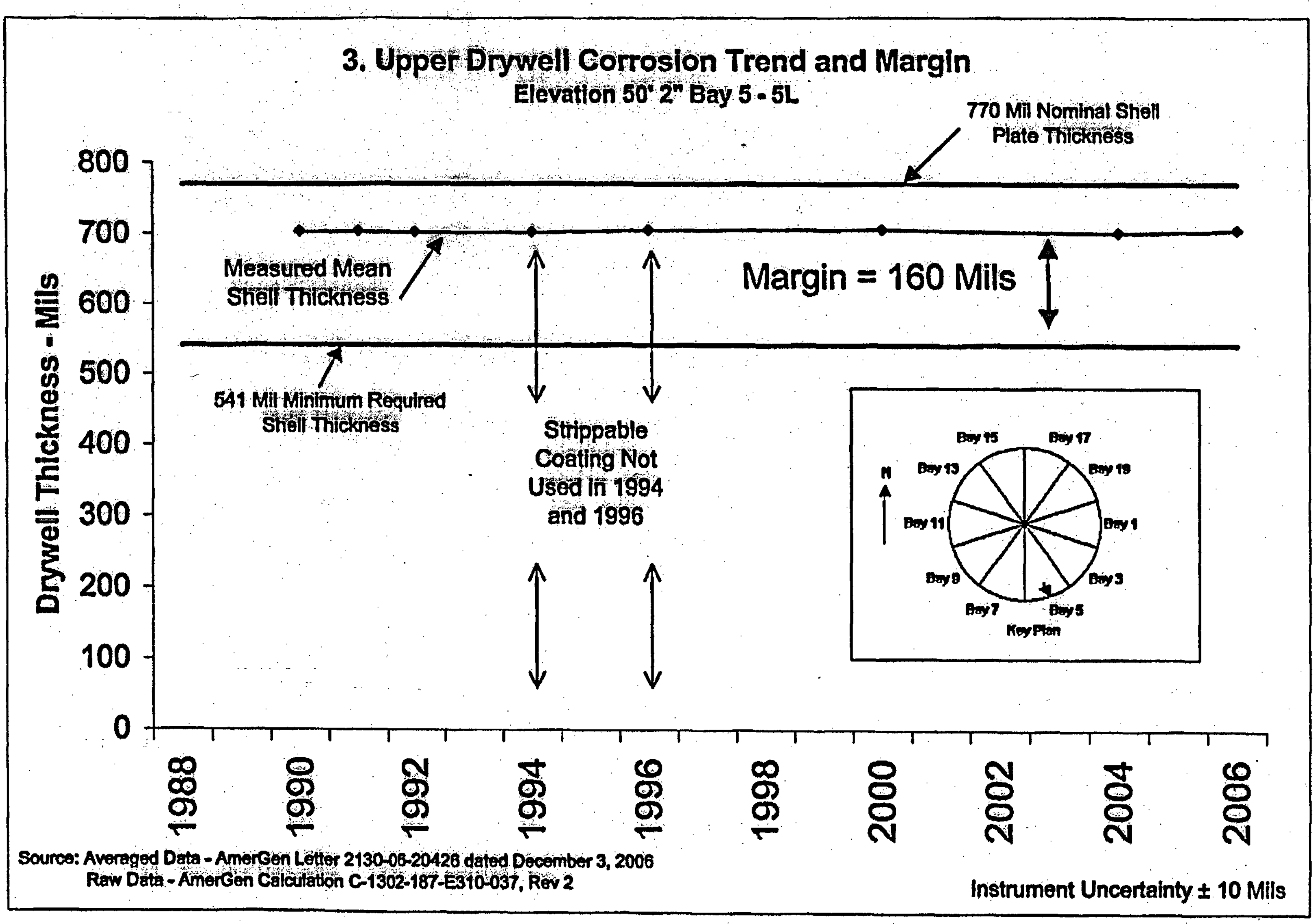
Raw Data - AmerGen Calculation C-1302-187-E310-037, Rev 2

Instrument Uncertainty ± 10 Mils



3. Upper Drywell Corrosion Trend and Margin

Elevation 50' 2" Bay 5 - 5L

770 Mil Nominal Shell Plate Thickness

Measured Mean Shell Thickness

Margin = 160 Mils

541 Mil Minimum Required Shell Thickness

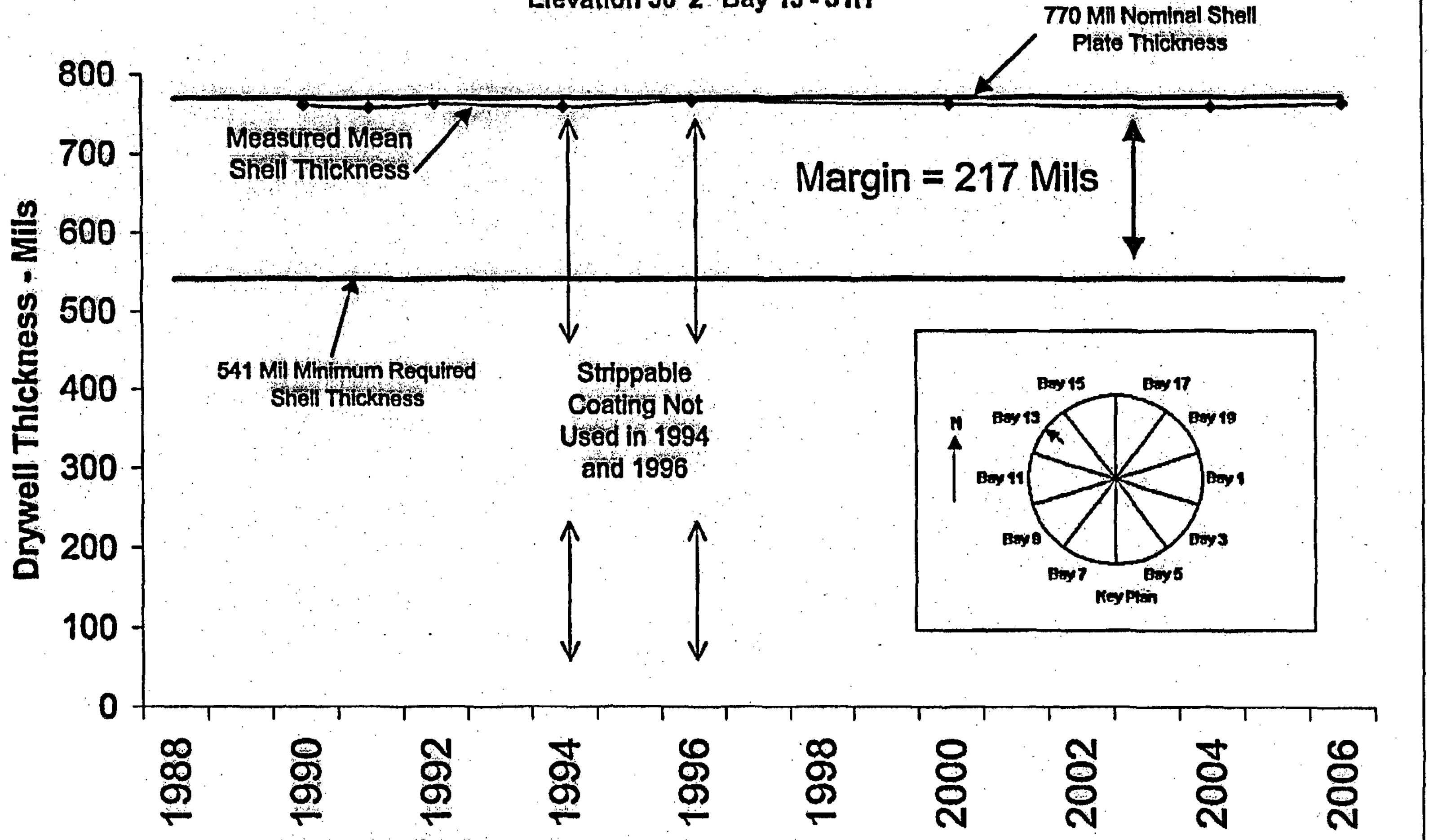
Strippable Coating Not Used in 1994 and 1996

Source: Averaged Data - AmerGen Letter 2130-06-20426 dated December 3, 2006
Raw Data - AmerGen Calculation C-1302-187-E310-037, Rev 2

Instrument Uncertainty ± 10 Mils

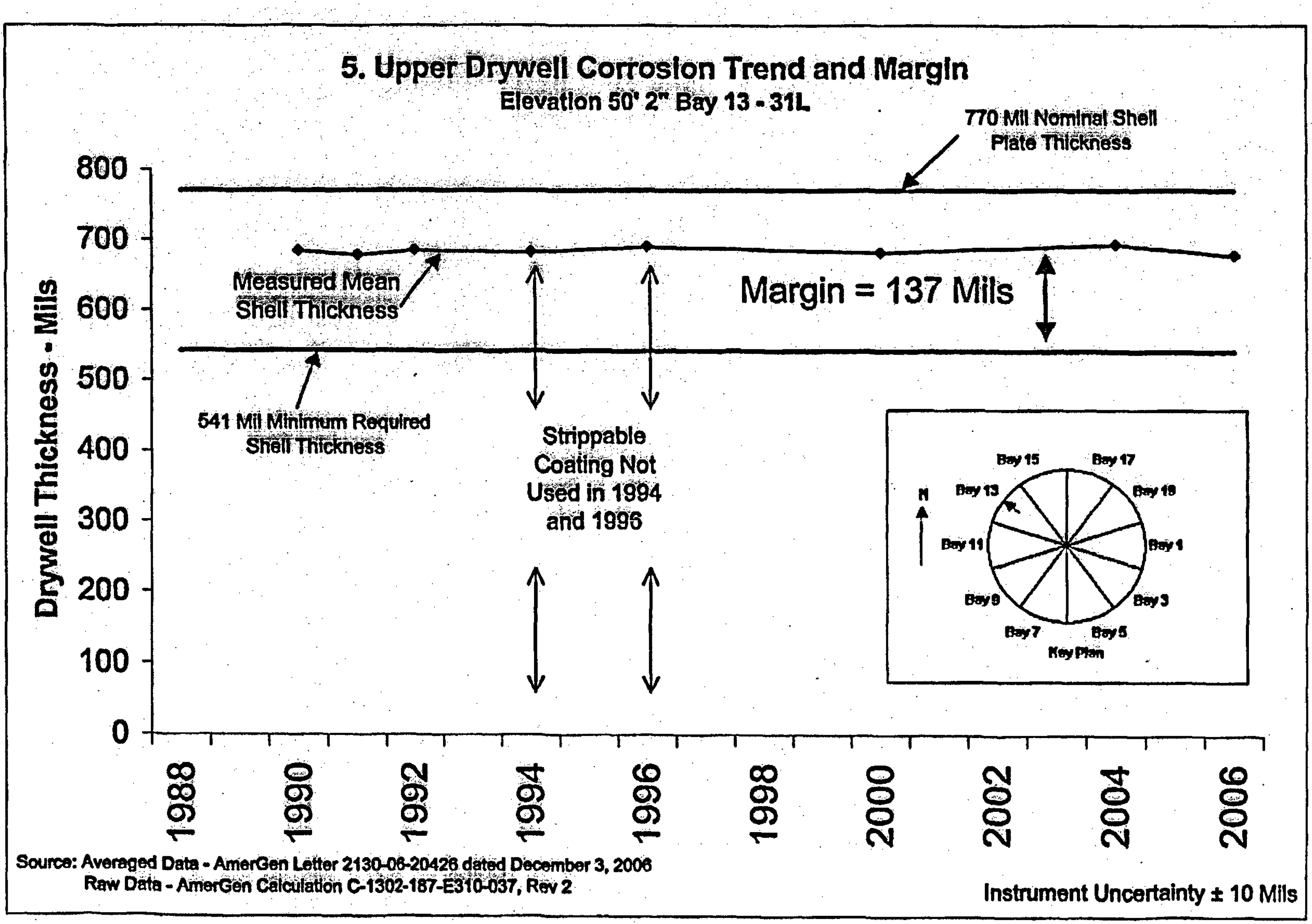
4. Upper Drywell Corrosion Trend and Margin

Elevation 50' 2" Bay 13 - 31H



Source: Averaged Data - AmerGen Letter 2130-06-20426 dated December 3, 2006
Raw Data - AmerGen Calculation C-1302-187-E310-037, Rev 2

Instrument Uncertainty ± 10 Mils

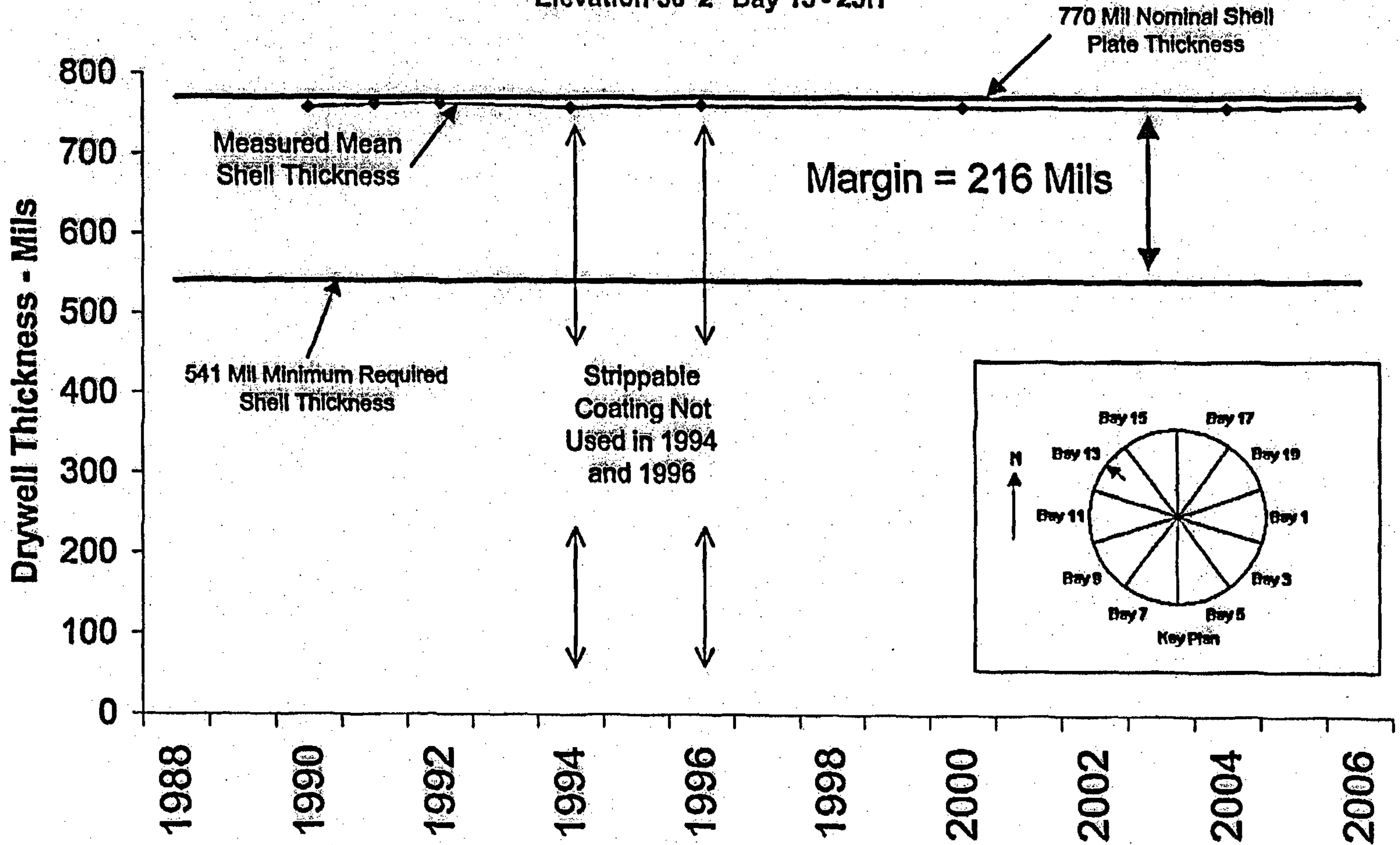


5. Upper Drywell Corrosion Trend and Margin

Elevation 50' 2" Bay 13 - 31L

Source: Averaged Data - AmerGen Letter 2130-06-20426 dated December 3, 2006
Raw Data - AmerGen Calculation C-1302-187-E310-037, Rev 2

Instrument Uncertainty ± 10 Mils

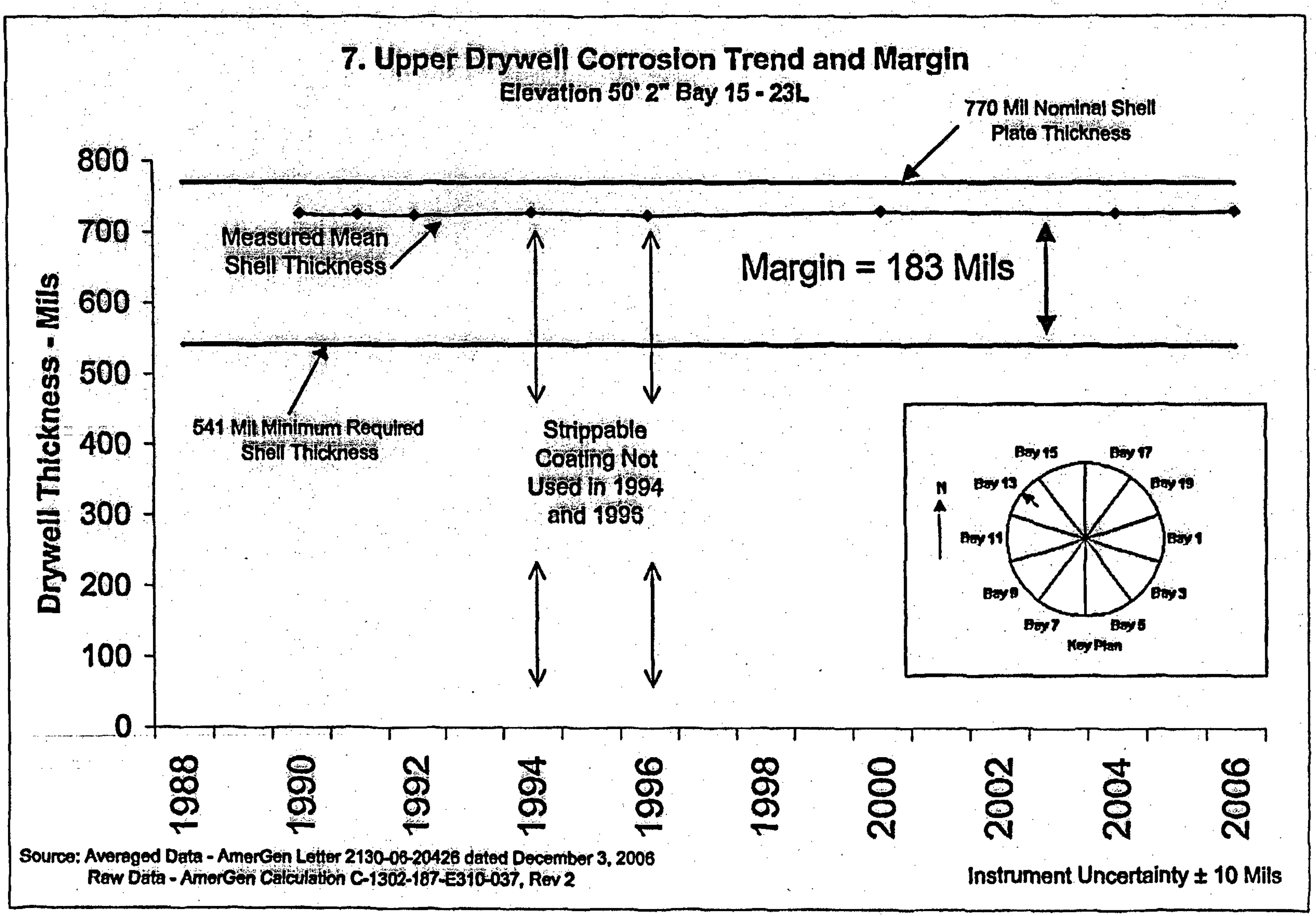


6. Upper Drywell Corrosion Trend and Margin

Elevation 50' 2" Bay 15 - 23H

Source: Averaged Data - AmerGen Letter 2130-06-20426 dated December 3, 2006
Raw Data - AmerGen Calculation C-1302-187-E310-037, Rev 2

Instrument Uncertainty ± 10 Mils



7. Upper Drywell Corrosion Trend and Margin

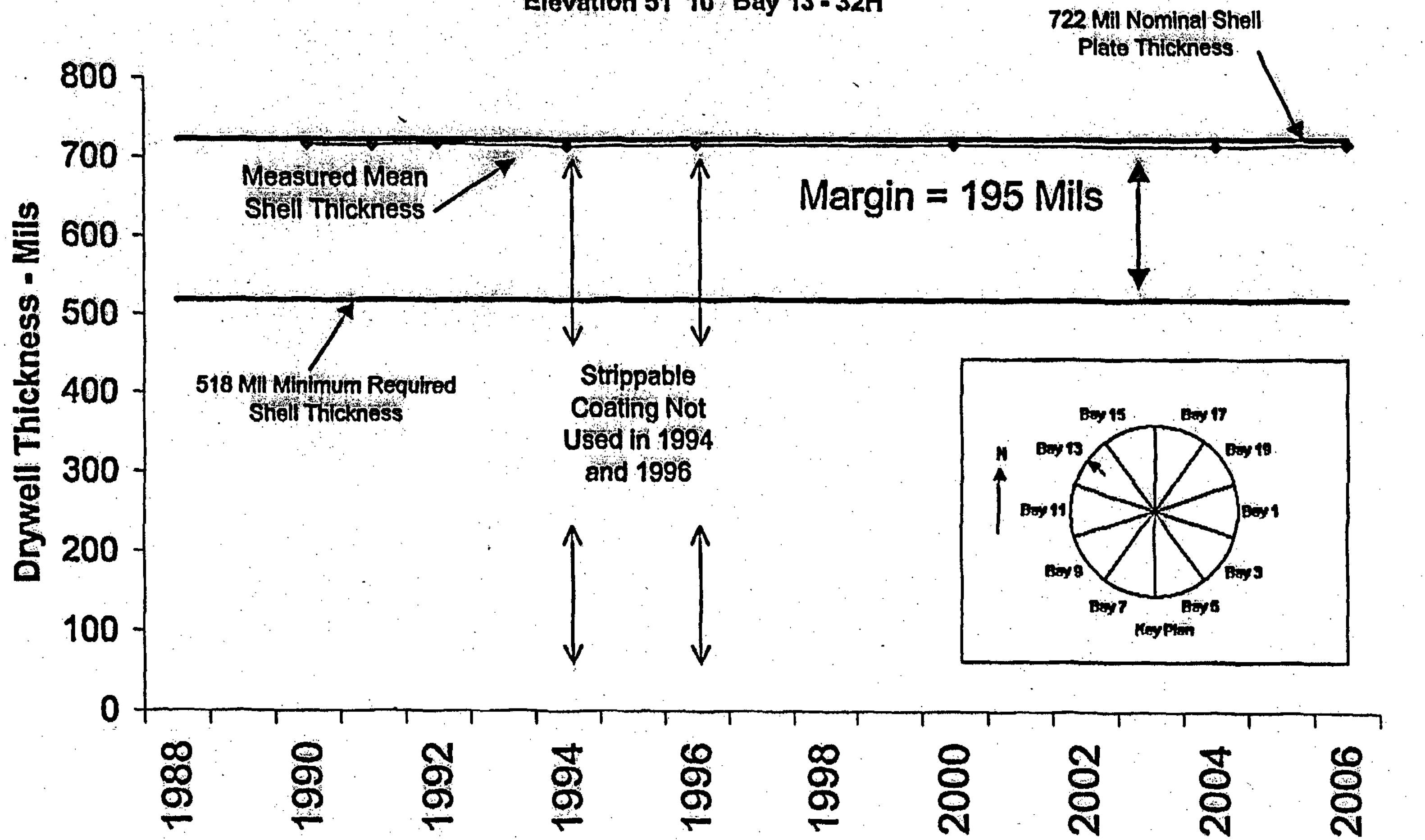
Elevation 50' 2" Bay 15 - 23L

Source: Averaged Data - AmerGen Letter 2130-06-20426 dated December 3, 2006
Raw Data - AmerGen Calculation C-1302-187-E310-037, Rev 2

Instrument Uncertainty ± 10 Mils

8. Upper Drywell Corrosion Trend and Margin

Elevation 51' 10" Bay 13 - 32H

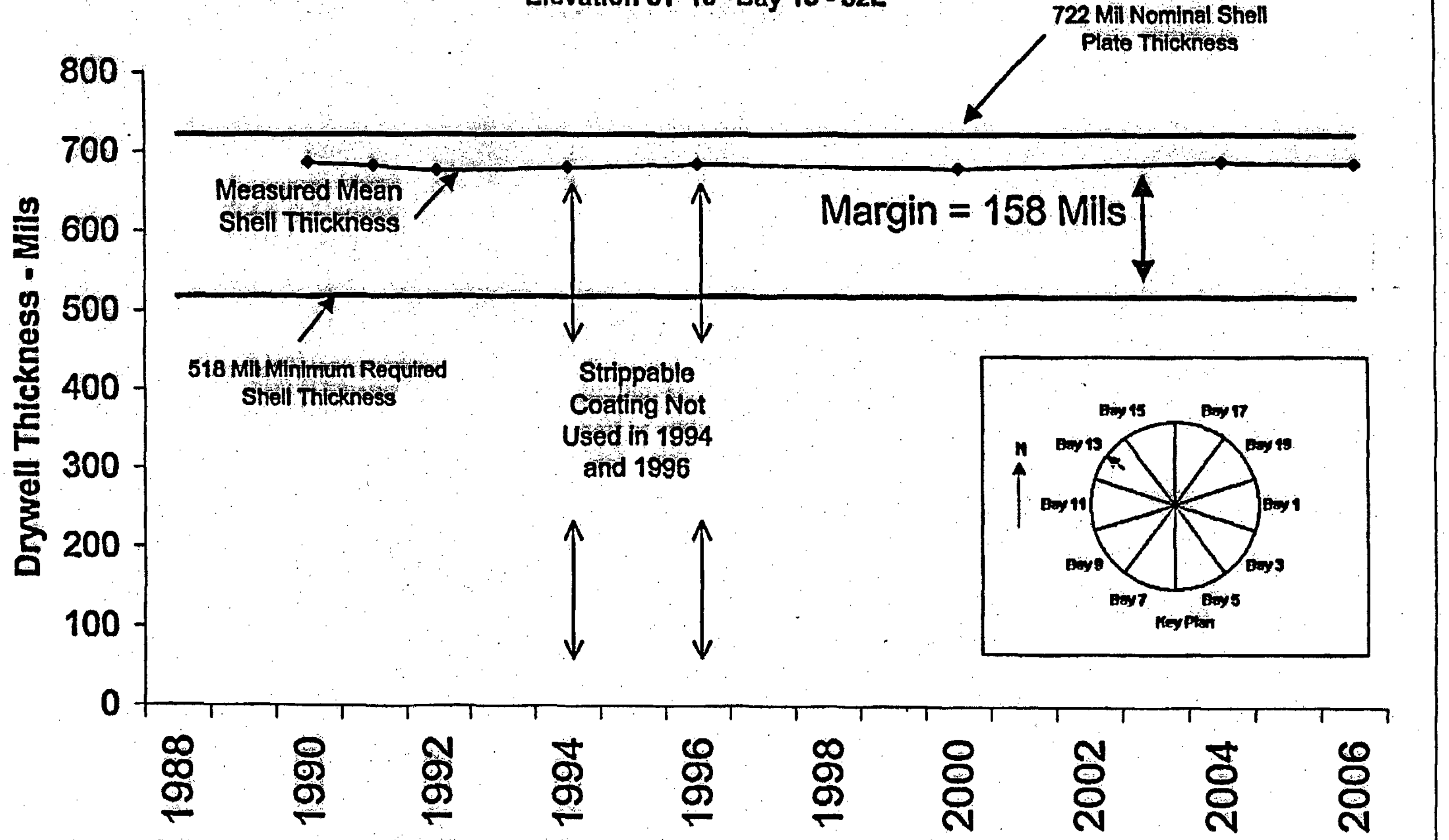


Source: Averaged Data - AmerGen Letter 2130-06-20426 dated December 3, 2006
Raw Data - AmerGen Calculation C-1302-187-E310-037, Rev 2

Instrument Uncertainty ± 10 Mils

9. Upper Drywell Corrosion Trend and Margin

Elevation 51' 10" Bay 13 - 32L

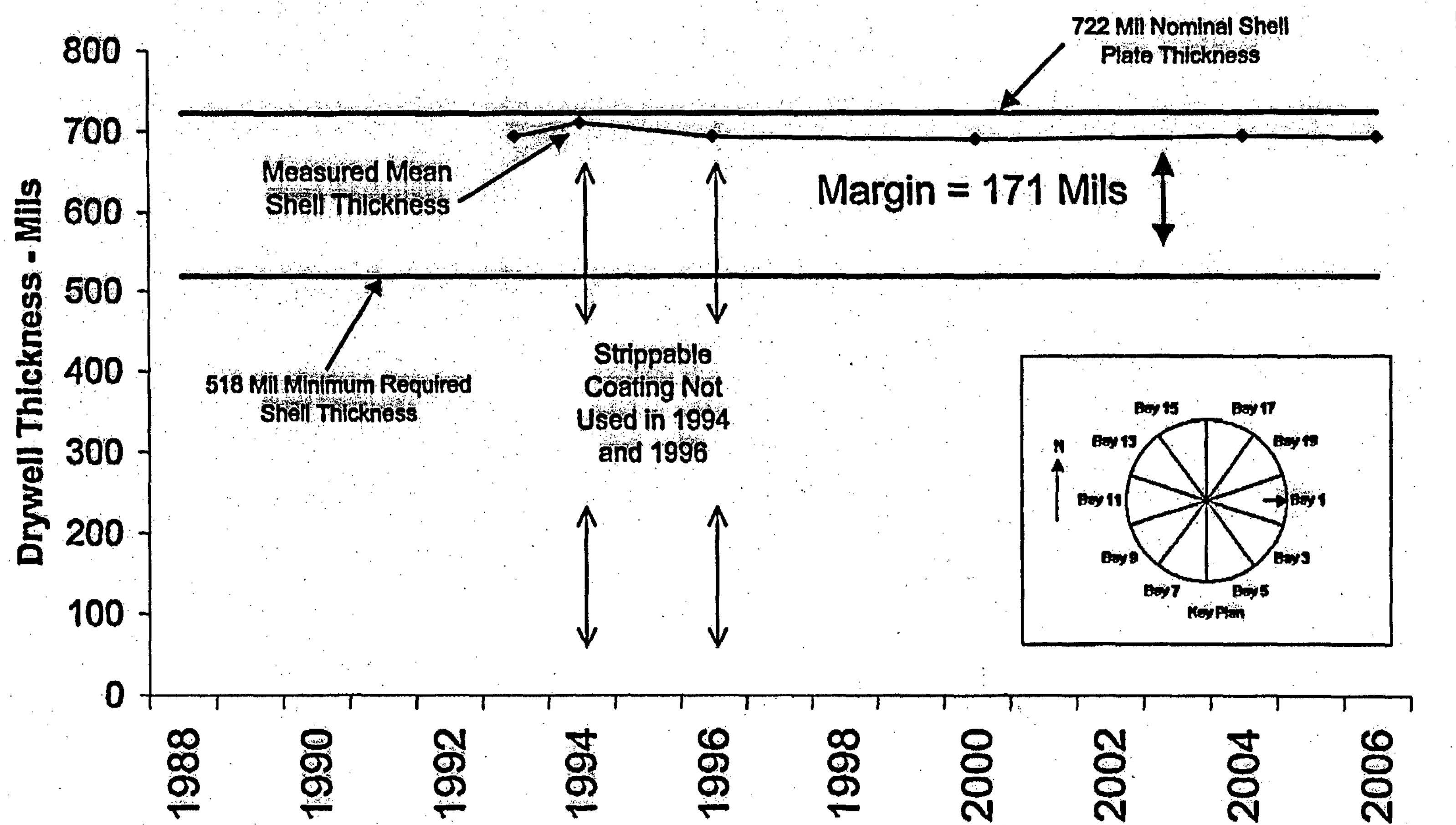


Source: Averaged Data - AmerGen Letter 2130-06-20426 dated December 3, 2006
Raw Data - AmerGen Calculation C-1302-187-E310-037, Rev 2

Instrument Uncertainty ± 10 Mils

10. Upper Drywell Corrosion Trend and Margin

Elevation 60' 10" Bay 1 - 50 - 22

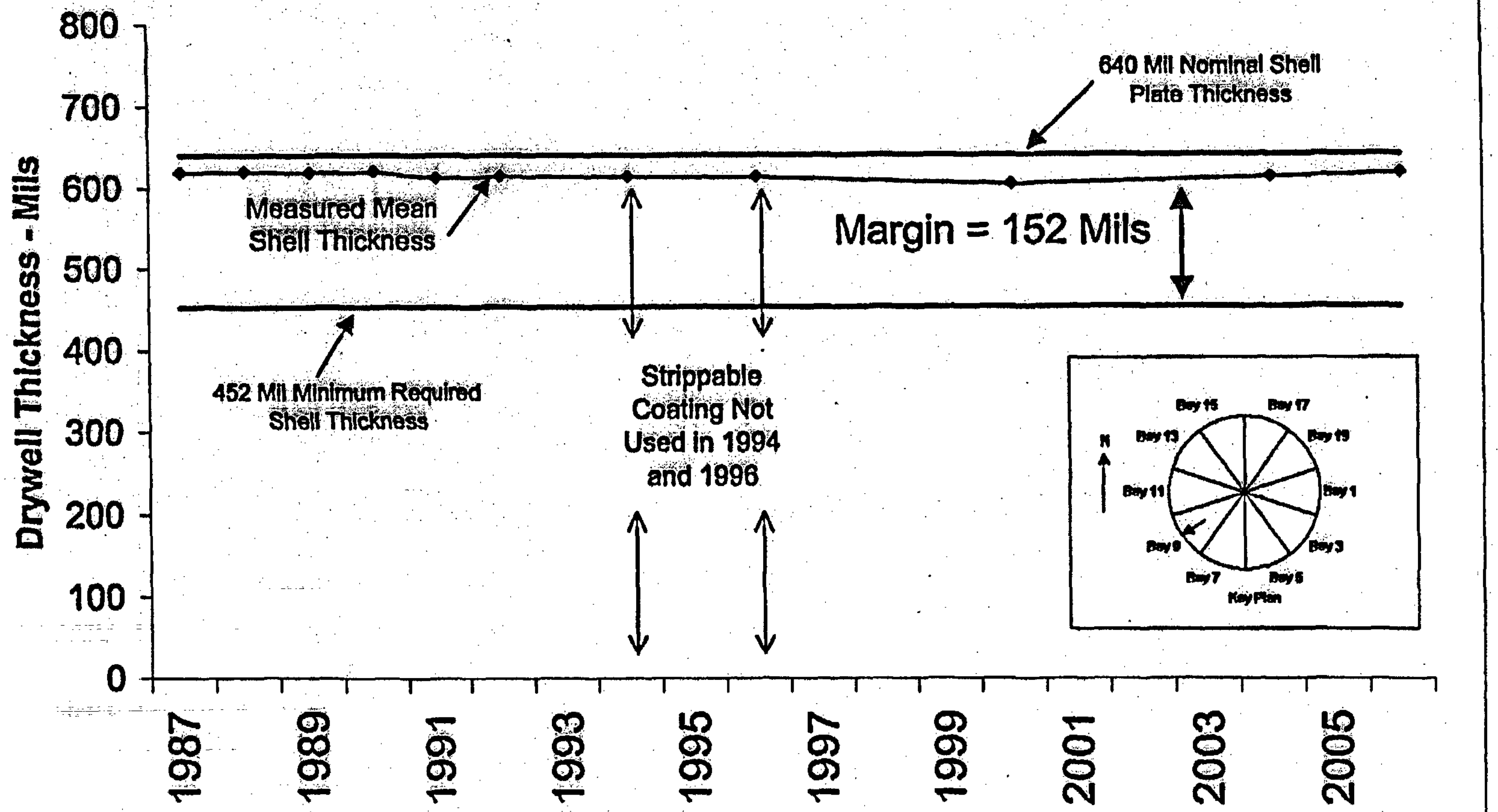


Source: Averaged Data - AmerGen Letter 2130-06-20426 dated December 3, 2006
Raw Data - AmerGen Calculation C-1302-187-E310-037, Rev 2

Instrument Uncertainty ± 10 Mils

11. Upper Drywell Corrosion Trend and Margin

Elevation 87' 5" Bay 9 - 20

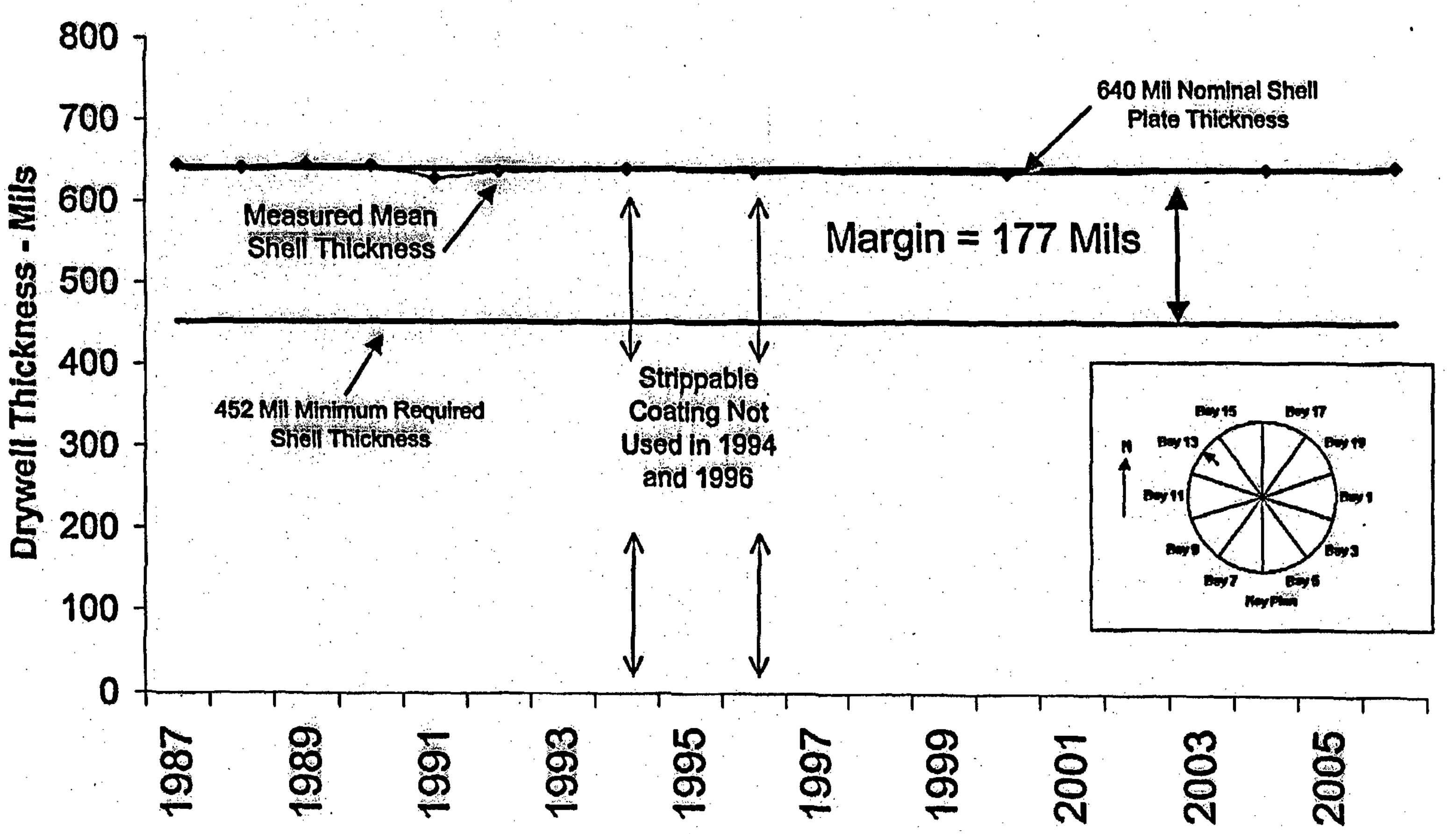


Source: Averaged Data - AmerGen Letter 2130-06-20426 dated December 3, 2006
Raw Data - AmerGen Calculation C-1302-187-E310-037, Rev 2

Instrument Uncertainty ± 10 Mils

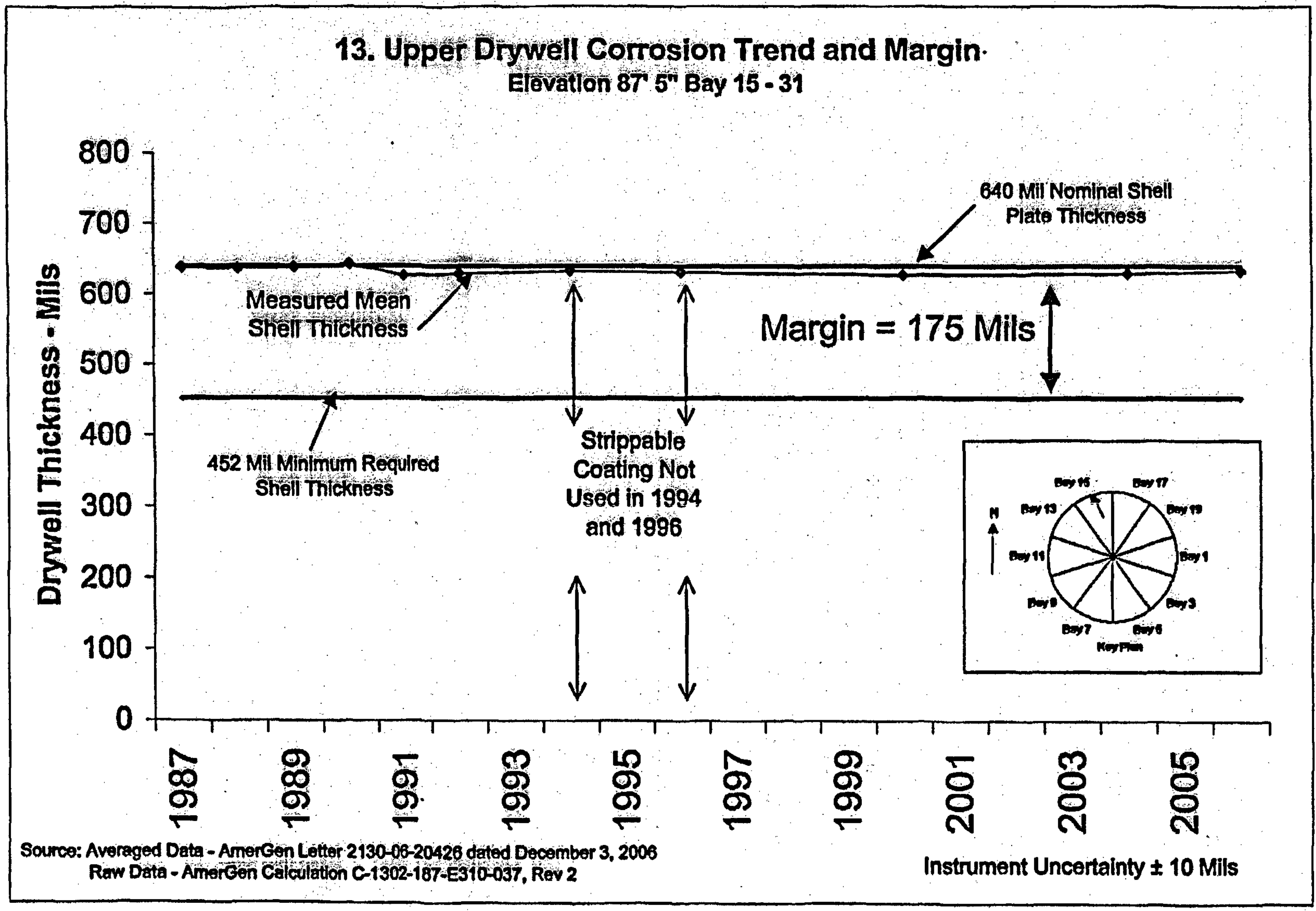
12. Upper Drywell Corrosion Trend and Margin

Elevation 87' 5" Bay 13 - 28



Source: Averaged Data - AmerGen Letter 2130-06-20426 dated December 3, 2006
Raw Data - AmerGen Calculation C-1302-187-E310-037, Rev 2

Instrument Uncertainty ± 10 Mils



13. Upper Drywell Corrosion Trend and Margin

Elevation 87' 5" Bay 15 - 31

Source: Averaged Data - AmerGen Letter 2130-06-20426 dated December 3, 2006
Raw Data - AmerGen Calculation C-1302-187-E310-037, Rev 2

Instrument Uncertainty ± 10 Mils

The following discussion addresses corrosion of the Oyster Creek outer drywell shell in the sanded region. Part I, below, provides an overview of historic information pre-dating the October 2006 outage. The discussion in Part II sets forth information discovered and analyzed as a result of the October 2006 outage. Overall conclusions about the drywell, and its continued operation during the proposed twenty-year renewal term, are summarized in Part III.

I. Historical Summary and Past Findings

In the 1980's, the Oyster Creek containment drywell experienced wall thinning in the sandbed region caused by water in contact with the outer drywell shell. Beginning in 1986, corrective actions were implemented to monitor, mitigate or reduce the rate of corrosion, which was initially estimated to vary from negligible in certain bays to 39 mils/year at the thinnest location in bay 13 (Ref [10]). The corrective actions were effective in reducing accelerated corrosion as evidenced by the decline in the rate of corrosion starting in 1990 (see Attachment 1).

Beginning in 1986, UT thickness measurements were taken at elevation 11'3" from the interior of the drywell shell in each bay using a 6"x6" template every refueling outage and outage of opportunity. The template is centered on points determined by UT thickness measurements taken between 1983 and 1986 to be thinnest location in each bay. The points were marked on the shell to ensure that the same location is examined each time (See Attachment 2).

Analysis and trending of UT thickness data collected between 1986 and 1992 showed that thinning of the shell was not uniform and varied within a bay and from one bay to another. The measured average thickness in some bays (1,3,5,7,15) is nearly equal to the plate original nominal thickness of 1154 mils. In other bays, the nominal thickness is reduced significantly, with bay 19 having the thinnest area of 800 mils. In all cases, the average thickness is greater than 736 mils, which is required to satisfy ASME Code buckling stress requirements.

As shown in Table-1 below, the thinnest average measured area in each bay has adequate thickness margin in addition to the ASME Code safety factor of 2 for refueling load combination and 1.67 for post accident load combination (Ref [32]). As explained in Part II, below, AmerGen took UT thickness measurements during the October 2006 refueling outage to confirm the margin remains within the calculated uncertainty listed in Table-6.

Table-1. Minimum Available Thickness Margin

Bay No.	1	3	5	7	9	11	13	15	17	19
Minimum Available Margin, mils	365	439	432	397	256	84	101	306	74	64

Corrosion mitigating actions in the sand bed region were completed in 1992, when the sand was completely removed from the region, followed by removal of corrosion products, and preparation of the shell surface for the epoxy coating. Prior to applying the coating, the entire surface of the sandbed area was visually inspected to validate UT thickness measurements, previously made from inside the drywell, and to identify local areas thinner than the minimum required average general thickness of 736 mils. 125 local areas were identified by visual inspection as areas that could be potentially thinner than 736 mils (See Table-2). UT thickness measurements of the 125 locations identified 20 locally thinned areas less than the minimum required general thickness of 736 mils, but greater than analyzed local criteria of 536 mils (the minimum required to withstand buckling), and 490 mils local criteria developed in accordance with ASME Code requirements (the minimum required to withstand design pressure).

Following the UT inspections discussed above, the outer drywell shell surface in the sandbed region was coated with a multi-layered epoxy coating system designed for moisture environment. The sandbed region floor also was repaired to improve drainage of the region and the junction of the embedded outer drywell shell with the sandbed region concrete floor was sealed to prevent moisture intrusion into the embedded outer drywell shell.

Analysis of UT thickness measurements conducted in 1992 and 1994 showed that corrosion of the outer drywell shell in the sandbed region had been arrested. UT thickness measurements taken in 1996 also indicated that corrosion in the outer drywell shell had been arrested. Some of the1996 data contained anomalies that are not readily justifiable but the anomalies did not significantly change the results (Ref [37]). Between 1996 and the October 2006 outage, UT thickness measurements had not been taken; instead the epoxy coating in selected bays was inspected every other refueling outage.

Coating inspections conducted in 1994 (Bays 11, 3), 1996 (Bays 11, 17), 2000 (Bays 1, 13), and 2004 (Bays 1,13) showed that the coating was in good condition and there were no indications that the outer drywell shell was undergoing further corrosion (Ref [34]). Furthermore, the periodic UT thickness measurements of the shell in the upper regions of the drywell that are not coated with epoxy can be used conservatively as an indicator of the condition of the outer drywell shell in the sandbed region. The 2004 and 2006 upper region UT results showed that the highest general corrosion rate is less than 1 mil/year.

A detailed discussion of the various historic activities follows:

A. Initial Corrective Actions

Upon discovery of water in the sandbed region in 1980, corrective actions were initiated to a) determine the source of water leakage, b) establish if corrosion is occurring by taking UT thickness measurements, and c) assess the impact of corrosion on the drywell structural integrity.

1. Source of Water Leakage Into the Sand Bed Region

Extensive examination and testing of potential water sources concluded that water found in the sandbed region was from the refueling cavity during refueling outages. Cracks were identified in the reactor cavity stainless steel liner that permitted water to leak from the cavity, collect in an improperly functioning concrete trough below the cavity seals, and enter the gap between the outer drywell shell and the reactor building concrete. Once water entered the gap, it flowed down to the sandbed region. The water collected and was retained in the sandbed region in part as a result of unfinished concrete floor in some bays and clogged sandbed drains. Refer to the section 4 of this Enclosure for additional details.

2. Initial Ultrasonic Testing (UT) Thickness Measurements

Initial UT thickness measurements were made in 1983 from inside the drywell, through paint, above the concrete floor level (elev. 10' 3") in the bays that corresponded to where water was observed coming from sandbed drains. The measurements indicated that the drywell shell was thinner than expected. The accuracy of these measurements was questioned because the readings were taken through paint. As a result, calibration tests were conducted to evaluate the impact of the paint on the UTs. The test results indicated that UT measurements through paint overestimated the actual thickness by 0.3% for a 5-mil coating and 1.5% for a 10-mil coating. For this reason, the paint was removed at the inspection locations and a new set of UT measurements was taken from inside the drywell in 1986. The new UT readings continued to indicate that the drywell shell was thinner in those sand bed bays. (Ref [7])

The scope of the UTs was expanded to include several areas near the drywell floor adjacent to the sandbed region (elevation 11' 3"). The new readings also indicated that the drywell shell was thinner than expected. (Ref [7])

As a result of the 1986 UT readings, a program was initiated to obtain detailed measurements in order to determine the extent and characterization of the thinning. Where thinning was detected, additional measurements were made in a cross pattern to determine the extent of the thinning. After the cross pattern was completed, the lowest reading at each location was used to expand the UT readings to a 6"x6" grid on 1" center with the lowest reading at the center of the grid. Approximately

560 total UT measurements were made in the ten bays at locations shown in drawing 3E-SK-S-85 (Ref [4a]). In 1986, as part of an ongoing effort at the Oyster Creek Generating Station to investigate the impact of water on the outer drywell shell, concrete was excavated at two locations inside the drywell (referred to as trenches) to expose the drywell shell below the Elevation 10' 3" concrete floor level to allow ultrasonic (UT) measurements to be taken to characterize the vertical profile of corrosion in the sand bed region outside the shell. The trenches (approximately 18" wide) were located in Bays 5 and 17 with the bottom of the trenches at approximate elevations 8' 9" and 9' 3" respectively (The elevation of the sand bed region floor outside the drywell is approximately 8' 11"). A total of 579 UT thickness measurements were taken inside the 2 trenches. The measurements inside the 2 trenches showed that the reduction in shell thickness below the drywell concrete floor level (Elev. 10' 3") is no greater than indicated above the floor level (Ref [7], Ref [4a], Ref [8], Ref [47])

Additional UT thickness measurements were taken at the plate-to-plate welds under the vent lines and the vent opening reinforcement plates. These areas were given extra consideration on the basis that material sensitized by welding may have been attacked by a corrosion mechanism with greater potential for damage or cracking. The readings did not detect wall thinning or cracks at these locations (Ref [7]).

3. UT Thickness Data Statistical Analysis Prior to 2006

The following steps have been performed to test and analyze the UT measurement data for those locations where 6"x6" grid data has been taken at least three times. The results of the analysis yield the measured average general thickness (± standard error), F-Ratio, which was used to determine if corrosion was occurring, and the upper 95% confidence interval was used after corrosion was identified. See Table-5, Table-6, and Attachment 1 for the results of the analysis. The steps are:

- Edit each 49-point data set by setting all invalid points to "missing". Invalid points are those that are declared invalid by the UT operator or are at a plug (i.e., core sample) location.
- Perform a Univariate Analysis of each 49 point data set to ensure that the data is normally distributed.
- Calculate the mean thickness and variance of each 49-point data set.
- Perform an Analysis of Variance F-test to determine if there is a significant difference between the means of the data sets.
- Using the mean thickness values for each 6"x6" grid, perform linear regression analysis over time at each location

- Perform F-test for significance of regression at the 5% level of significance.

- Calculate the ratio of the observed F value to the critical F value at 5% level of significance. The result of this test indicates whether or not the regression model is more appropriate than the mean level.

- Calculate the coefficient of determination (R^2) to assess how well the regression model explains the percentage of total error and thus how useful the regression line will be as a predictor

- Determine if the residual values for the regression equations are normally distributed.

- Calculate the y-intercept, the slope and their respective standard errors. The y-intercept represents the fitted mean thickness at time zero, the slope represents the corrosion rate, and the standard errors represent the uncertainty or random error of the two parameters. Calculate the upper 95% one-sided confidence interval about the computed slope to provide an estimate of the maximum probable corrosion rate at 95% confidence after corrosion was identified.

- When the corrosion rate is not statistically significant compared to random variations in the mean thickness, the slope and confidence interval slope computed in the regression analysis still provides an estimate of the corrosion rate, which could be masked by the random variations.

- Use the chi-square goodness-of-fit test results to determine if low thickness measurements are significant pits. If the measurement deviates from the mean thickness by three standard deviations, it is to

Table 3 – Core Sample Thickness Evaluation

Sample No.	Location (Bay No.)	Pre-removal UT Average thickness, mils	Post-removal Measured Average Thickness, mils
1	19C	815	825
2	15A	1170	1170
3	17D	840	860
4	19A	830	847
5	11A	860	885
6	11A	1170	1190
7	19A	1140	1181

Source: Ref [1]

In summary, extensive UT readings of drywell shell thickness were taken inside the drywell to establish areas of largest wall thinning between 1986 and 1992. UT measurements were also taken in 2 trenches excavated in the drywell concrete floor to establish the vertical profile of corrosion in the sandbed region in 1986 and in 1988. The measurements showed that corrosion in the sandbed region below the drywell floor level, elevation 10' 3", was no greater than the corrosion measured at the floor level. UT measurements taken from outside the drywell after removing the sand in 1992 (discussed in section C.1below) confirmed this observation. Thus locations selected inside the drywell for repetitive UT measurements represented the condition of the entire sandbed region.

5. Initial Analysis to Assess Impact of Corrosion on the Drywell Structural Integrity and Operability.

A detailed engineering analysis was conducted in 1987, assuming a corroded thickness of 700 mils. The analysis concluded that, with sand in place and conservatively assuming the thickness was reduced to 700 mils, the drywell was capable of performing its intended function and that the containment is operable (Ref [2])

B. Other Corrective Actions Taken in Response to UT Measurements

As a result of significant wall thinning and accelerated rate of corrosion in the sandbed region (bays 11, 13, 17, and 19), Oyster Creek initiated additional corrective actions in 1987 to assess the impact on corrosion on the drywell intended function, and minimize the rate of corrosion. These included but were not limited to: a) an initial analysis to determine if the containment was operable, b) actions to minimize the potential for water intrusion into the affected area, c) actions to effect removal of any water that might intrude into the affected area, d) installation of a cathodic protection system in 2 bays, e) taking UT measurements every refueling outage and outage of opportunity, and f) trending the UT results. Refer to (Ref [32]) for additional details.

1. Corrective Actions to Minimize the Rate of Corrosion

Beginning in 1988, the strippable coating was applied to reactor cavity walls to minimize water leakage during the refueling outages. Leakage monitoring, implemented later, confirmed that this coating is effective in minimizing the water intrusion into the sandbed region. See section 4 of this Enclosure for additional details.

UT thickness measurements taken through 1988 showed that the corrosion rate of the outer drywell shell in the sandbed region continued to increase (see Attachment 1). Also the rate of corrosion in the bays where the cathodic protection system was installed showed no improvement. It was then concluded that the most effective way to mitigate corrosion was to remove the sand and corrosion products, and apply a protective coating to the outer drywell surface in sandbed region. Refer to section C.1 below for details of the coating. (Ref [9], Ref [32]).

2. Engineering Analysis Performed to Establish the Minimum Required Thickness With Sand Removed

An engineering analysis, based on ASME Code requirements, was conducted in the early 1990's to establish the minimum required general thickness without sand for both pressure and buckling stress (Ref [15], Ref [16], Ref [32]). The analysis was based on a partial finite element model (36-degree slice – Fig. 1) of the drywell. Loads and load combinations were in accordance with the original design basis requirements as follow: (Ref [16])

CASE I - INITIAL TEST CONDITION
Deadweight + Design Pressure (62 psi) + Seismic (2 x DBE)

CASE II - FINAL TEST CONDITION
Deadweight + Design Pressure (35 psi)+ Seismic (2 x DBE)

CASE III - NORMAL OPERATING CONDITION
Deadweight + Pressure (2 psi external) + Seismic (2 x DBE)

CASE IV - REFUELING CONDITION
Deadweight + Pressure (2 psi external) + Water Load + Seismic (2 x DBE)

CASE V - ACCIDENT CONDITION
Deadweight + Pressure (62 psi @ 175'F or 35 psi @ 281'F) + Seismic (2 x DBE)

CASE VI - POST ACCIDENT CONDITION
Deadweight + Water Load @ 74'6" + Seismic (2 x DBE)

Note: Subsequent to this analysis GE developed Oyster Creek plant specific accident pressure, approved in accordance with Technical Specification Amendment 165 (Ref [46])

The results of the analysis showed that the minimum required thickness was controlled by buckling and that a general thickness of 736 mils will satisfy ASME Code requirements with a safety factor of 2 against buckling for the controlling operating load combination (Case IV - refueling condition), and 1.67 safety factor for accident flooding load combination (Case V – Accident condition). See Table 4 below for additional details). (Ref [32]).

Local areas where the thickness was less than the general 736 mils were evaluated based on 490 mils local acceptance criteria (Ref [42]). The local acceptance criteria of 490 mils was confined to an area less than 2½"[1] in diameter experiencing primary membrane + bending stresses 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 x (square root of Rt). Also Paragraph NE-3335.1 only applies to openings in shells that are closer than two times their average diameter.

A review of all the 1992 UT data presented in Appendix D of calculation C-1302-187-5320-024 (Ref [42]) indicated that all thicknesses in the drywell sand bed region exceeded the required pressure thickness by a substantial margin. Therefore, the requirements for pressure reinforcement specified in the previous paragraph were not required for the very local wall thickness evaluation presented in Calculation C-1302-187-5320-024 (Ref [42]).

Reviewing the stability analyses provided in both the GE Report 9-4 (Ref [16]) and the GE Letter Report Sand Bed Local Thinning and Raising the Fixity Height Analysis (Ref [22]) and recognizing that the plate elements in the sand bed region of the model are 3" x 3" it was clear that the circumferential buckling lobes for the drywell were substantially larger than the 2 ½"[1] diameter for very local wall areas. This, combined with the local reinforcement surrounding these local areas, indicated that these areas would have no impact on the buckling margins in the shell. It was also clear from the GE Letter Report (Ref [22]) that a uniform reduction in thickness of 27% to 0.536" over a one square foot area would only create a 9.5% reduction in the load factor and theoretical buckling stress for the whole drywell resulting in the largest reduction possible. In addition, to the reported result for the 27% reduction in wall thickness, a second buckling analysis was performed for a wall thickness reduction of 13.5% over a

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[1] In some evaluations 2" diameter is conservatively used to define very local areas instead of 2 ½"

one square foot area which only reduced the load factor and theoretical buckling stress by 3.5% for the whole drywell resulting in the largest reduction possible. To bring these results into perspective, a review of the NDE reports indicated there were 20 UT measured areas in the whole sand bed region that had thicknesses less than the 0.736 inch thickness used in GE Report 9-4 (ref [16]) which cover a conservative total area of 0.68 square feet of the drywell surface with an average thickness of 0.703" or a 4.5% reduction in wall thickness. Therefore, to effectively change the buckling margins on the drywell shell in the sand bed region, a reduced thickness would have to cover approximately one square foot of shell area at a location in the shell that is most susceptible to buckling with a reduction in thickness greater than 25%. GE analysis concluded that the buckling of the shell was unaffected by the distance between the very local wall thicknesses; in fact, these local areas could be contiguous provided their total area did not exceed one square foot and their average thickness was greater than the thickness analyzed in the GE Letter Report (Ref [22]) and provided the methodology of Code Case N284 was employed to determine the allowable buckling load for the drywell. Furthermore, all of these very local wall areas were centered about the vents, which significantly stiffen the shell. This stiffening effect limits the shell buckling to a point in the sand bed region, which is located at the midpoint between two vents. (Ref [35], [32], [16])

Table 4 – Buckling Analysis Summary

	Load Combination	
	CASE IV – REFUELING CONDITION	CASE V – ACCIDENT CONDITION
Service Condition	Design	Level C
Thickness used in Analysis, mils	736	736
Factor of Safety Applied	2.00	1.67
Applied Compressive Meridional Stress (ksi)	7.59	12.0
Allowable Compressive Meridional Stress (ksi)	7.59	12.93
Actual Buckling Safety Factor[1]	2.00	1.80

Source: Ref [16]

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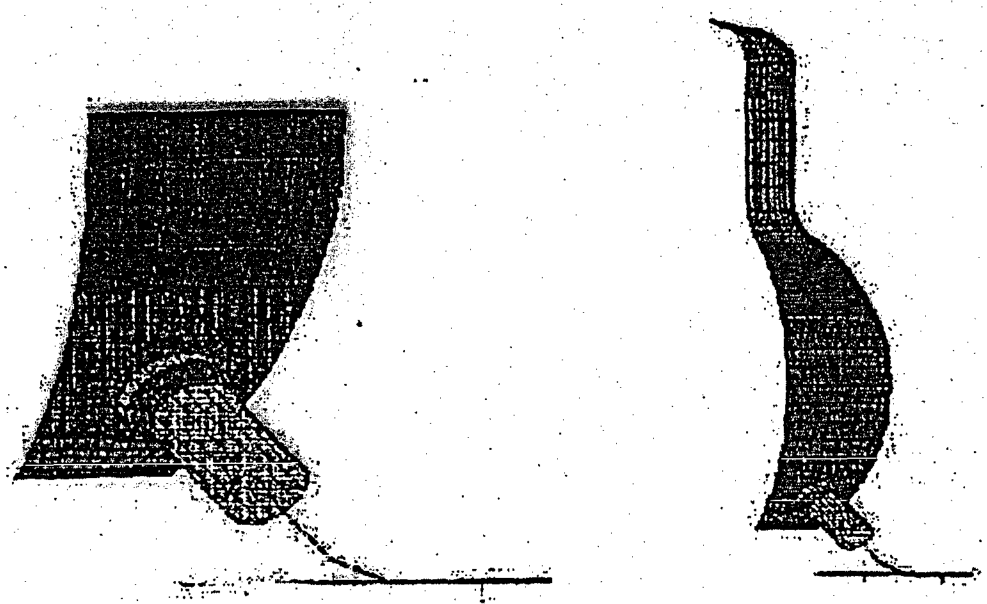
[1] The actual buckling safety factor is greater than 2.00 and 1.80 since the minimum measured general thickness is greater than 0.736 inches.



View of Sandbed Region View

36 Degree Slice Finite Element

Fig. 1 – Drywell Analysis ANSYS Finite Element Model

C. Final Corrective Actions (early 1990's)

The corrective actions, implemented in early 1993, included removal of sand from the sandbed region, performance of additional UT inspections on the outside of the drywell shell to confirm the results of measurements previously taken from the inside, and application of epoxy coating to the exterior surface of the drywell to protect it from further corrosion.

1. Removal of the sand was initiated in 1988 and completed in 1992. The surface of the outer drywell shell was cleaned in preparation for coating (Ref [19]). Before the coating was applied, inspection of the outer drywell shell in all 10 sandbed bays was conducted. 125 UT measurements were taken in local areas suspected by visual inspection to be less than the minimum required general thickness of 736 mils. Of the 125 UT thickness measurements, 20 were determined to be less than 736 mils, but greater than the analyzed local thickness of 536 mils. The locally thinned areas were evaluated using criteria provided in ASME Section III, Subsection NE3213.10 and found acceptable (Ref [32], [35]). See Table 2.

Table 2 – UT Thickness Measurement of Locally Thinned Areas Taken from Outside The Drywell in the Sandbed Region.

Location	1992 UT Measurements			2006 UT Measurements		
	No. of UT	Number of UT < 736 mils	Thickness in mils	No. of UT	Number of UT < 736 mils	Thickness in mils
Bay 1	23	9	700, 710, 705, 700, 680, 690, 714, 724, 726	23	10	710, 690, 665,680,731, 669,711,722, 719,712
Bay 3	8	0		8	0	
Bay 5	8	0		7	0	
Bay 7	7	0		5	0	
Bay 9	10	0		10	0	
Bay 11	8	1	705	8	1	700
Bay 13	29	9	672, 722, 718, 655, 618, 718, 728, 685, 683	15	6	708, 658, 602,704, 669,666
Bay 15	11	1	722	11	0	
Bay 17	11	1	720	10	1	681
Bay 19	10	0		9	0	
Total	125	21		106[1]	18	

Source: Ref [42], Ref [47]

[1] The locally thinned areas prepared for UT measurements in 1992 were measured in 2006. However the inspection team was able to locate only 106 points instead of 125.

2. Coating of the Outer Drywell Shell in the Sandbed Region:

In 1992 the outer drywell shell was coated with a DEVOE Epoxy system, comprised of one coat of DEVOE 167 Rust Penetrating Sealer followed by two coats of Devran 184 epoxy coating (see attachment 3, Ref [19])

The DEVOE coating system was selected based on anticipation of less than ideal surface preparation of the outer drywell shell due to the confined space of the sandbed region. It was designed for application on surfaces prepared by hand cleaning tools to remove loose rust, mill scale, and other detrimental foreign matter in accordance with Steel Structures

Paint Council surface Preparation Specification No. 2 (SSPC-SP2). (Ref [17])

The Pre-Prime DEVOE 167 Sealer penetrates through rusty surfaces and provides a means of reinforcing rusty steel substrates and thus insures adhesion of the Devran 184. The sealer was recommended by its manufacturer for use in areas where, due to restrictions or economics, blasting or a thorough hand cleaning was not feasible. (Ref[17])

The Devran 184 epoxy coating was designed for coating of tank bottoms, including water tanks, fuel tanks, and selected chemical tanks. (Ref [17])

Before the coating was used, a set of tests was performed outside the sandbed using a mock-up of the sandbed space and lighting. The purpose of these tests was to establish and qualify the painting process considering the limited space and visibility in the sandbed region. Each set of tests was performed on rusted carbon steel test panels that were prepared using tools to resemble as closely as possible the expected condition of the drywell exterior surface. To further simulate the condition of the drywell exterior, the test panels were cleaned with DEVOE DevPrep 88 cleaner and then washed with high-pressure water (Ref [20])

DEVOE Pre-Prime 167 and Devran 184 coatings were applied to the test panel surfaces using brushes and rollers. The wet and dry film thickness of each coat was measured and used to determine the expected ranges of the coating thickness for the drywell exterior surface. Tests were performed to determine if holidays or pinholes were present in the coatings. (Ref [20])

3. Repair of Sandbed Floor to Improve Drainage

The unfinished floor in the sandbed regions was built up using the same epoxy that was used to coat the shell, and reshaped to allow drainage through the sandbed floor drain of any water that may leak into the region. At that time, the joint between the sandbed floor and the external drywell shell was sealed with a caulk compatible with the epoxy coating to prevent any water from coming in contact with any portion of the drywell shell embedded below the level of the sandbed floor. See Section 7 of this Enclosure for additional information.

4. Validation of Corrective Actions Effectiveness

UT inspections of the sandbed region were conducted in 1992, 1994, and 1996 from inside the drywell. The results of these inspections showed that the corrective actions had been effective in arresting corrosion of the outer drywell shell in the sand bed region. (See Table-6). After 1996, additional UT measurements were not taken in the sandbed region; instead, the epoxy coating in critical bays was inspected for cracking, flaking, blistering, peeling, discoloration, and other signs of distress. Inspections conducted in 1994 (Bays 3, 11), 1996 (Bays 11, 17), 2000 (Bays 1, 13), and 2004 (Bays 1,13) show that the coating was in good condition and there were no indications that the outer drywell shell was undergoing further corrosion (Ref [34]). Furthermore the periodic UT thickness measurements of the shell in the upper regions of the drywell could be used conservatively as an indicator of the condition of the outer drywell shell in the sandbed region. This was because the operating environment was similar in the sandbed region and the upper region of the drywell and the shell in the upper region does not have an epoxy coating. The 2004 upper region UT results showed that the highest corrosion rate is less than 1 mil/year.

Table 5 – Sandbed Region Drywell Shell 95% Confidence Level Average Thickness[1]

Bay	Loc	Dec-86	Feb-87	Apr-87	May-87	Aug-87	Sep-87	Jul-88	Oct-88	Jun-89	Sep-89	Feb-90	Apr-90	Mar-91	May-91	Nov-91	May-92	Sep-92	Sep-94	Sep-96	Oct-2006
1D									1115										1101	1151	1122
3D									1178										1184	1175	1180
5D									1174										1168	1173	1185
7D									1135										1136	1138	1133
9A									1155										1157	1155	1154
9D		1072							1021	1054	1020	1026	1022	993	1008	992	1000	1004	992	1008	993
11A				919	905	922	905	913	888	881	892	881	870	845	844	833	842	825	820	830	822
11C	Btm				917	954	916	906	891	877	891	870	865	858	863	856	882	859	850	883	855
	Top				1046	1109	1079	1045	1009	1016	1005	952	977	982	1002	964	1010	970	982	1042	958
13A		919							905	883	883	862	853	855	853	849	865	858	837	853	846
13D	Btm								962				932	909	901	900	931	906	895	933	904
	Top													1072	1049	1048	1088	1055	1037	1059	1047
13C																		1149	1140	1154	1142
15A									1120										1114	1127	1121
15D		1089							1056	1060	1061	1059	1057	1060	1050	1042	1065	1058	1053	1066	1053
17A	Btm	999							957	965	955	954	951	935	942	933	948	941	934	997	935
	Top	999							1133	1130	1131	1128	1128	1131	1129	1123	1125	1125	1129	1144	1122
17D			922		895	891	895	878	862	857	847	836	829	825	829	822	823	817	810	848	818
17/19	Btm								982	1019	1131	990	986	975	969	954	972	976	963	967	964
	Top								1004	999	955	1010	1006	987	982	971	990	989	975	991	972
19A			884		873	859	858	849	837	829	825	812	808	817	803	803	809	800	806	815	807
19B					898	892	888	864	857	826	845	840	837	853	844	846	847	840	824	837	848
19C					901	888	888	873	856	845	845	831	825	843	823	822	832	819	820	854	824

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[1] Source: Ref 47

Table 6 – Minimum Available Thickness Margin Based on Minimum 95% Confidence Level Average Thickness. (Thickness in mils)

Location		Pre-1992	May 1992[1]	Sept 1992		1994[2]		1996[3]		2006[4]		Min. Required	Nominal Thick.	Margin
				Thick	Std Error	Thick	Std Error	Thick	Std Error	Thick	Std Error			
1D		1115				1101	± 10.0	1151	± 13.6	1122	± 8.4	736	1154	365
3D		1178				1184	± 4.9	1175	± 7.5	1180	± 5.7			439
5D		1174				1168	± 2.6	1173	± 2.2	1185	± 2			432
7D		1135				1136	± 4.3	1138	± 5.9	1133	± 6.5			397
9A		1155				1157	± 4.5	1155	± 4.8	1154	± 4.2			418
9D		992	1000	1004	±10.0	992	± 10.4	1008	± 10.6	993	± 11.2			256
11A		833	842	825	±8.2	820	± 7.7	830	± 8.7	822	± 8.0			84
11C	Bot	856	882	859	±6.4	850	± 4.5	883	± 7.4	855	± 4.5			114
	Top	952	1010	970	±23.8	982	± 23.4	1042	± 21.4	958	± 24.7			216
13A		849	865	858	±9.6	837	± 7.8	853	± 8.8	846	± 8.2			101
13D	Bot	900	931	906	±9.0	895	± 8.2	933	± 9.6	904	± 8.9			159
	Top	1048	1088	1055	±14.1	1037	± 13.6	1059	±11.2	1047	± 13,7			196
13C		932		1149	±1.9	1140	± 3.8	1154	±3.2	1142	± 3.1			196
15A		1120				1114	± 16.3	1127	± 10.8	1121	± 16.6			378
15D		1042	1065	1058	±8.7	1053	± 9.0	1066	± 8.5	1053	± 8.9			306
17A	Bot	933	948	941	±11.8	934	± 10.7	997	± 10.7	935	± 10.5			197
	Top	999	1125	1125	±7.2	1129	± 6.8	1144	± 11.1	1122	± 7.2			263
17D		822	823	817	±9.2	810	± 9.5	848	± 8.9	818	± 9.5			74
17/19 Frame	Top	954	972	976	±4.8	963	± 4.9	967	± 6.0	964	± 4.8			218
	Bot	955	990	989	±6.3	975	± 7.8	991	± 6.2	972	± 5.9			219
19A		803	809	800	±8.4	806	± 9.9	815	± 9.6	807	± 8.9			64
19B		826	847	840	±8.7	824	± 7.8	837	± 9.5	848	± 8.6			88
19C		822	832	819	±11.0	820	± 10.5	854	± 11.8	824	± 11.3			83

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1. Source – Reference 21
2. Source – Reference 25
3. Source – Reference 27
4. Source – Reference 31, 47

Note: Shaded cells indicate thickness value used to conservatively calculate the margin

II. 2006 Confirmatory Actions

During the 2006 refueling outage (1R21), AmerGen performed UT of the drywell shell in the sandbed region from inside the drywell, at the same 19 grid locations where UT was performed in 1992, 1994, and 1996. Location of the UT grid is centered at elevation 11' 3" in an area of the drywell shell that corresponds to the sandbed region. The 2006 UT measurements were made in accordance with the enhanced Oyster Creek ASME Section XI, Subsection IWE (B1.27) Aging Management Program. The data was statistically analyzed using the methodology described in section 3 to determine the 95% confidence level mean thickness. The results of the statistical analysis of the 2006 UT data were compared to the 1992, 1994 and 1996 data statistical analysis results. Some of the 1996 data contained anomalies that are not readily explained, but the anomalies did not significantly change the results. The comparison confirmed that corrosion on the exterior surfaces of the drywell shell in the sandbed region has been arrested.

Analysis of the 2006 UT data, at the 19 grid locations indicates that the minimum measured 95% confidence level mean thickness in any bay is 807 mils (bay #19A). This is compared to the 95% confidence level minimum measured mean thickness in bay #19 of 806 mils and 800 mils measured in 1994 and 1992 respectively. Considering the instrument accuracy of ±10mils these values are considered equivalent. Thus no statistically observable corrosion has occurred since 1992 and the minimum drywell shell mean thickness at the grid locations remains greater than 736 mils as required to satisfy the worst case buckling analysis, and the minimum available margin of 64 mils for any bay reported prior to taking 2006 UT thickness measurements remains bounded. (Ref [47])

In its statistical analysis of drywell corrosion data, AmerGen has used the F-ratio test as part of its method to determine whether there is ongoing corrosion. In analysis of the data from this outage, AmerGen determined that different statistical treatment of the data would be appropriate to estimate bounding corrosion rates in the sandbed region. Using this updated statistical test of the data, AmerGen cannot statistically confirm that the sandbed region has a corrosion rate of zero. This is because of the high variance in UT data within each 49-point grid (standard within a range of deviation 60 to 100 mils), the relatively limited number of data sets that have been taken and the time frame over which data has been collected since the sand was removed in 1992. The high variance in UT data within the grids is a result of the drywell exterior surface roughness caused by corrosion that occurred prior to 1992. However, AmerGen continues to believe that corrosion of the exterior surface of the drywell shell in the sandbed region has been arrested as evidenced by little change in the mean thickness of the 19 monitored (grid) locations and the observed good condition of the epoxy coating during the 2006 inspection.

In addition to the UT measurements at the 19 grid locations, a total of 294 UT thickness measurements were taken in the bay #5 trench and 290 measurements were taken in the bay #17 trench during the 2006 refueling outage. The computed mean thickness value of the drywell shell taken within the two trenches is 1074 mils for bay #5 and 986 mils for bay #17. These values, when compared to the 1986 mean thickness values of 1112 mils for the bay #5 trench and 1024 mils for the bay #17 trench, indicated that wall thinning of approximately 38 mils has taken place in each trench since 1986. Engineering evaluation of the results concluded that considering that the exterior surface of bay #5 had experienced a corrosion rate of up to 11.3 mils/yr between 1986 and 1992 and the exterior surface of bay #17 had experienced a corrosion rate of up to 21.1 mils/yr in the same period, the 38 mils wall thinning measured in 2006 is due to corrosion on the exterior surface of the drywell between 1986 and 1992. (Ref [47])

Additionally the 95% confidence level minimum computed drywell shell mean thickness based on 2006 UT measurements within the two trenches is greater by a margin of 250 mils than the minimum required thickness of 736 mils for buckling. Also this margin is significantly greater than the minimum computed margin at other monitored locations outside the trenches (64 mils). Individual points within the two trenches met the local thickness acceptance criterion of 490 mils for pressure computed based on ASME Section III, Subsection NE, Class MC Components, Paragraph 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 individual points also met a local buckling criterion of 536 mils previously established by engineering analysis. (Ref [47])

The above UT thickness measurements were supplemented by additional UT measurements taken at 106 points from outside the drywell in the sandbed region, distributed among the ten bays. The locations of these measurements were established in 1992 as being the thinnest local areas based on visual inspection of the exterior surface of the drywell shell before it was coated. The thinnest location measured in 2006 is 602 mils versus 618 mils measured in 1992. The difference between the two measurements does not necessarily mean a wall thinning of 16 mils has taken place since 1992. This is because the 2006 UT data could not be compared directly with the 1992 data due to the difference in UT instruments and measurement technique used in 2006, and the uncertainty associated with precisely locating the 1992 UT points. A review of the 2006 data for the 106 external locations indicated that the measured local thickness is greater than the local acceptance criteria of 0.490" for pressure and 536 mils for local buckling. (Ref [47])

As stated above, the 2006 UT data of the locally thinned areas (106 points) could not be correlated directly with the corresponding 1992 UT data. This is largely due to using a more accurate UT instrument and the procedure used to take the measurements.. In addition the inner drywell shell surface could be subject to some insignificant corrosion due to water intrusion onto the embedded shell (see discussion below). For these reasons the Oyster Creek ASME Section XI, Subsection IWE Program (B.1.27) will be further enhanced to require UT measurements of the locally thinned areas in 2008 and periodically during the period of extended operation. (Ref [47])

During the 2006 refueling outage (1R21), AmerGen conducted VT-1 inspections of the epoxy coating in all ten bays in accordance with ASME Section XI, Subsection IWE, and AmerGen's Protective Coating Monitoring and Maintenance Program. These inspections would have documented any flaking, blistering, peeling, discoloration, and other signs of degradation of the coating. The VT-1 inspections found the coating to be in good condition with no degradation.

Based on these VT-1 inspections, AmerGen has confirmed that no further corrosion of the drywell shell is occurring from the exterior of the epoxy-coated sandbed region. Monitoring of the coating in accordance with the ASME Section XI, Subsection IWE and AmerGen's Protective Coating Monitoring and Maintenance Program will continue to ensure that the drywell shell maintains its intended function during the period of extended operation. (Ref [47])

A. Aging Management Program for the Extended Period of Operation:

AmerGen is committed to a comprehensive aging management program to ensure that significant corrosion is detected and corrected prior to impacting the intended functions of the drywell (Ref [47]). The program elements for the sandbed region include:

1. A strippable coating will be applied to the reactor cavity liner to prevent water intrusion into the gap between the drywell shield wall and the drywell shell during periods when the reactor cavity is flooded.
2. The reactor cavity seal leakage trough drains and the drywell sand bed region drains will be monitored for leakage during refueling outages and during the plant operating cycle:
    - The sand bed region drains will be monitored daily during refueling outages. If leakage is detected, procedures will be in place to determine the source of leakage and investigate and address the impact of leakage on the drywell shell, including verification of the condition of the drywell shell coating and moisture barrier (seal) in the sand bed region and performance of UT examinations of the shell in the upper regions. UTs will also be performed on any areas in the sand bed region where visual inspection indicates the coating is damaged and corrosion has occurred. UT results will be evaluated per the existing program. Any degraded coating or moisture barrier will be repaired. These actions will be completed prior to exiting the associated outage.
    - The sand bed region drains will be monitored quarterly during the plant operating cycle. If leakage is identified, the source of water will be investigated, corrective actions taken or planned as appropriate. In addition, if leakage is detected, the following items will be performed during the next refueling outage:
        - o Inspection of the drywell shell coating and moisture barrier (seal) in the affected bays in the sand bed region
        - o UTs of the upper drywell region consistent with the existing program

  - UTs will be performed on any areas in the sand bed region where visual inspection indicates the coating is damaged and corrosion has occurred
  - UT results will be evaluated per the existing program

  Any degraded coating or moisture barrier will be repaired

3. The Inservice Inspection (ISI) Program will be enhanced to require inspection of 100% of the epoxy coating every 10 years during the period of extended operation. These inspections will be performed in accordance with ASME Section XI, Subsection IWE. Performance of the inspections will be staggered such that at least three bays will be examined every other refueling outage. Inspection of the coating is accomplished through the Protective Coating Monitoring and Maintenance Program (B.1.33)

4. When the sand bed region drywell shell coating inspection is performed, the seal at the junction between the sand bed region concrete and the embedded drywell shell will be inspected

5. The reactor cavity seal leakage concrete trough drain will be verified to be clear from blockage once per refueling cycle.

6. UT thickness measurements will be taken from outside the drywell in the sandbed region during the 2008 refueling outage on the locally thinned areas examined during the October 2006 refueling outage. The locally thinned areas are distributed both vertically and around the perimeter of the drywell in all ten bays such that potential corrosion of the drywell shell would be detected.

7. Starting in 2010, drywell shell UT thickness measurements will be taken from outside the drywell in the sandbed region in two bays per outage, such that inspections will be performed in all 10 bays within a 10-year period. The two bays with the most locally thinned areas (bay #1 and bay #13) will be inspected in 2010. If the UT examinations yield unacceptable results, then the locally thinned areas in all 10 bays will be inspected in the refueling outage that the unacceptable results are identified.

8. Perform visual inspection of the drywell shell inside the trench in bay #5 and bay #17 and take UT measurements inside these trenches in 2008 at the same locations examined in 2006. Repeat (both the UT and visual) inspections at refueling outages during the period of extended operation until the trenches are restored to the original design configuration using concrete or other suitable material to prevent moisture collection in these areas.

After each inspection, UT thickness measurements results will be evaluated and compared with previous UT thickness measurements. If unsatisfactory results are identified, then additional corrective actions will be initiated, as necessary, to ensure the drywell shell integrity is maintained throughout the period of extended operation (Ref [47]).

III. Conclusion

Corrosion of the Oyster Creek outer drywell shell has been investigated since the early 1980's. Corrective actions, implemented beginning in 1986, have arrested corrosion. AmerGen conducted UT thickness inspections of the shell in the sandbed region in 2006 (1R21) to confirm corrosion has been arrested in the outer drywell shell. The results showed that corrosion of the exterior drywell shell has been arrested. AmerGen also conducted VT-1 inspections of the epoxy coating in all ten bays in accordance with ASME Section XI, Subsection IWE, and AmerGen's Protective Coating Monitoring and Maintenance Program. The VT-1 inspections found the coating to be in good condition with no degradation.

Engineering analysis of the drywell using a conservative uniform general thickness of 736 mils for the entire sandbed region concluded that the drywell meets its design requirements during the current term with adequate margin.

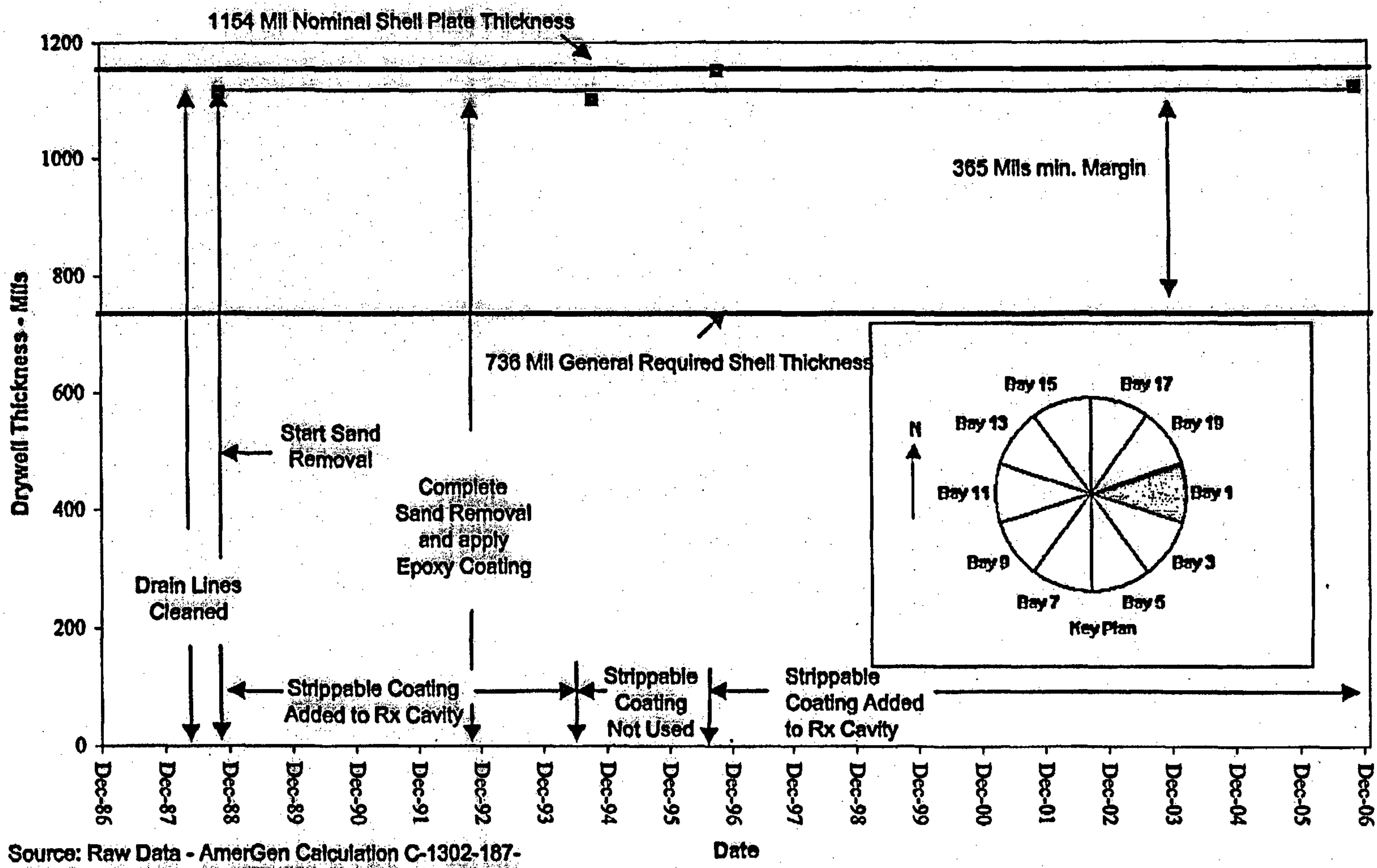
AmerGen is committed to implementing a comprehensive aging management program during the extended period of operation to preserve the existing margin. The program is designed to detect, mitigate, and correct drywell shell degradations. These activities provide reasonable assurance that wall thinning of the drywell will be detected and corrected prior to impacting the intended function of the drywell.

ATTACHMENT 1

GRAPHICAL PRESENTATION OF SANDBED DATA

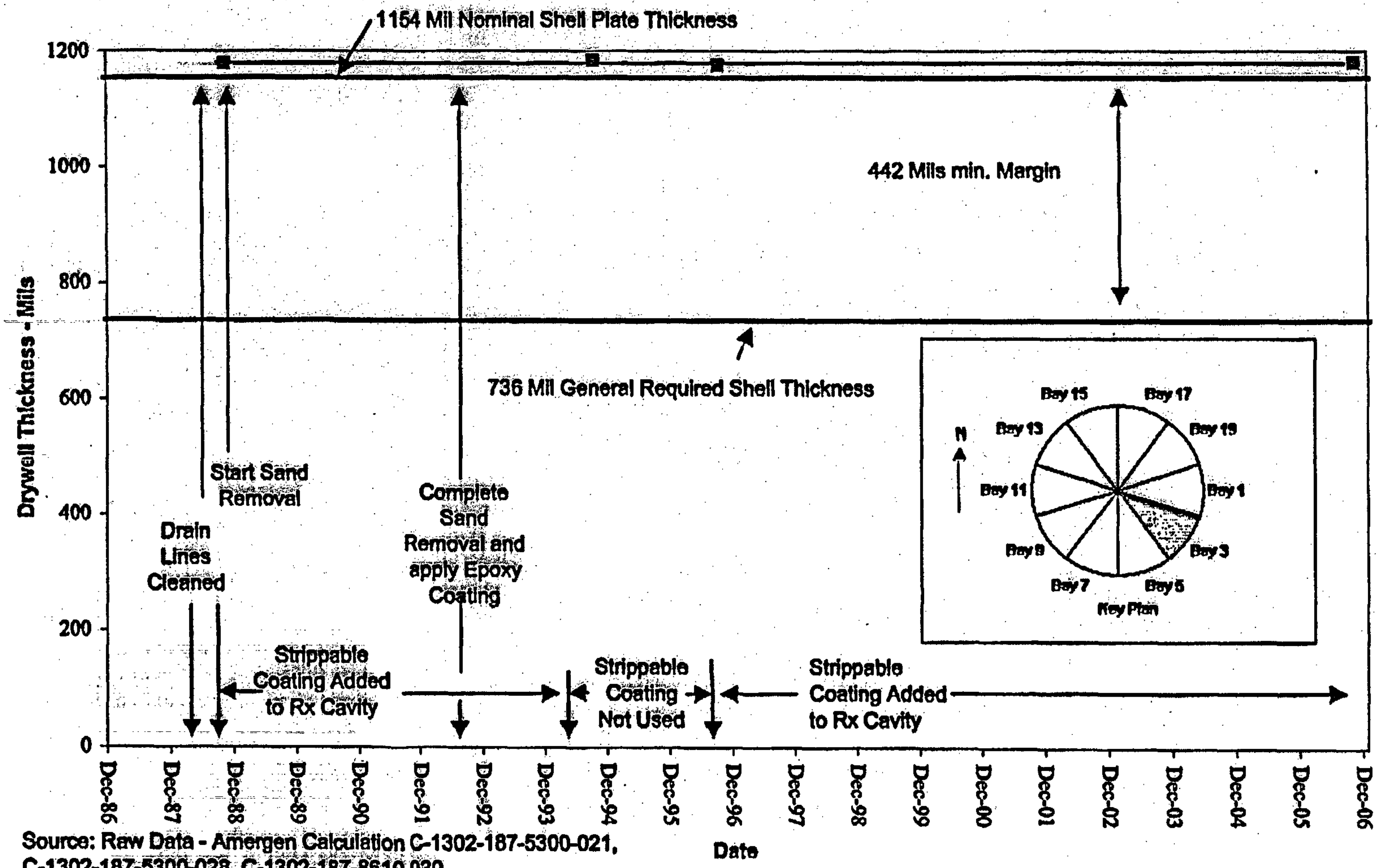
Source of data for the graphs:
Ref. [21], Ref [25], Ref [27], Ref [31], and Ref [47]

Figure 1. Sandbed Bay # 1D



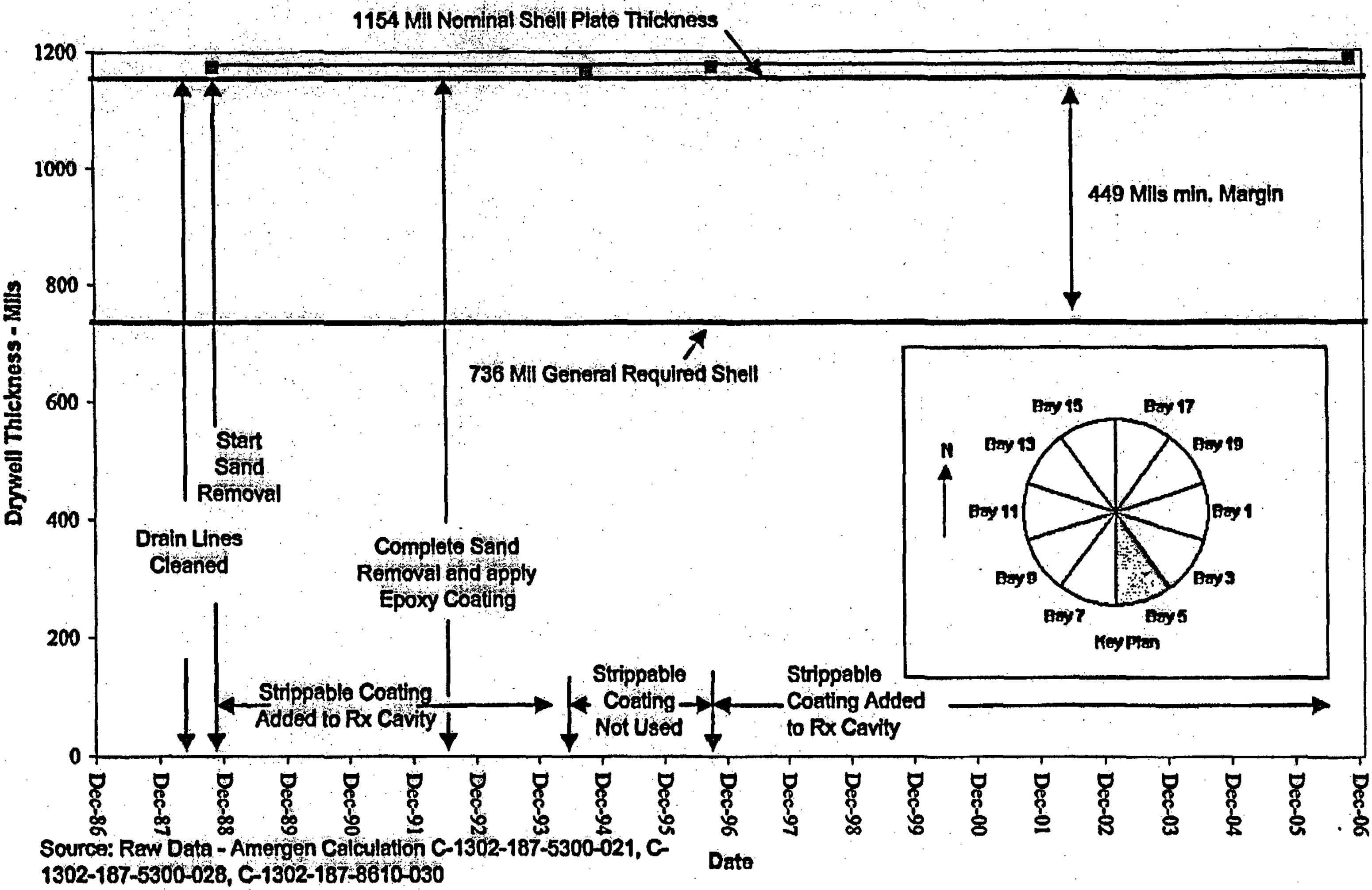
Source: Raw Data - AmerGen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

Figure 2. Sandbed Bay #3D



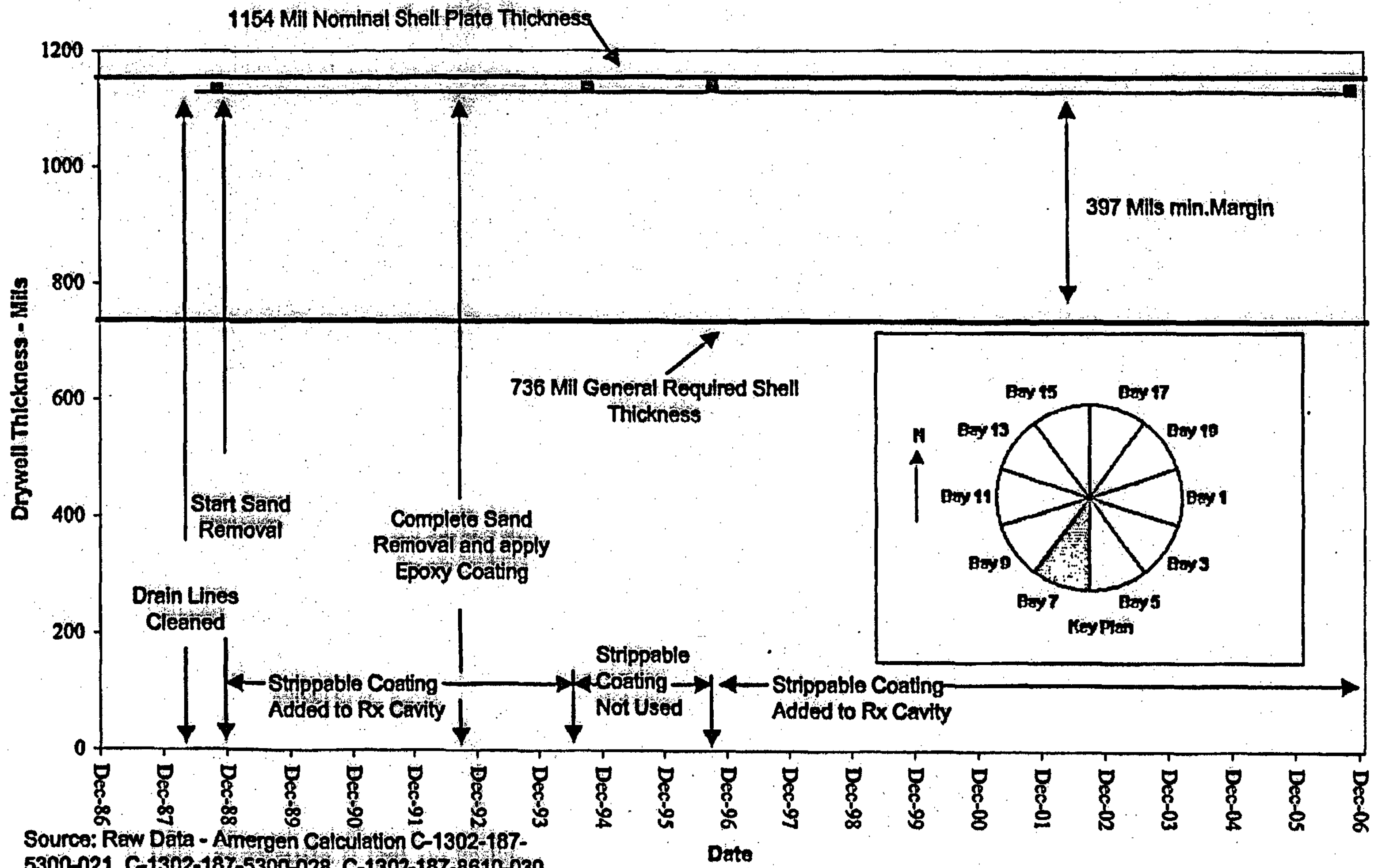
Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

Figure 3. Sandbed Bay # 5D



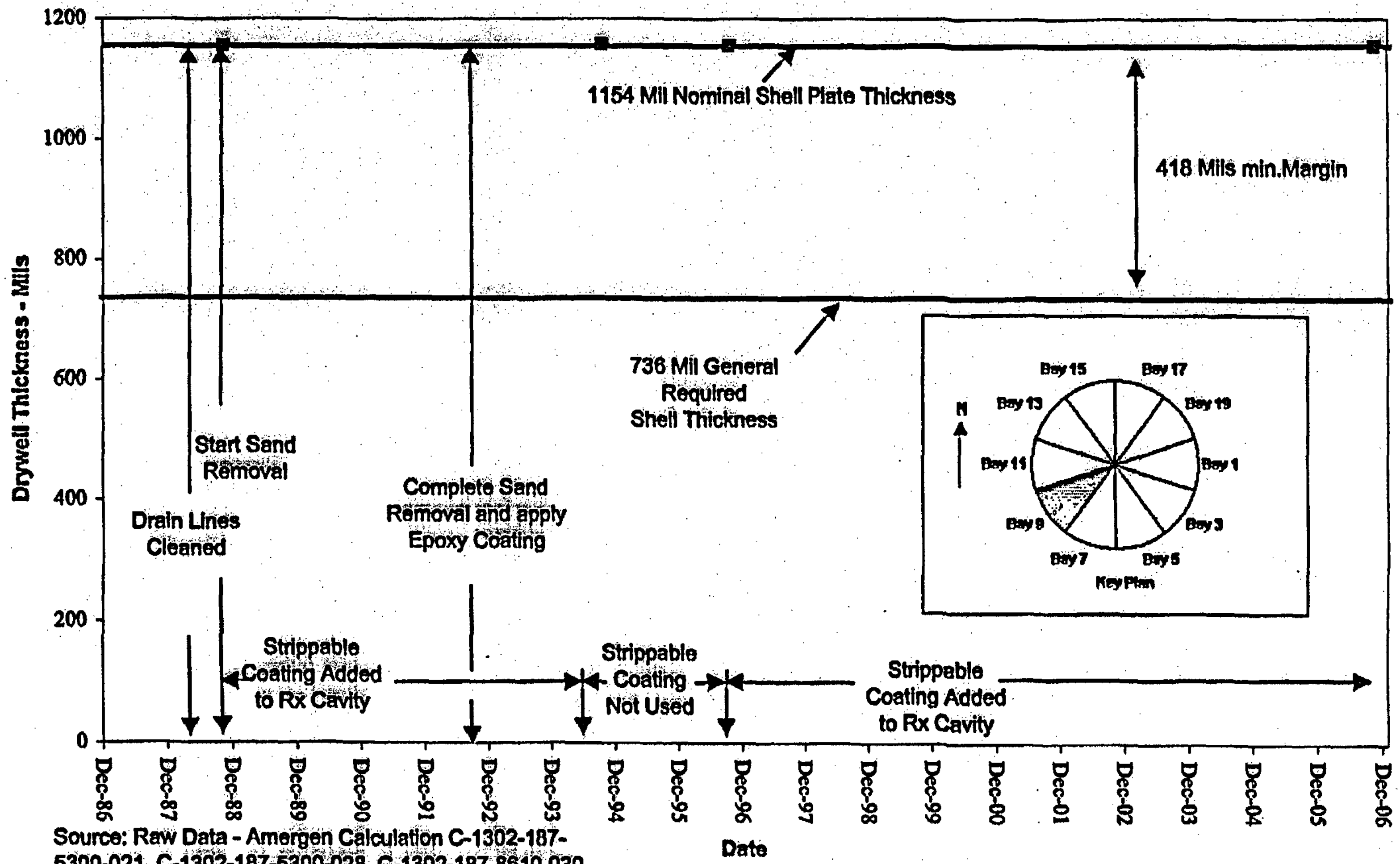
Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

Figure 4. Sandbed Bay # 7D



Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

Figure 5. Sandbed Bay # 9A



Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

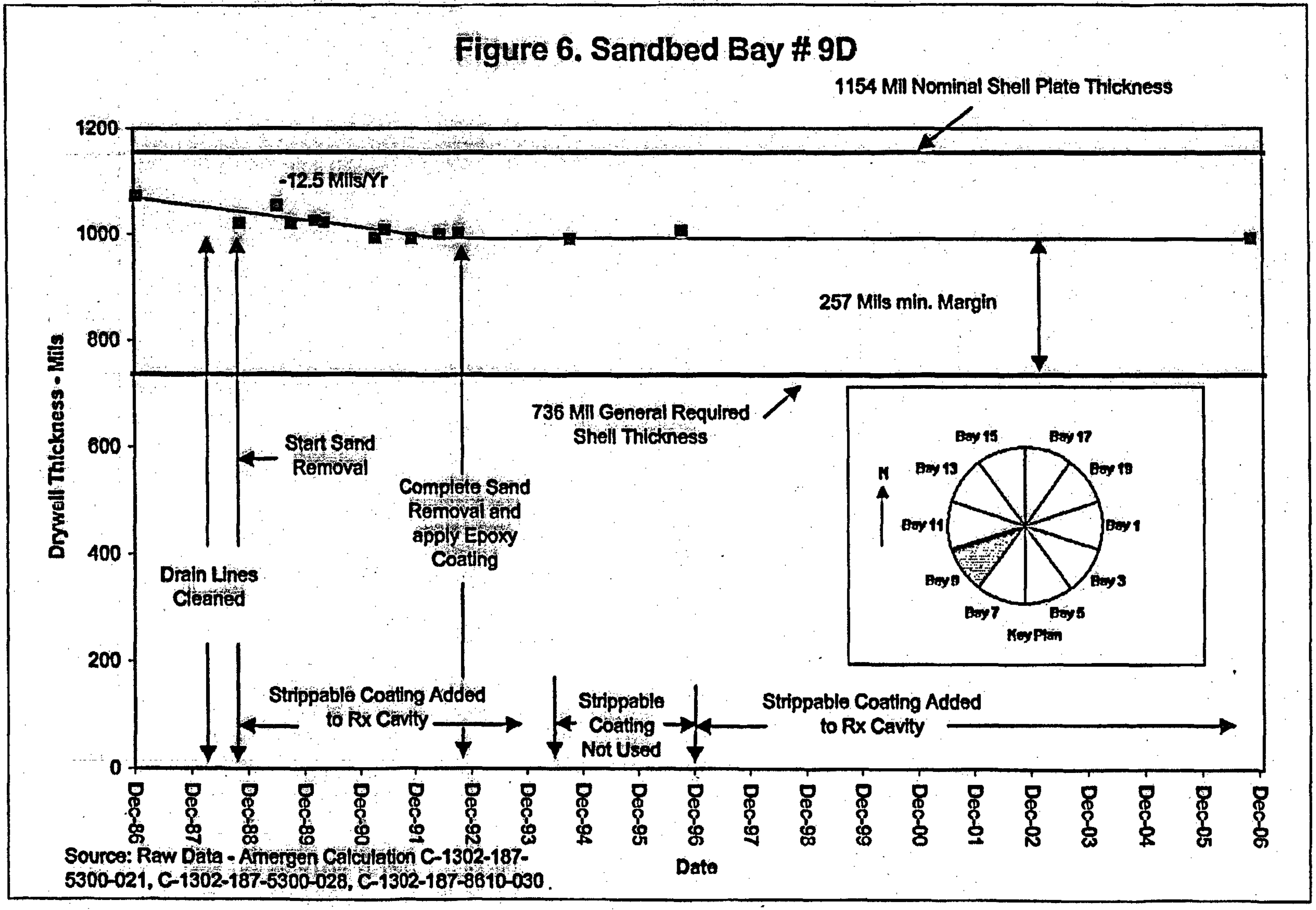
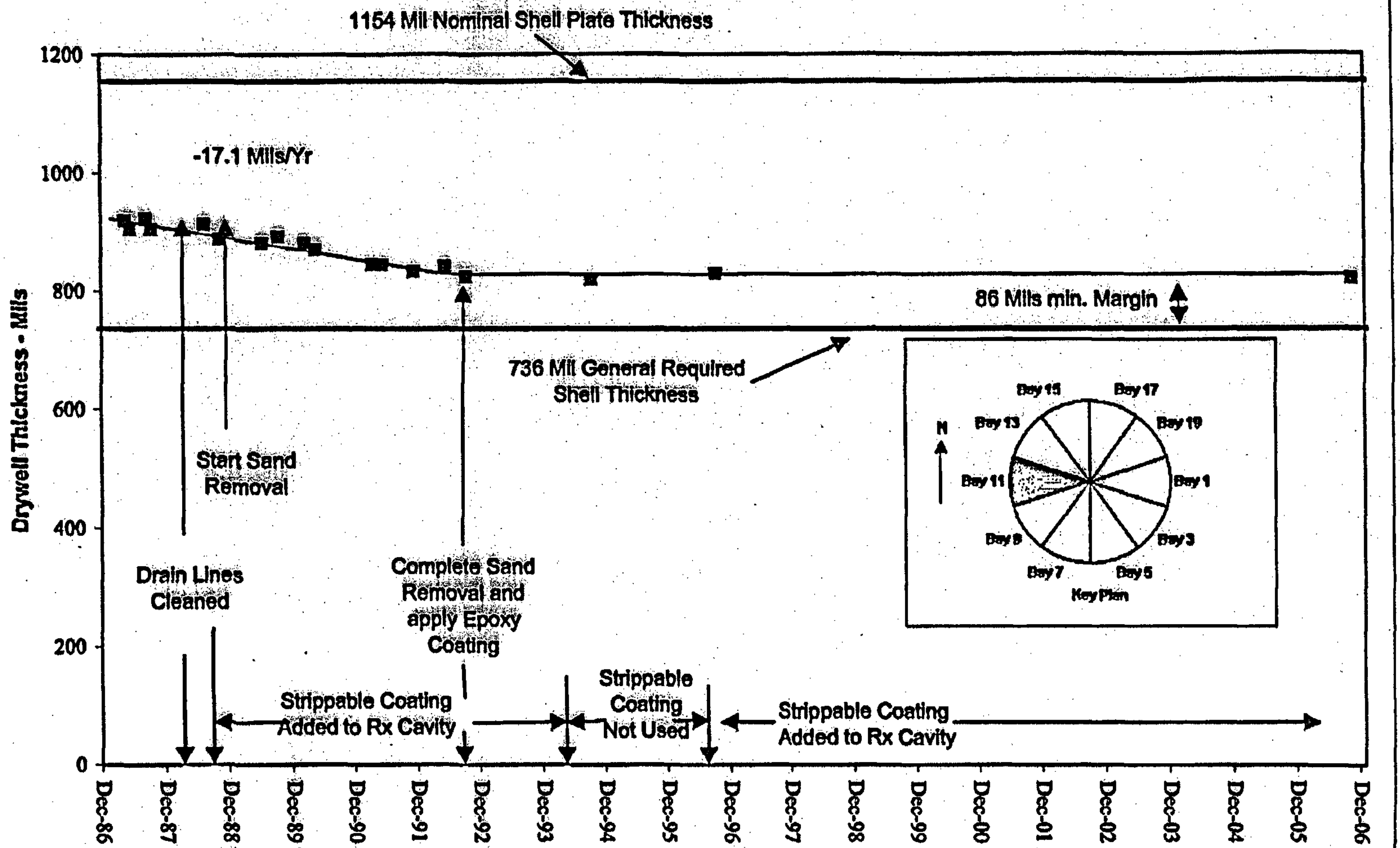


Figure 6. Sandbed Bay # 9D

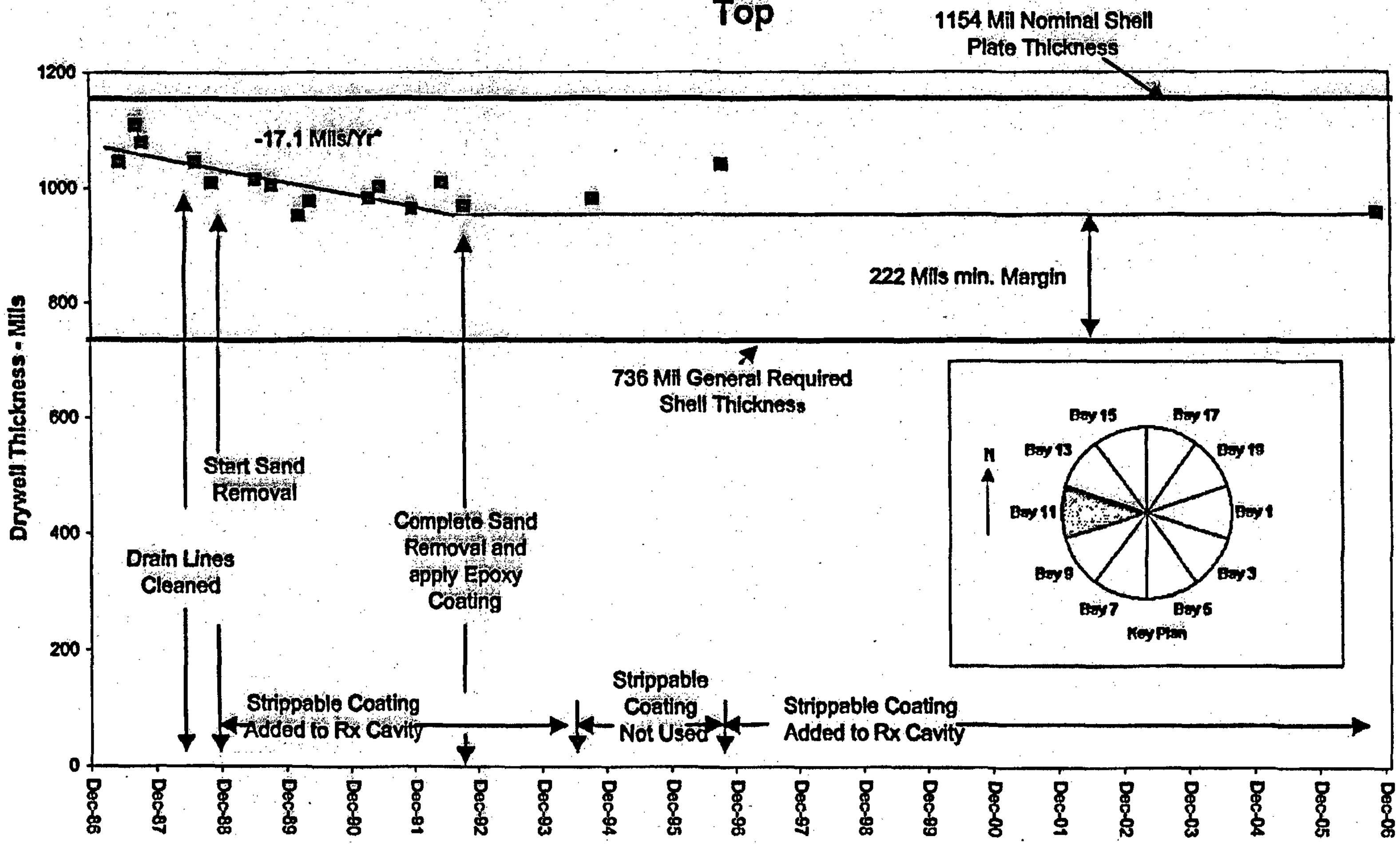
Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

Figure 7. Sandbed Bay #11A



Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

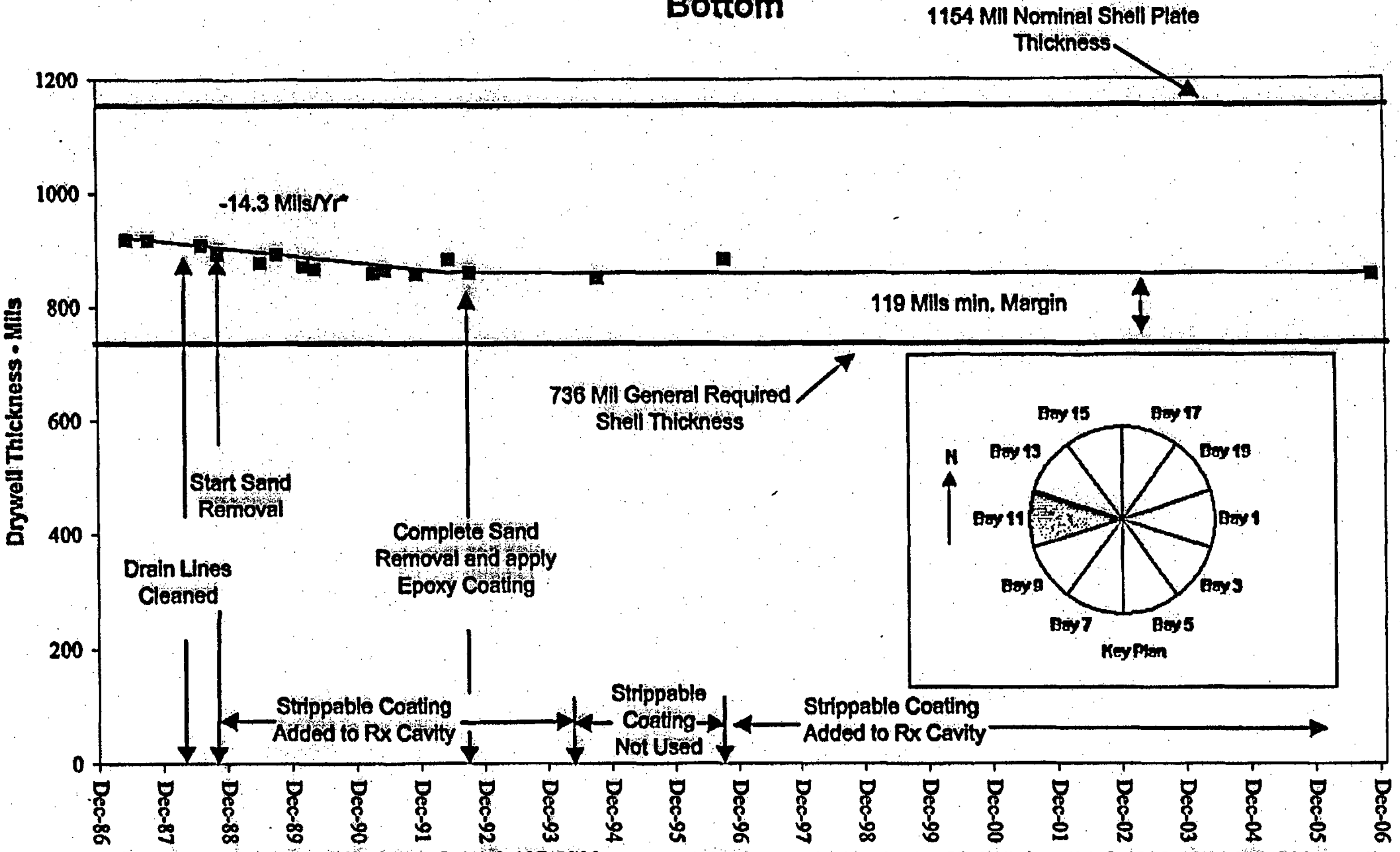
Figure 8. Sandbed Bay #11C
Top



Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-

(*Maximum calculated rate -35.2 mils/yr 4/91, C-1302-187-5300-011 Rev. 1)

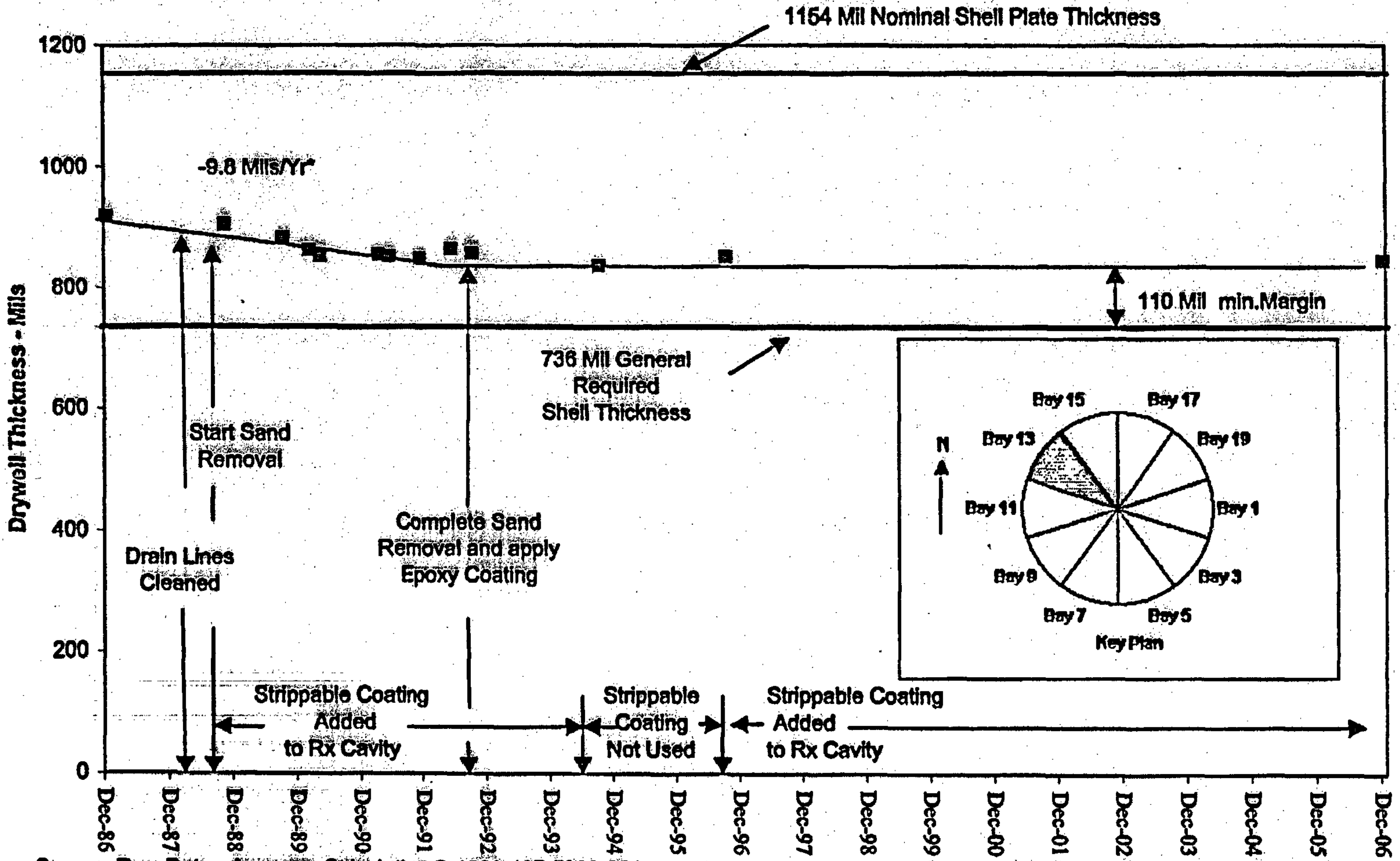
Figure 9. Sandbed Bay #11C Bottom



Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

Date (*Maximum calculated rate -22.4mils/yr 4/91,C-1302-187-5300-011 Rev.1)

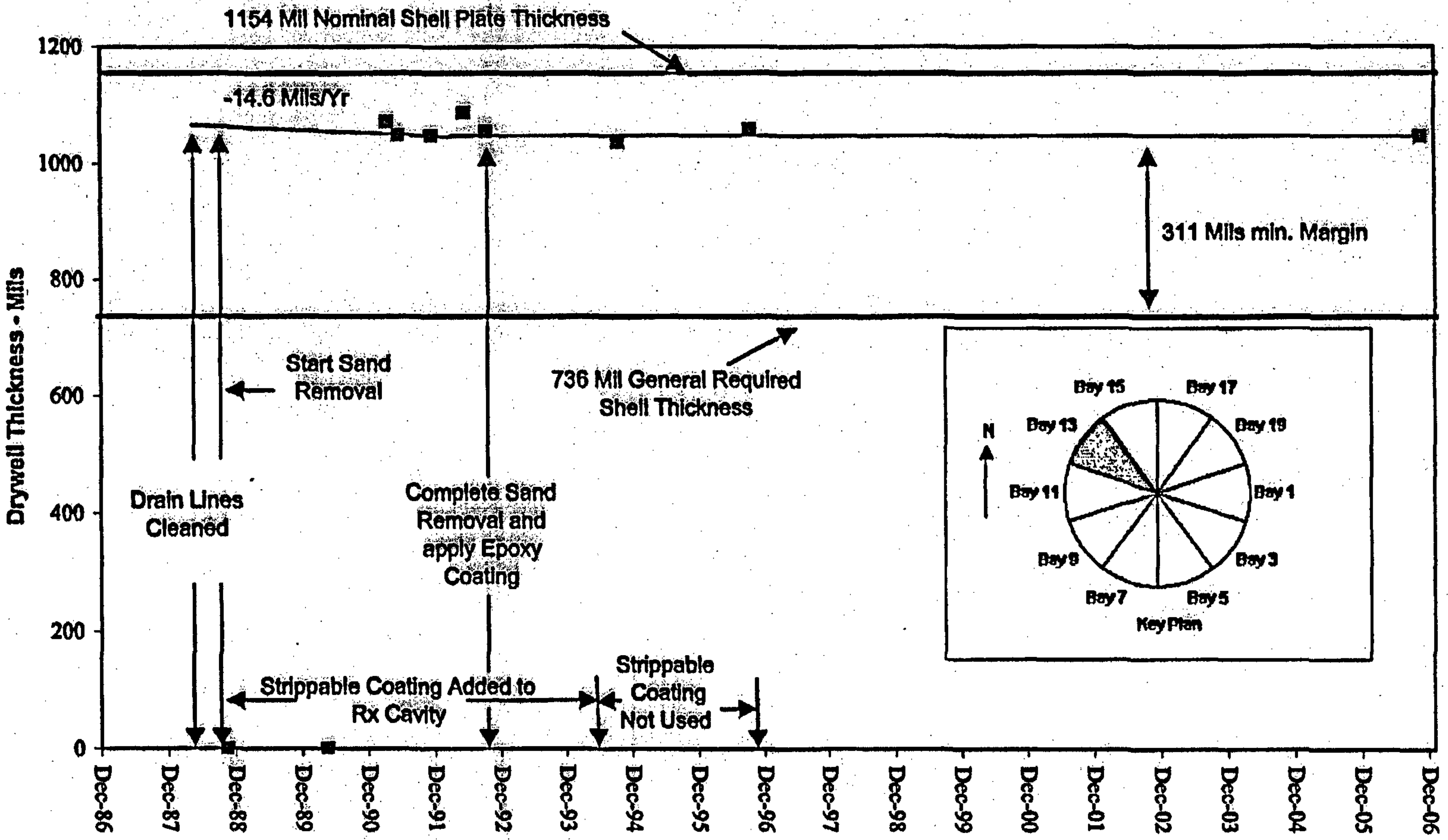
Figure 10. Sandbed Bay #13A



Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

(*Maximum Calculated rate -39.1 mils/yr 4/91, C-1302-187-5300-011 Rev. 1)

Figure 11. Sandbed Bay #13D
Top



Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

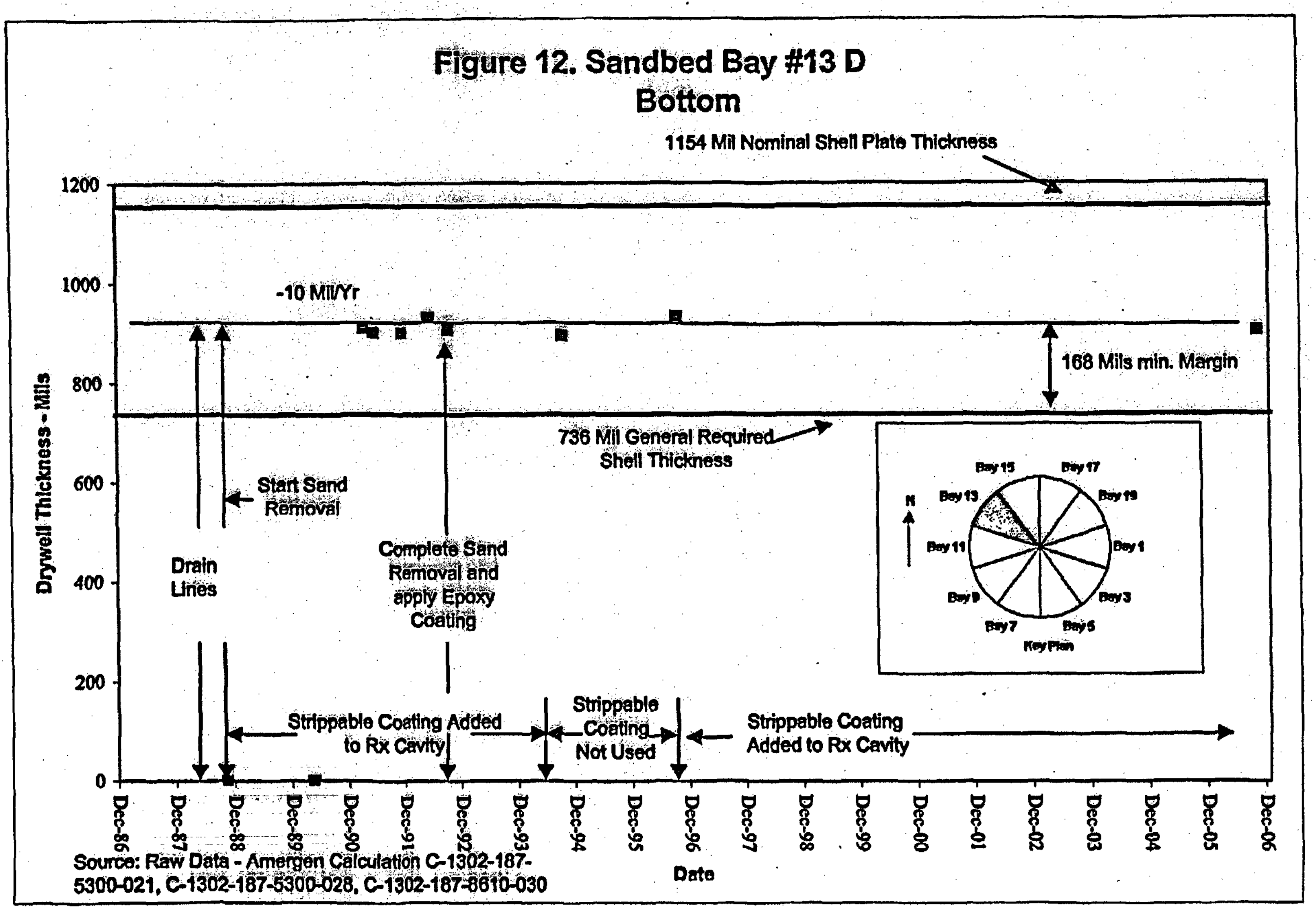
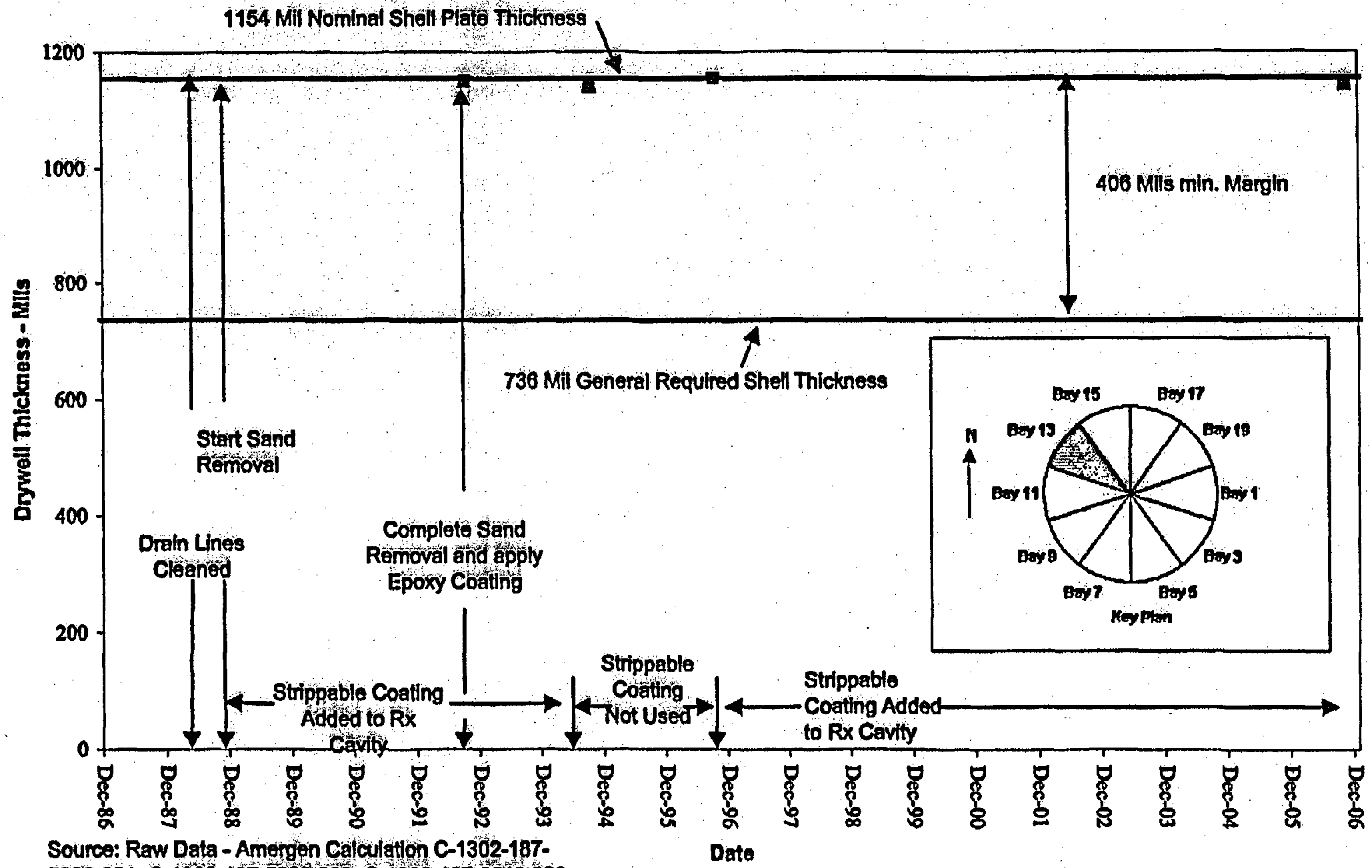


Figure 12. Sandbed Bay #13 D
Bottom

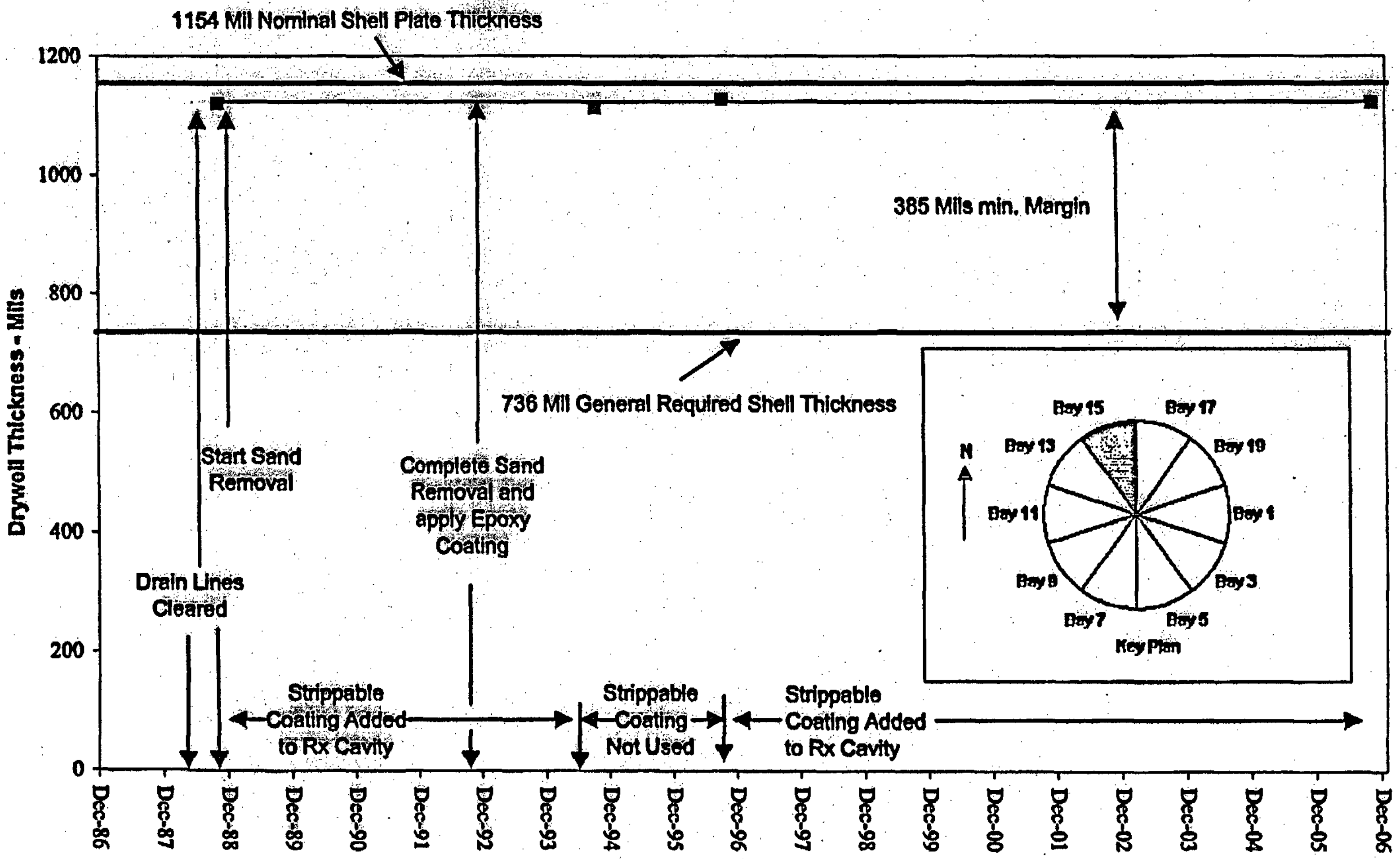
Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

Figure 13. Sandbed Bay # 13C



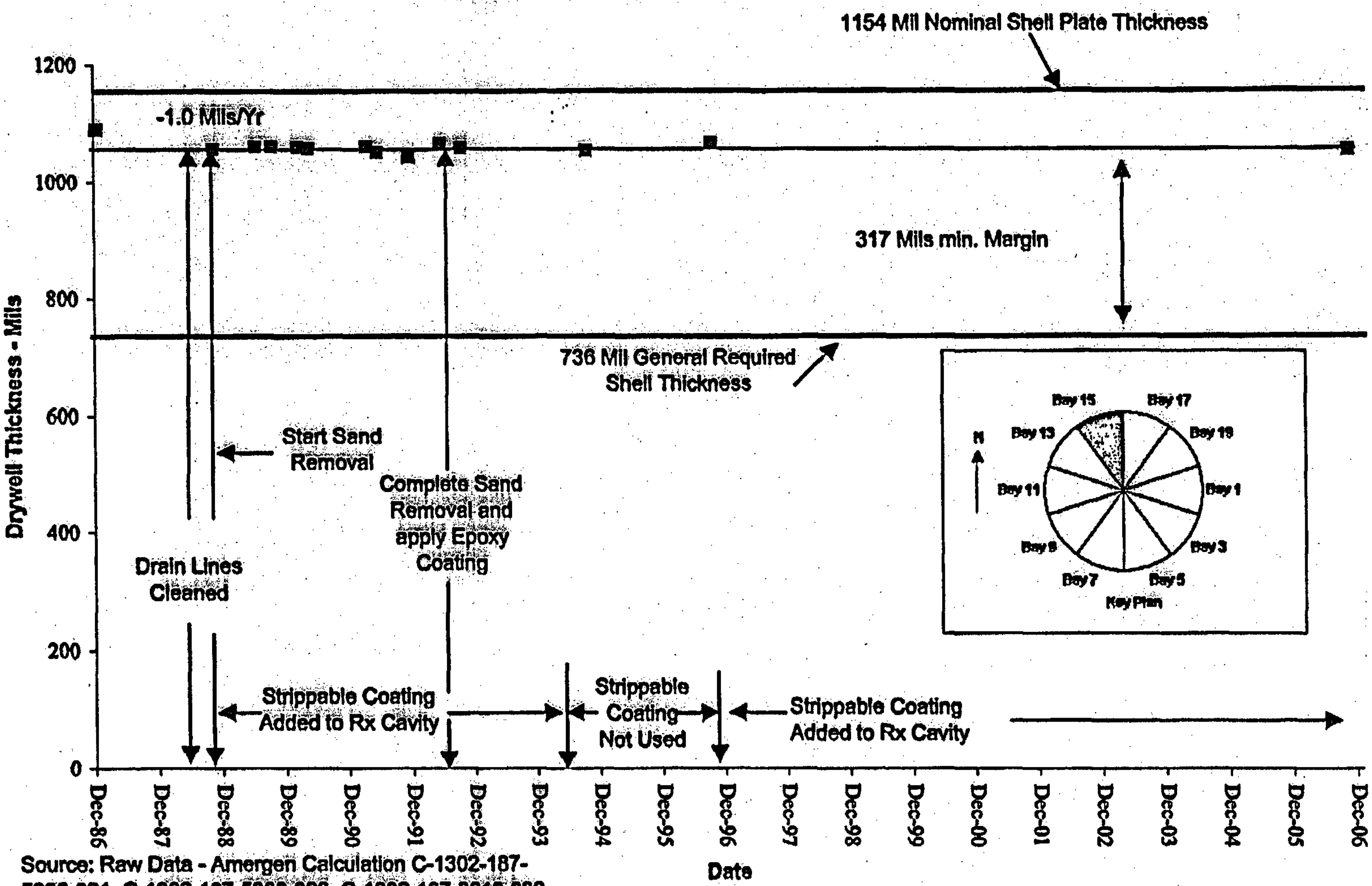
Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

Figure 14. Sandbed Bay # 15A



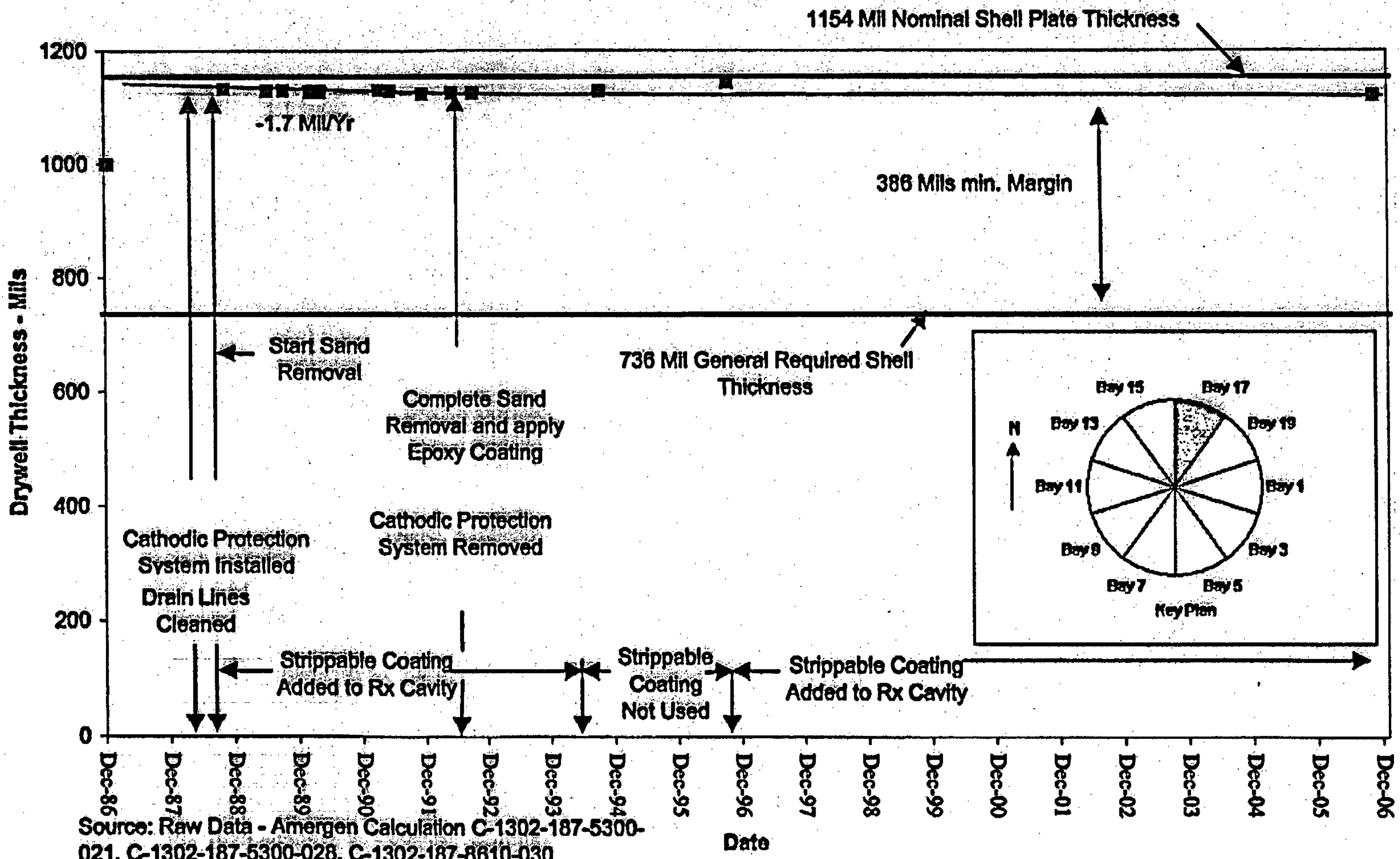
Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

Figure 15. Sandbed Bay #15 D



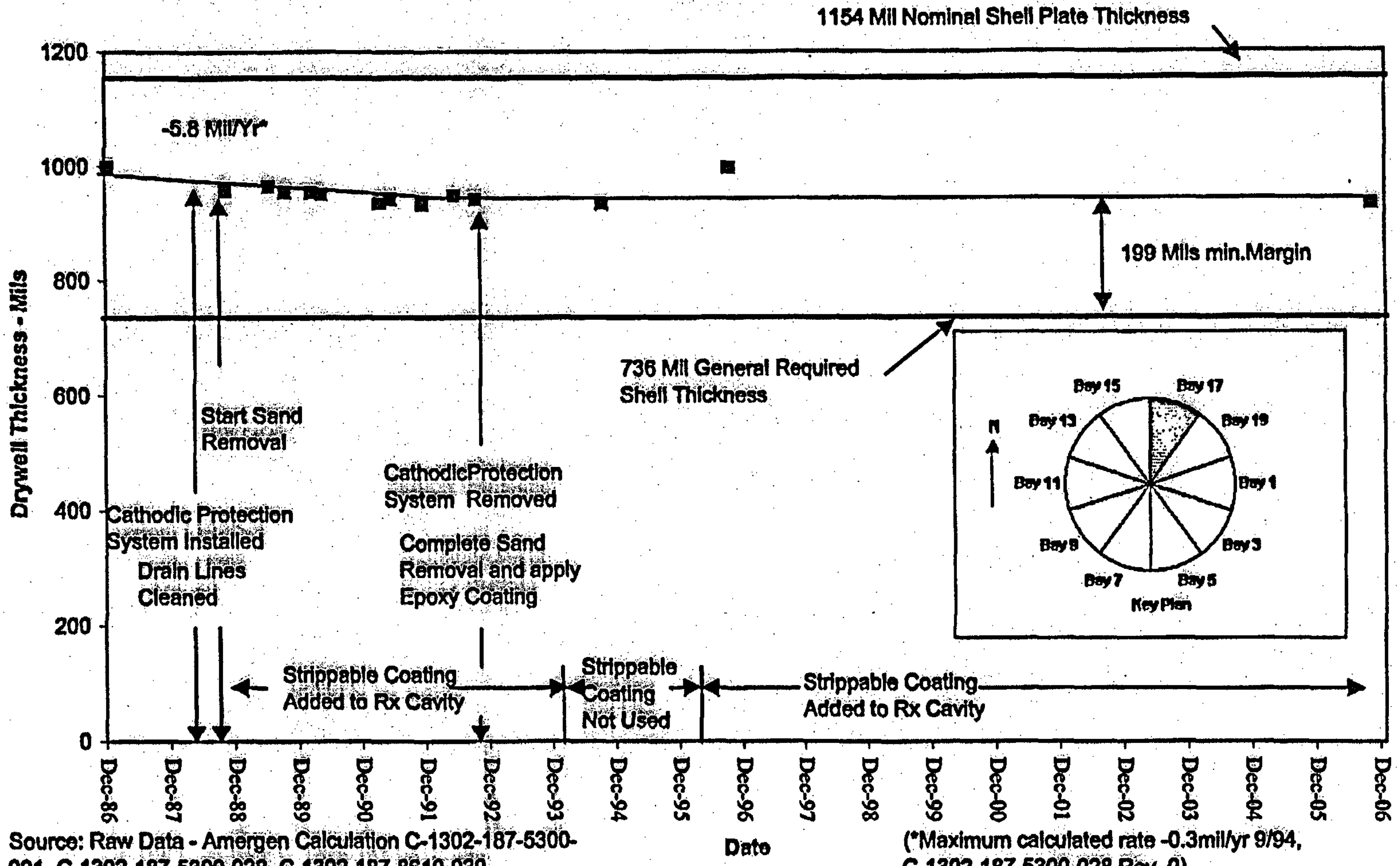
Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

Figure 16. Sandbed Bay #17A
Top



Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

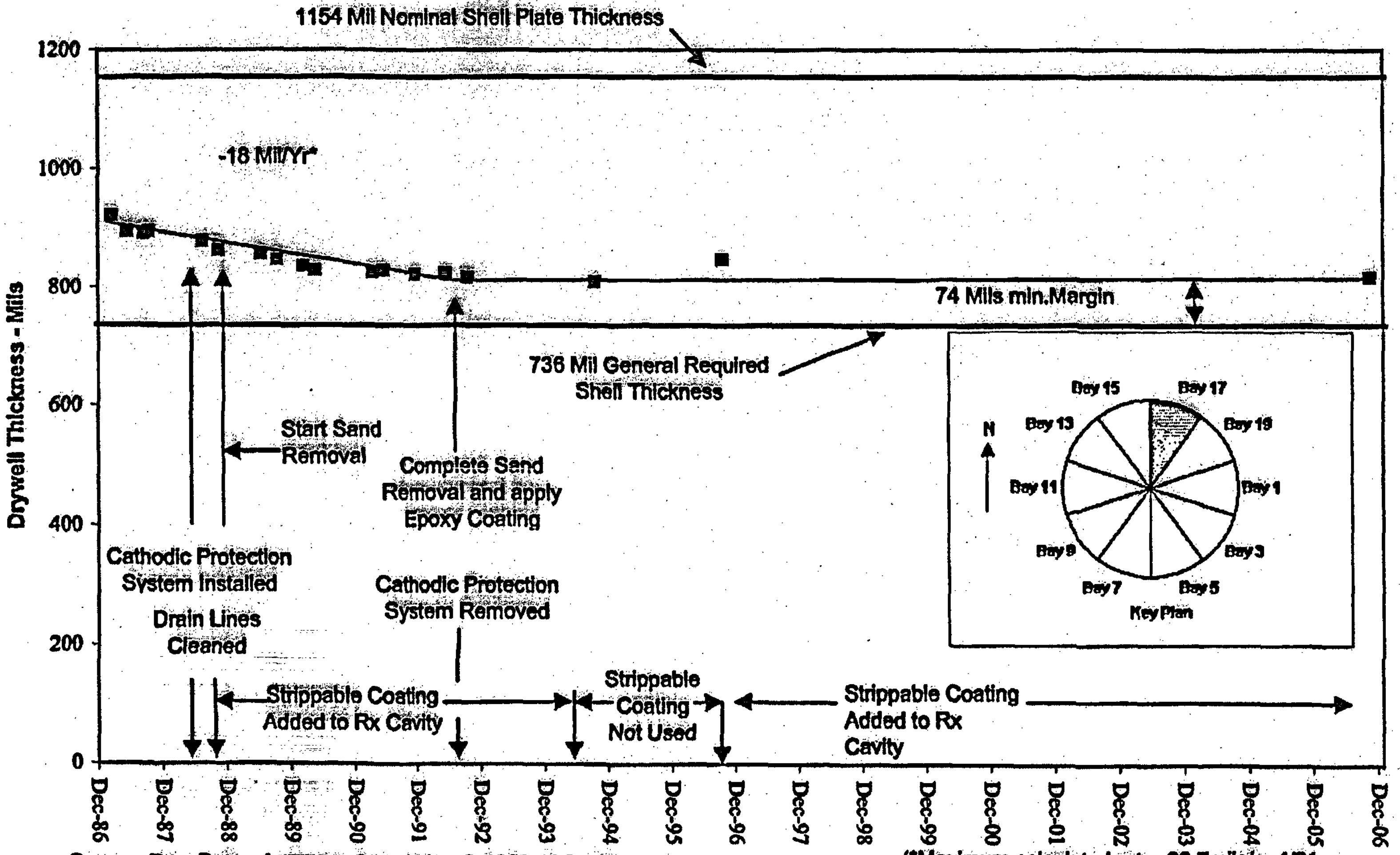
Figure 17. Sandbed Bay #17A
Bottom



Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

(*Maximum calculated rate -0.3mil/yr 9/94, C-1302-187-5300-028 Rev. 0)

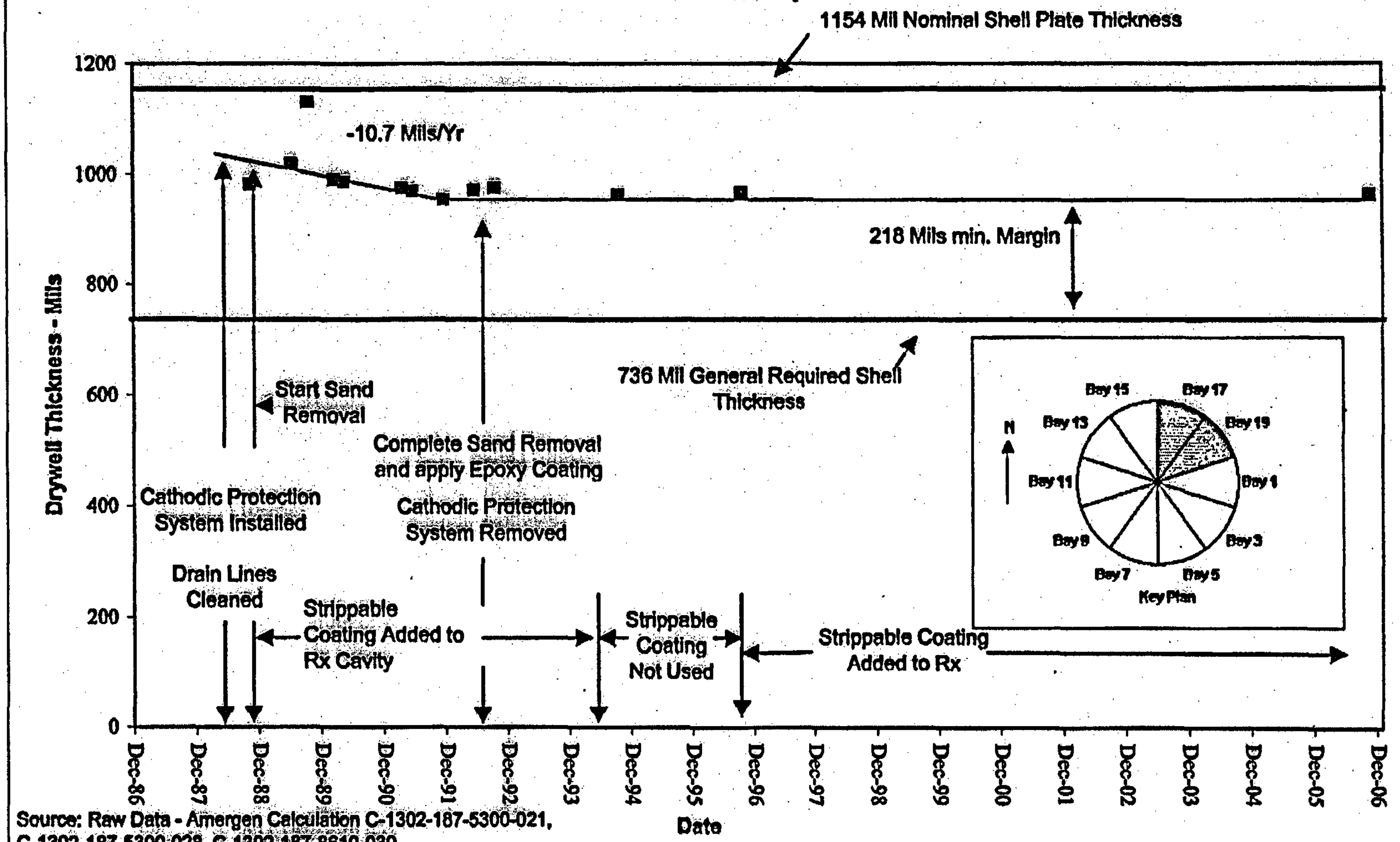
Figure 18. Sandbed Bay #17D



Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

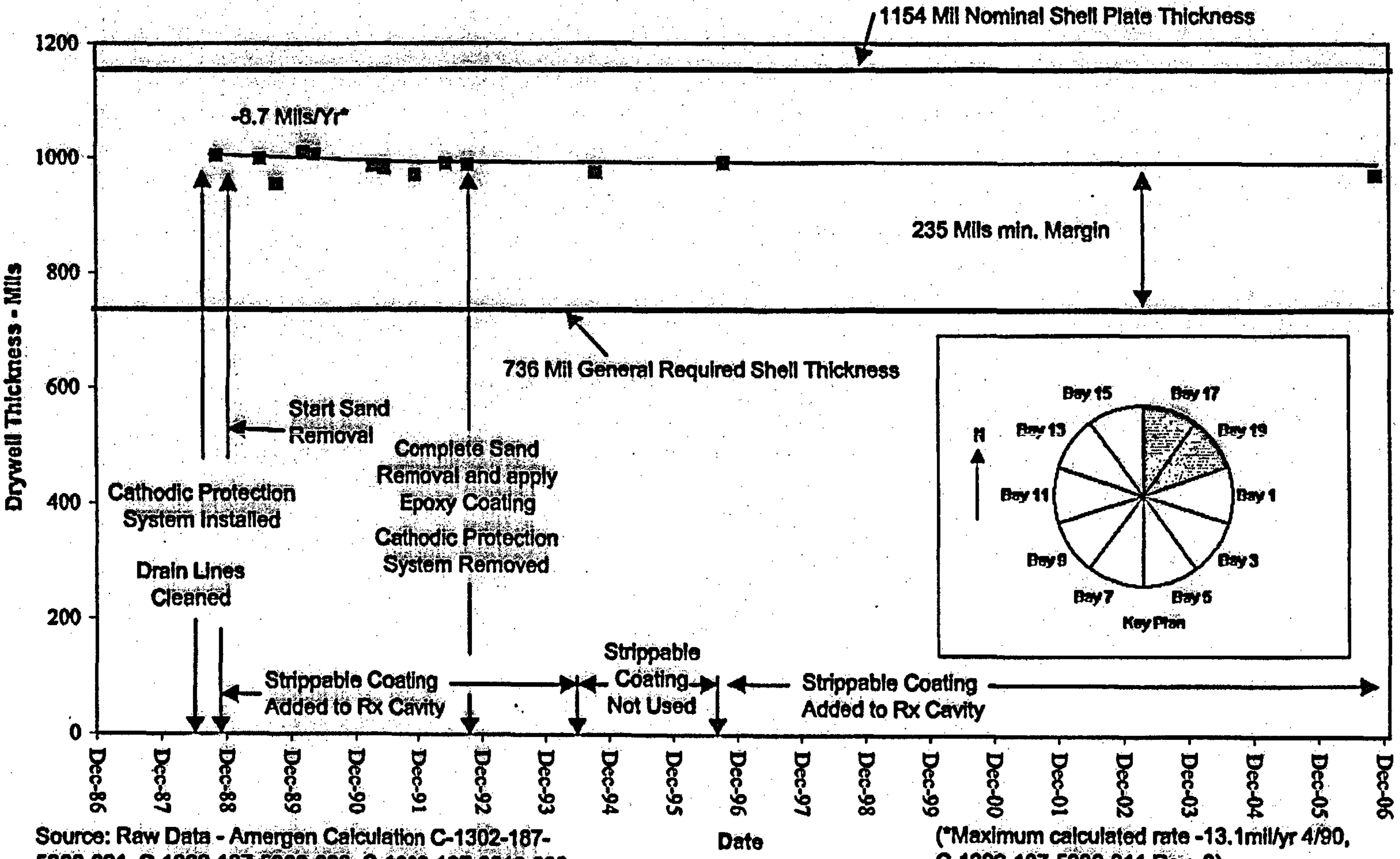
(*Maximum calculated rate -23.7mils/yr 4/91, C-1302-187-5300-011 Rev. 1)

Figure 19. Sandbed Bay #17/19
Frame Top



Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

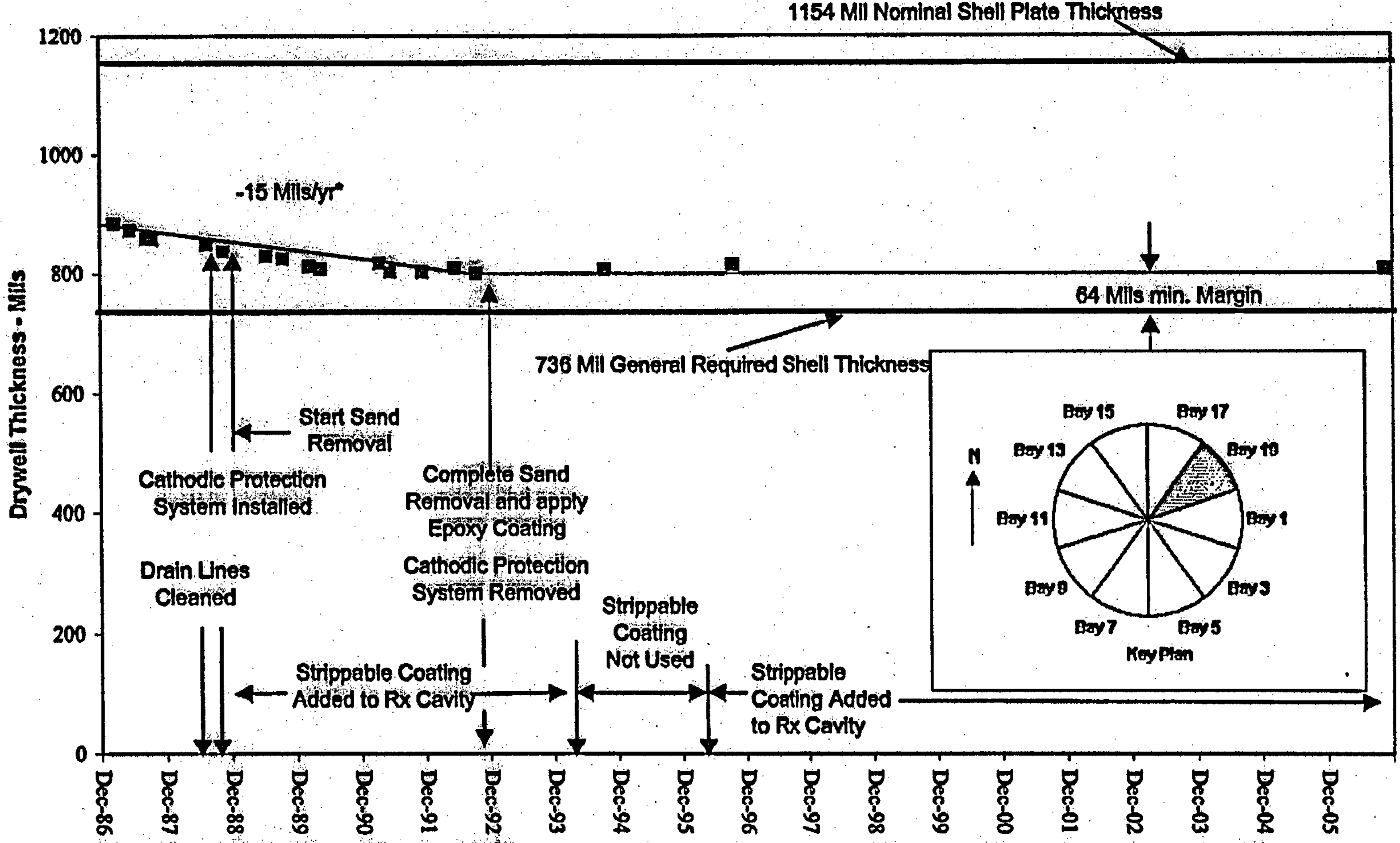
Figure 20. Sandbed Bays # 17/19
Frame Bottom



Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

(*Maximum calculated rate -13.1mil/yr 4/90, C-1302-187-5300-011 Rev. 0)

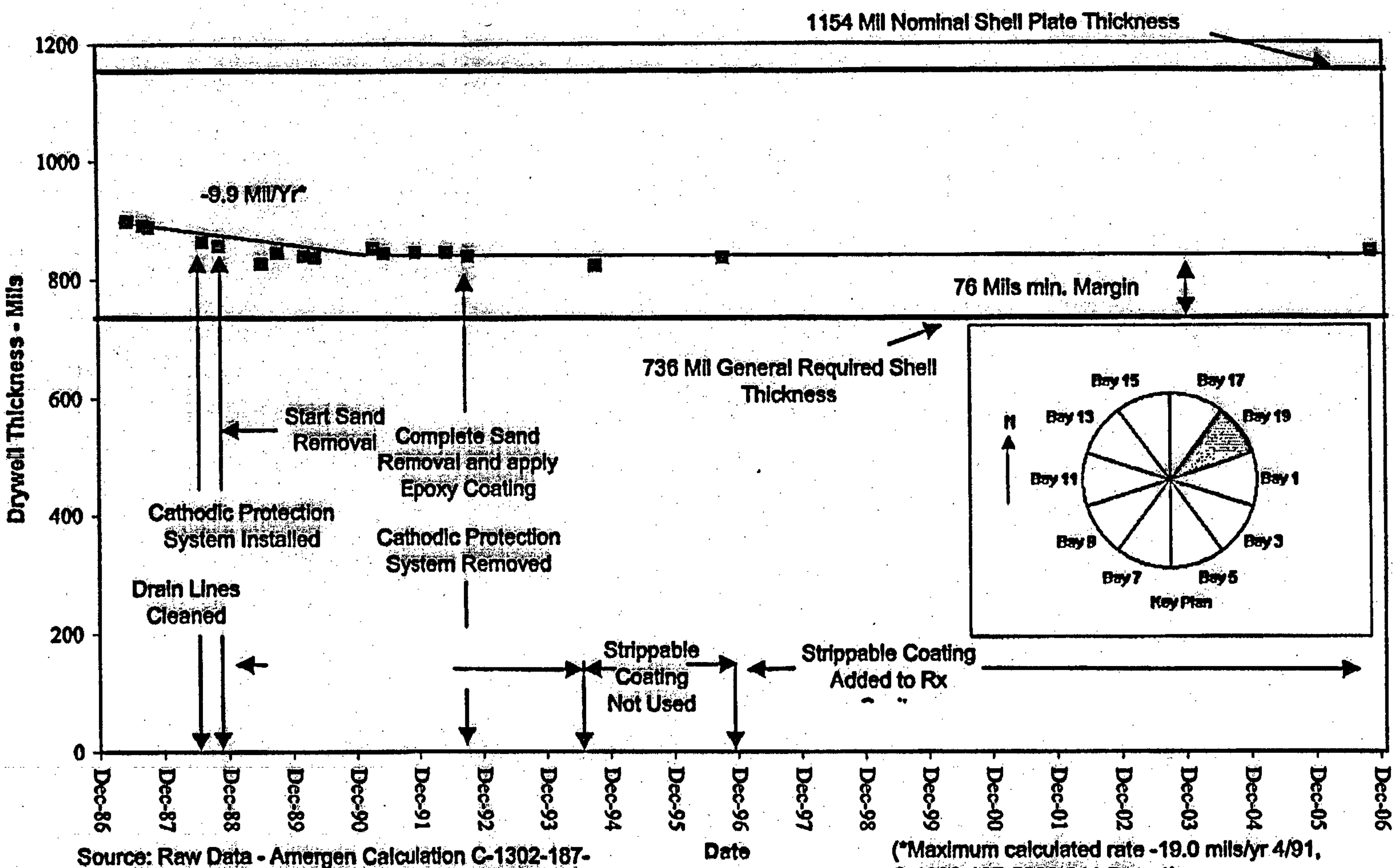
Figure 21 Sandbed Bay # 19A



Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

(*Maximum calculated rate -21.4mil/yr 4/91, C-1302-187-5300-011 Rev. 1)

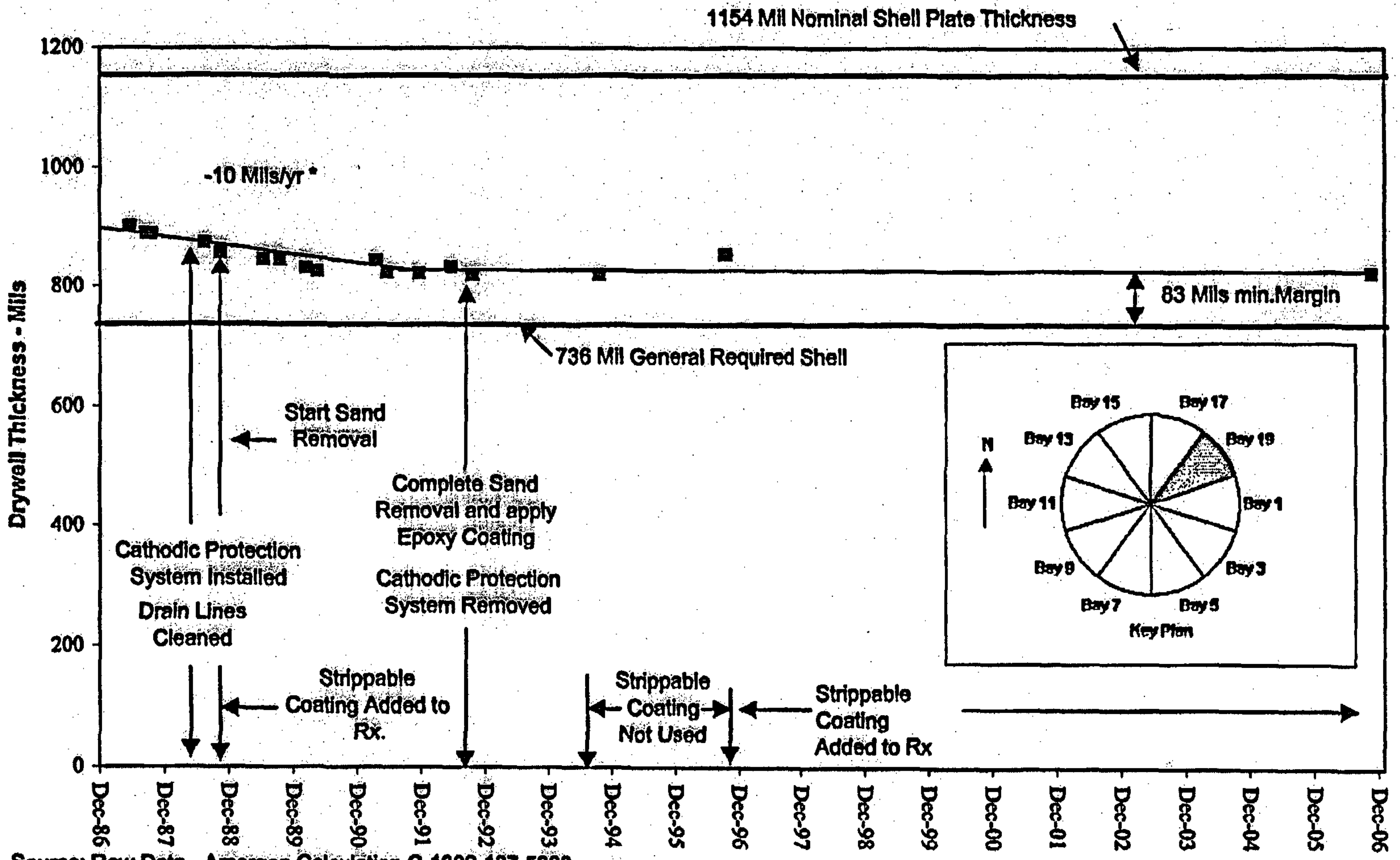
Figure 22. Sandbed Bay #19 B



Source: Raw Data - Amergen Calculation C-1302-187-5300-021, C-1302-187-5300-028, C-1302-187-8610-030

(*Maximum calculated rate -19.0 mils/yr 4/91, C-1302-187-5300-011 Rev. 1)

Figure 23. Sandbed Bay # 19C

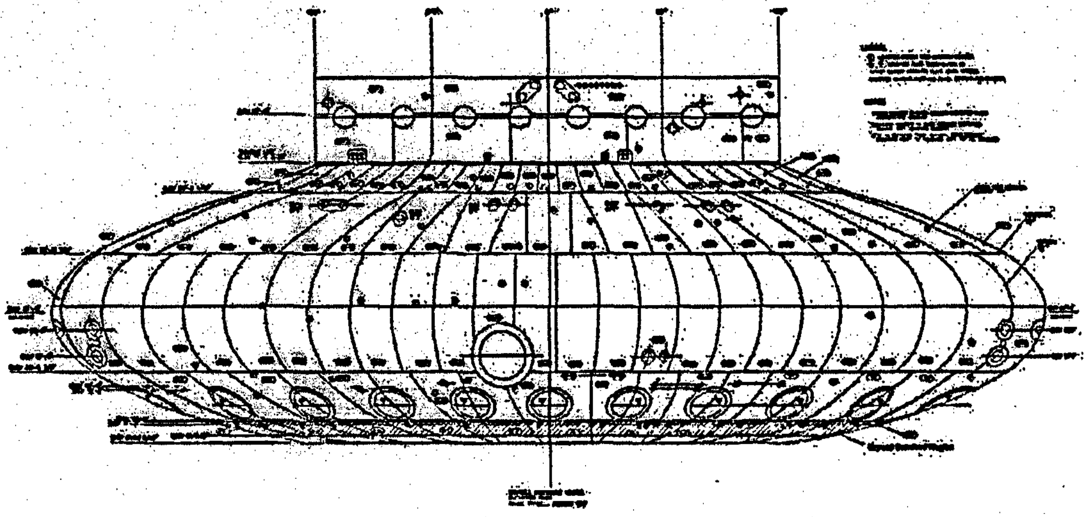


Source: Raw Data - Amergen Calculation C-1302-187-5300 021, C-1302-187-5300-028, C-1302-187-8610-030

(*Maximum calculated rate -24.3mils/yr 4/91, C-1302-187-5300-011 Rev.1)

ATTACHMENT 2

LOCATION OF UT MEASUREMENTS



[illegible]

Attachment 3 – Sandbed Region Epoxy Coating Specification

DEVOE Epoxy Coating System	• Pre-Prime 167 (Epoxy Primer) • Devran 184 (Epoxy paint) • Demat 124S (Epoxy caulk) • DevPrep 88 (Cleaner)
Service Life	The specification requirement for ideal service life is at least 20 years. However, it was recognized that practical coatings may require maintenance sooner than 20 years. The service life is determined by periodic inspection to ensure degradations are detected and corrected before failure of the coating.
Environmental Conditions	• The coating is qualified for temperature Up 250 degree F • Wetting & Drying
Abrasion Resistance	• The material should be sufficiently abrasion resistant to avoid damage from video cameras, temperature probes, radiation monitors, and other similar devices.
Adhesion	• The coating should remain intact and attached to the drywell for the full range of general operating conditions and for the expected light abrasion during inspections and maintenance
Direct Impact Resistance	• The coating should remain intact and attached to the drywell for the full range of general operating conditions and for the expected light abrasion during inspections and maintenance
Weathering Resistance	• N/A. The area to be coated is not exposed to weathering or direct light
Decontaminability	• N/A
Thermal Conductivity	• N/A
Maintenance	• Periodic inspection to determine if maintenance is required
Repairability	• Repairable in the limited access area using equipment available on site
Color	• Color or tint for one coat should provide a good visual contrast with previous coat or substrate • Light gray to provide good light reflectance and easy detection of surface contamination and color changes indicating deterioration, and to make the need to repair a damaged or abraded area more evident
Gamma Radiation	• DEVOE coatings have not been tested for resistance to gamma radiation. Degradation due to exposure to Gamma radiation is determined by periodic inspection.

Source: Ref [19]

This discussion addresses the embedded external Oyster Creek drywell shell ("embedded shell"). Part I, below, provides an overview of commitment information regarding the embedded shell prior to the October 2006 outage. The discussion in Part II sets forth information discovered and analyzed as a result of the October 2006 outage. Overall conclusions about the embedded shell, and continued performance of its intended function during the proposed twenty-year renewal term, are summarized in Part III.

A question regarding the embedded shell was posed to AmerGen at a June 1, 2006 NRC public meeting, and later documented in Ref [36]:

> "Inspection of Inaccessible Regions:
>
> It is not clear to the NRC whether the junction between the 1.154 inch plate and the 0.676 inch plate at the elevation 6 foot 10¼ inches is represented in the UT sampling plan. This area is below the bottom of the sand-pocket area, and is in contact with the concrete alkaline environment. However in the past, before sealing of the junction between the steel and the concrete, this area would have been subjected to the same type of contaminated water as the drywell shell in the sand-pocket area. The NRC considers this junction to be an area for possible corrosion. The NRC requested the applicant to incorporate this area in the sampling plan or justify why it should not be part of the sampling plan."

In October 2006, the ACRS License Renewal Subcommittee also asked about possible corrosion in the embedded region and AmerGen's confidence that corrosion there would be no greater than in the sandbed region, due to the inability to inspect the shell embedded in the concrete. (Ref [44], Pages 84 & 85)

In answer to these inquiries, AmerGen provides the historical information in Part I of this document.

I. Historical Summary - The Embedded Shell

The condition of the embedded shell was communicated in a response to the NRC dated June 20, 2006 (Ref [37]):

"Response:
A review of the drywell construction and fabrication details shows that the drywell skirt is welded to the 1.154 inch thick plate below the sand bed floor before the end of the 1.154" thick plate. This thick plate is welded to the 0.676" plate at elevation 6 foot 10 1/4 inches. One of the purposes of the skirt, which is also now embedded in concrete, was to support the drywell during construction. The presence of the skirt prevents moisture intrusion into the 0.676" plate. Reference Figure 7 in Section 3 of this Enclosure.

Both the 1.154" thick plate and the 0.676" thick plate are embedded in concrete and are inaccessible for inspection as recognized by ASME Section XI, Subsection IWE-1232 and NRC Guidance (NUREG-1801 Rev. 1) for license renewal. These documents credit pressure testing performed in accordance with 10 CFR Part 50 Appendix J, Type A test, for managing aging effects of inaccessible portions of the drywell shell. NUREG-1801 and Ref [30] indicate that corrosion of embedded steel is not significant if the following conditions are satisfied:

1. Concrete meeting the specifications of ACI 318 or 349 and the guidance of 201.2R was used for the containment shell or liner.
2. The concrete is monitored to ensure that it is free of cracks that provide a path for water seepage to the surface of the containment shell or liner.
3. The moisture barrier, at the junction where the shell or liner becomes embedded, is subject to aging management activities in accordance with ASME Section XI, Subsection IWE requirements.
4. Water ponding on the containment concrete floor are not common and when detected are cleaned up in a timely manner."

The Response also indicated:

"The corrosion of the drywell shell in the sand bed region was caused by the moisture trapped in the sand bed due to water leakage into the region. The source of leakage was determined to be the reactor cavity, which is filled with demineralized water during refueling outages. The water passed over the Firebar-D coating that was applied to the drywell shell to allow for formation of the required seismic gap between the drywell shell and the encircling concrete shield wall. The Firebar-D material is a magnesium oxychloride compound. The drywell was erected onsite and exposed to salt air environment during construction, which could also introduce contaminants to the sandbed environment. Chemistry test results on wet sand conducted in 1986 indicated that the leachate from the moist sand had a pH of 8.46 and contained only 45 ppb chlorides and <17 ppb sulfates.

As noted in Ref [30], this water is not aggressive to concrete since the pH is greater than 5.5, the chlorides are less than 500 ppm and sulfates are less than1500 ppm. This means that the wetted concrete environment will provide a high pH environment that will protect the embedded shell from corrosion. Additionally, the corrosion rates calculated for the carbon steel plugs removed from the drywell shell in the sand bed region were comparable to carbon steel exposed to typical waters over a similar temperature range. While an increase in the salinity and impurity of the water will increase the kinetics of the corrosion reaction by increasing the electrolyte conductivity and can alter the form of corrosion experienced by steel (e.g., from general corrosion to pitting corrosion), impurities such as chloride and sulfate are not fundamentally involved in the corrosion anodic and cathodic reactions. In fact, increasing the salinity of the water decreases the dissolved oxygen content of the water and, thus, reduces the concentration of cathodic reactant present for the corrosion reaction." (Ref [37])

The removal of the sand from the sandbed region in 1992 afforded the first opportunity to inspect the sandbed floor and evaluate its condition. There were a number of bays in which the sandbed floor was noted as being unfinished (i.e., the floor lacked a smooth surface with appropriate slope that would direct any water entering the sandbed region away from the drywell shell to the drain). This was documented in Update 10 (4/97) to the Oyster Creek FSAR, Section 3.8.2.8 (Drywell Corrosion) (Ref [46]).

The condition of the sandbed floor also was noted in a May 5, 1993 meeting between GPU Nuclear Corporation and the NRR Staff on the Oyster Creek Drywell Corrosion Mitigation Program (Ref [24]). The presentation slides used during that meeting identified the sandbed floor in some bays to be "cratered with some craters adjacent to the shell. A few craters were big, about 12-13 feet long, 12-20 inches deep and 8-12 inches wide." AmerGen believes that the small quantity, low velocity and non-aggressive chemistry of the water that entered the sandbed region while the sand was present could not have eroded concrete to the extent identified and, therefore, the craters have existed since original construction. (Ref [48])

Several corrective actions were implemented to mitigate corrosion of the drywell shell. These mitigative actions were designed to minimize water intrusion into the sand bed region, provide for an effective drainage of the region in the event of water leakage, and monitor the drains to detect leakage. (See Sections 4 & 6 of this Enclosure). Specifically, as part of the corrosion mitigation activities performed in 1992, the outer shell of the drywell was cleaned and then coated with an epoxy coating including portions of the shell below the current level of the sandbed floor in those bays where the floor was unfinished. The unfinished floors in the sandbed regions were then built up using the same epoxy that was used to coat the shell, and reshaped to allow drainage through the sandbed floor drain of any water that may leak into the region. At that time, the joint between the sandbed floor and the external drywell shell was sealed with a caulk compatible with the epoxy coating to prevent any water from coming in contact with any portion of the drywell shell embedded below the level of the sandbed floor. (Ref [19], Section 6.12).

II. Confirmatory Actions During The 2006 Outage

AmerGen visually inspected the sandbed regions in all 10 bays during the 2006 outage. As part of these inspections, the integrity of the epoxy floor and the caulk sealant between the external drywell shell and the floor of the sandbed region were inspected. No degradation of the caulking between the coated drywell shell and the epoxy coating on the sand bed regions floors was observed. Accordingly, no repairs were required. (Ref [47])

AmerGen observed in 8 of 10 bays separation/cracking of the floor epoxy coating. These areas had no impact on the exterior drywell shell epoxy coating or the caulk seal between the drywell shell and the sand bed floors because the cracks were in areas of the floor away from the shell. The separation/cracking was repaired prior to the conclusion of the October, 2006 outage.

The 1.154 inch thick plate of the external drywell shell between the embedded support skirt and the floor of the sandbed region likely experienced some historical corrosion. However, AmerGen expected such corrosion to be bounded by the corrosion in the non-embedded regions due to the formation of a thin protective oxide passive film over the shell from the highly alkaline concrete. (Ref [29]). During the October 2006 outage, AmerGen implemented a commitment to inspect the drywell shell from the inside of the drywell in two trenches excavated in 1986 in the concrete floor (Discussed in more detail in Section 8 of this Enclosure). An additional portion of one of the trenches was further excavated to expose a small portion of the drywell shell that had, up until October 2006, been embedded in concrete on both sides. An average thickness of 1.113 inches was ultrasonically measured which, when compared with a nominal wall thickness of 1.154 inches, indicates an average total wall loss of 41 mils since construction in the late 1960s (approximately 40 years). AmerGen assumes that the majority of this wall loss occurred from the exterior of the shell and prior to 1992 (Ref [47]), when the sand and standing water was removed from the sandbed region. However, assuming that the 41 mils wall loss occurred over the first 40 years, and that there is an ongoing corrosion of about 1 mil per year, there is still adequate margin for the proposed 20-year period of extended operation.

For the reasons stated below, the exterior of the 0.676 inch thick plate embedded in the concrete below the attachment point of the steel support skirt has been protected from contact with water on the outside of the drywell shell and, therefore, likely did not (and does not now) experience corrosion. The weld that attaches the skirt to the drywell shell is continuous around the exterior of the drywell shell preventing water on the exterior of the drywell from continuing into the 0.676 inch plate region. Although there are cutouts in the skirt to facilitate initial construction, these cutouts are at least 2 feet below the attachment weld. Notes on installation drawings indicate that other openings in the skirt were closed as concrete placement proceeded. For water on the outside of the shell to contact the 0.676 inch plate, it would need to migrate downward through the concrete, through the opening in the skirt and then over two feet upward to the shell. The water on the outside of the shell that may have entered the space between the exterior drywell shell and the sandbed floor prior to the joint being caulked lacks the driving force (including wicking) necessary to navigate such a tortuous path through the concrete.

Also, although the bottom of the drywell is below the level of the groundwater table, it is not credible that groundwater could have migrated through the concrete under this portion of the shell and caused external corrosion in the 0.676 inch plate. The Reactor Building Foundation floor is a 10 ft thick reinforced concrete slab. The bottom elevation of the slab is minus 29' 6" and its top elevation is minus 19' 6". There is a waterproof membrane at the bottom of the mat that extends up the outside of the exterior walls to an Elevation of 5' 0". The concrete pedestal that supports the Containment shell is located at the center of the mat. The containment shell is spherical in shape at the base and has a bottom elevation of 2' 3". The Torus Room completely surrounds this concrete pedestal with a floor elevation of minus 19' 6" (top of mat). (A more detailed description of the drywell is provided in Section 3 of this Enclosure)

In order for ground water to reach the lowest point of the containment shell it would need to penetrate the waterproof membrane then migrate through the 10 ft concrete mat then migrate through the pedestal concrete. Since there is no waterproofing on this interior concrete pedestal, or other interior walls, any water contained or migrating in the pedestal would seek the path of least resistance and flow into the Torus Room. This path would be through the concrete itself or along construction joints in the pedestal. If water was able to make its way along the path outlined above, and actually reach the base of the containment shell, the Torus Room would be flooded. There are sumps in the basement of the Reactor Building that collect any water in leakage and would prevent significant accumulation of water in the Torus Room.

Periodic testing of the drywell integrity is required by 10CFR50, Appendix J. In particular, the Type A test measures the containment system overall integrated leakage rate and must be conducted under conditions representing design basis loss-of-coolant accident containment peak pressure. The most recent Appendix J, Type A test of the drywell shell (Nov. 2000) confirmed the integrity of the shell in the embedded region and satisfied all Code acceptance criteria.

III. Conclusions

From the above discussion, the conclusions are as follows:

- The corrosion of the external embedded drywell shell is bounded by the corrosion in the sandbed region. This is a reasonable conclusion for two primary reasons:

  1. "The carbon steel in the embedded region is in contact with high pH concrete that allows the creation of a passive film on the steel surface. That is, the presence of abundant amounts of calcium hydroxide and relatively small amounts of alkali elements, such as sodium and potassium, gives concrete a very high alkalinity (e.g., pH of 12 to 13). In fact, thermodynamic calculations reveal no corrosion of iron (steel) above pH 10 at room temperature.

  2. Uniform corrosion will tend to occur when some surface regions become anodic for a short period, but their location and that of the cathodic regions constantly change. For example, general corrosion/rusting of mild steel will occur when there is a uniform supply of oxygen available across the surface of the steel and there is a uniform distribution of defects in the oxide film as is usually the case in the non-protective films formed on unalloyed steel. In the absence of areas of high internal stress (e.g., cold-worked regions) or segregated zones (e.g., non-uniform distributions of sulfide inclusions), a number of anodic regions will develop across the surface. Some areas will become less active while new anodic regions become available. Therefore, overall attack takes place at a number of anodic sites whose positions may change, leading to general rusting across the surface.

     If the supply of oxygen is not uniform across a surface, then any regions that are depleted in oxygen will become anodic as the case of moist sand in contact with the drywell steel. The remainder of the drywell surface including the embedded steel has oxygen available to it and therefore acts as a large cathodic area. When the cathodic area is larger, local attack will occur in the smaller anodic region. This phenomenon is referred to as differential aeration.

Therefore, due to the creation of a differential aeration cell, the adjacent carbon steel in contact with the moist sand bed acts as an anode that sacrifices itself to the benefit of the steel in the embedded region. That is, the corrosion of the sand cushion steel preferentially corrodes as galvanically coupled to the embedded steel." (Ref [37])

- "Craters" identified in the sandbed region floors when the sand was initially removed were created during initial construction (pre-1969). (Ref [48])
- Measures taken to prevent water from entering the sandbed region and any further water intrusion into the area between the concrete and the external drywell shell are effective because they preclude "two of the four necessary fundamental parameters necessary for any form of corrosion to occur, an electrolyte, (i.e., moisture) and the cathodic reactant (i.e., oxygen), while only the lack of one fundamental parameter is sufficient to prevent corrosion. Sealing off the embedded steel prevents refreshment of moisture in the embedded region." (Ref [37]) The ultrasonic measurements taken during the October, 2006 outage of a section of the drywell shell previously embedded on both sides since initial construction indicate the effectiveness of preventive measures in that, on average, in excess of 96% of the nominal wall remains in the embedded portion of the drywell shell immediately below the sandbed region.
- Any oxygen trapped by the caulk sealant would most likely have been consumed and a thin protective oxide passive film would have been formed from contact with the highly alkaline concrete thereby minimizing further corrosion because "residual moisture will not support any subsequent corrosion once all the dissolved oxygen is consumed in the cathodic corrosion reaction. The cessation of the corrosion reaction will occur regardless of the presence of contaminants that may be dissolved in the water (e.g., chloride, sulfate, etc.) since although these impurities can affect the kinetics of the corrosion reaction, they do not participate in the cathodic reduction reaction. Once the cathodic reaction is stopped, corrosion is stopped. Intermittent wetting and aeration of the embedded steel would produce only minimal additional corrosion." In addition, "[t]he presence of concrete in contact with the embedded steel will mitigate corrosion even if sufficient moisture and oxygen are available due to the spontaneous formation of a thin protective oxide passive film on the embedded steel surface in the highly alkaline solution of the concrete. As long as this film is not disturbed, it will keep the steel passive and protected from corrosion." (Ref [37])
- The sandbed floor was reshaped in 1992 to route water to the sandbed drains and away from the drywell shell and caulk sealant.
- Continued inspections of the caulk sealant have confirmed its integrity.

- Appendix J, Type A testing confirmed the integrity of the drywell shell in the embedded region.

"In summary, AmerGen has extensively investigated drywell corrosion, including the embedded shell. A review of plant operating and industry experience indicates that corrosion of embedded steel in concrete is not significant because it is protected by the high alkalinity in concrete. Corrosion could only become significant if the concrete environment is aggressive. Historical data shows that the environment in the sand bed region is not aggressive, and thus any water in contact with the embedded shell is not aggressive. The data also shows that corrosion of the drywell shell in the sand bed region is due to galvanic corrosion and impurities such as chlorides and sulfates are not fundamentally involved in the corrosion anodic and cathodic reactions. Thus, only limited corrosion would be anticipated for the drywell embedded shell

AmerGen has also committed to a comprehensive drywell corrosion-monitoring program for the period of extended operation. The program includes mitigative measures to prevent water intrusion into the sand bed region. The sand bed region concrete floor is sealed with epoxy coating. The junction between the sand bed region concrete floor and the drywell shell was sealed in 1992 to prevent moisture from impacting the embedded shell. Thus, additional significant corrosion of the embedded shell is not expected because of lack of moisture and depleted oxygen. AmerGen is committed to taking specific corrective actions, described in item 3 of Enclosure 1 to Ref. [39], prior to exceeding any design requirements, if water leakage is detected in the sand bed region drains.

For all of the above reasons, the corrosion rate for the embedded drywell shell is less than the corrosion rate of the sand bed region of the drywell shell. Also, direct monitoring of the drywell shell in the sand bed region adequately bounds any corrosion in the drywell embedded shell." (Ref [37])

This discussion addresses the potential for corrosion of the interior surface of the drywell shell that is embedded in the concrete floor inside the drywell (i.e., below the concrete floor at Elevation 10' 3"). See Figure 4 in Section 3 of this Enclosure. This area includes the shell behind the concrete curb at the edge of the concrete floor. All elevations of the interior drywell shell were presumed to be coated with primer (except those areas to be embedded in concrete) that was applied following fabrication of the material to protect the steel prior to and during installation.

Part I, below, provides an overview of historic information pre-dating the October 2006 outage. The discussion in Part II sets forth information discovered and analyzed as a result of the October 2006 outage. Overall conclusions about the drywell, and its continued operation during the proposed twenty-year renewal term, are summarized in Part III.

I. Historical Summary

The drywell is described in Section 3 of this Enclosure. Figure 1 (Section 3) shows a cross-section of the drywell. Figure 4 (Section 3) shows an elevation view of the construction of the drywell foundation including the configuration of the Torus Room. Figure 5 (Section 3) provides the details of the drywell floor including the drainage trough located in the area under the reactor vessel (referred to as the Sub-Pile Room). The two areas addressed in this discussion are the embedded portions of the 1.154" thick section internal to the drywell and the 0.676" thick section at the bottom of the drywell all of which is embedded internally (See Figure 4 in Section 3). Section 6 of this Enclosure identifies the minimum required average general thickness of the 1.154" thick section as 0.736". Since the 0.676" thick section is completely encased in concrete, it is only required to contain the maximum drywell pressure (44 psig) and is not required to withstand buckling or membrane stresses. The minimum required thickness for this section required due to the maximum drywell pressure is 0.479" per Reference [42].

In 1986, as part of an ongoing effort at the Oyster Creek Generating Station to investigate the impact of water on the outer drywell shell, concrete was excavated at two locations inside the drywell (referred to as trenches) to expose the drywell shell below the Elevation 10' 3" concrete floor level to allow ultrasonic (UT) measurements to be taken to characterize the vertical profile of corrosion in the sand bed region outside the shell. The trenches (approximately 18 inches wide) were located in Bays 5 and 17 (See Figure 3 in Section 3 of this Enclosure) with the bottom of the trenches at Elevations 8' 9" and 9' 3" respectively (The elevation of the sand bed region floor outside the drywell is approximately 8' 11").

Following UT examinations in 1986 and 1988, the exposed shell in the trenches was prepped and coated and the trenches were filled with Dow Corning 3-6548 silicone RTV foam covered with a protective layer of promatic low density silicone elastomer to the height of the concrete floor (Elevation 10' 3"). At that time, it was expected that these materials would prevent water that might be present on the drywell concrete floor from entering the trenches. Before the 2006 outage (discussed in Part II below), these materials had not been removed from the trenches since 1988.

During the preparation of a response to an NRC question (Ref [33]) during the Aging Management Review Audit, an internal memo was identified that indicated the intermittent presence of water in the two trenches inside the drywell. This was not an expected condition. That memo, dated January 3, 1995 was referenced in a 1996 Structural Walkdown Report but was not entered into the Corrective Action Process and was not considered as Operating Experience input to the Aging Management Program reviews.

Based on activities performed under the Structures Monitoring Program and IWE inspection program, and the reviews performed in support of the License Renewal Application, the water on the drywell floor and potentially inside the trenches was previously considered a temporary outage condition and not an operating environment for the embedded shell. However, in its response to an NRC Aging Management Review Audit question (Ref [33]), AmerGen committed to inspect the condition of the drywell interior shell in the trench areas and to evaluate any identified degradations prior to entering the period of extended operation (Commitment 27.5 in Ref. [39]). The results of these inspections and associated corrective actions are described in Section II below.

II. Confirmatory Actions During the October 2006 Refueling Outage

As noted above, AmerGen planned visual and ultrasonic (UT) inspections of the drywell shell in the trench areas during the 2006 refueling outage. The filler material in the trenches was removed and water was identified in the trenches (Bay 5 had 5 inches of standing water and Bay 17 had dampness but no standing water). (Ref: [47]) This condition was entered into the Corrective Action Process.

The presence of water in the trenches was indicative of water beneath the drywell floor surface, being in contact with both the drywell shell and drywell concrete. Following removal of the water from the trenches, visual inspections and UT measurements were performed in each trench. AmerGen has concluded (Ref. [47]) that most of the material loss occurred between 1986 and 1992 when sand and water remained in the sandbed region located adjacent to the exterior of the drywell shell and significant corrosion of the external shell was known to have occurred.

The following additional corrective/confirmatory actions related to the discovery of water in the trenches were taken during the October, 2006 Refueling Outage (Details may be found in Reference [47] transmitting a supplement to the License Renewal Application):

- Walkdowns, drawing reviews, tracer testing and chemistry samples were performed to identify the potential sources of water in the trenches.
- An engineering analysis was performed to evaluate the impact of the water on the drywell shell integrity.
- Field repairs/modifications were implemented to mitigate/minimize future water intrusion into the area between the shell and the concrete floor. These repairs/modifications consisted of (1) Repair of the trough concrete in the area under the reactor vessel to prevent water from potentially migrating through the concrete and reaching the drywell shell, (2) Caulking the interface between the

drywell shell and the drywell concrete floor/curb to prevent water from reaching the embedded shell and (3) Grouting/caulking the concrete/drywell shell interface in the trench areas.

- Additional concrete was removed from the Bay 5 trench to expose an additional 6 inches of drywell shell to allow visual inspection and UT measurements to be performed in the area of the shell that had been embedded in concrete (on both sides) until the 2006 outage.

III. Conclusions

An engineering evaluation of the Oyster Creek inner drywell shell condition was prepared by a structural engineer and reviewed by an industry corrosion expert and independent third-party expert to determine the impact of the as-found water on the continued integrity of the drywell shell. The evaluation utilized water chemical analysis, visual inspections and UT examinations to conclude that the measured water chemistry values and the lack of any indications of rebar degradation suggest that the protective passive film established during concrete installation at the embedded steel/concrete interface is still intact and significant corrosion of the interior embedded drywell shell would not be expected as long as this benign metal lost based on a current average thickness measurement of 1.113" versus a nominal plate thickness of 1.154" is only 0.041" (total wall loss for both inside and outside of the drywell shell). Although no continuing corrosion is expected, but conservatively assuming that a similar wall loss could occur between now and the end of the period of extended operation, a margin of 336 mils to the 0.736" required wall thickness would exist. Using a similarly conservative approach for the 0.676" embedded bottom head plate (0.479" required thickness for pressure retaining capability only as noted above) provides a margin of 115 mils to the end of the period of extended operation.

The engineering evaluations summarized above confirmed that the condition identified during the 2006 outage will not impact safe operation during the next operating cycle. Also, a conservative projection (noted above) of wall loss for the 1.154 and 0.676 inch thick embedded shell sections indicates that margin is provided in both sections through the period of extended operation.

Although a basis is established that ongoing corrosion of the shell embedded in concrete should not be expected and repairs/modifications have been performed to limit or prevent water from reaching the internal surface of the drywell shell, AmerGen has now established that the existence of water in contact with the internal surface of the drywell shell and concrete at and below the floor elevation will be assumed to be a normal operating environment. Therefore, aging management reviews have now been performed and new aging management activities are being specified to confirm that corrosion that could impact the ability of the drywell shell to perform its design functions for the period of extended operation is appropriately managed (Details may be found in Ref. [47]).

Ref. No.	Document	Document Date
	VOLUME 1	
1	Letter 5000-86-1116, GPU to NRC, Oyster Creek Drywell Containment with attached SE No. 000243-002 Rev. 0	12/18/86
2	Restart Analysis Report – Drywell Analysis Sand Transition Zone	2/9/87
3	GE Report No. 87-178-003, GE report "Corrosion Evaluation of the Oyster Creek Drywell" Rev. 1	3/6/87
4	Drawings	
	a) 3E-SK-S-85, Drywell Plan Elev. 11' – 3" 1986 Plots	12/16/86
	b) 3E-SK-S-89, Ultrasonic Testing Drywell Level 50' 2" & 87' 5"	10/16/87
	c) 3E-SK-M-275, Ultrasonic Testing Drywell Level 50' 2" March 1990	4/8/90
	d) 3E-SKM-358, Ultrasonic Testing Drywell Level 51' 10" April 1990	12/27/90
5	Memo, Oyster Creek Reactor Cavity Leakage	1/28/88
6	SE No. 328257-002, Temporary Repair of Reactor Cavity	10/19/88
7	TDR-851, Rev 0, Assessment of Oyster Creek Drywell Shell	12/27/88
8	Calculation C-1302-187-5300-005, "Statistical Analysis of Drywell Thickness Data Thru 12-31-88" Rev. 0	1/31/89
9	TDR-948, "Statistical Analysis of Drywell Thickness Data," Revision 1	2/1/89
10	Calculation C-1302-187-5300-011, "Statistical Analysis of Drywell Thickness Data Thru 4/24/90"	6/13/90
	VOLUME 2	
11	IS-402950-001, "Functional Requirement for Augmented Drywell Inspection," Rev. 0	10/4/90
12	TDR-1027, "Design of a UT Inspection Plan for the Drywell Containment Using Statistical Inference Methods," Rev. 1	11/1/90
13	Letter 5000-90-1995, GPU to NRC, Oyster Creek Drywell Containment	12/5/90
14	Letter, GPU to NRC, Oyster Creek Drywell Containment, dated November 26, 1990	11/26/90
15	Calculation GE Index 9-3 "An ASME Section VIII Evaluation of Oyster Creek Drywell for Without Sand Case Part 1 Stress Analysis"	2/91
16	Calculation GE Index 9-4 "An ASME Section VIII Evaluation of Oyster Creek Drywell for Without Sand Case Part 2 Stability Analysis"	2/91

Ref. No.	Document	Document Date
17	MPR Report 1275, Selection of Candidate Coatings and Steel Cleaning/Preparation Methods for the Oyster Creek Drywell Exterior in the Sand Bed Area	3/10/92
18	MPR-TP-83161-001, Test Plan for Qualifying the Painting Process for the Exterior Surface of the Drywell, Rev. 2	6/19/92
19	OC-MM-402950-010, "Cleaning and Coating the Drywell Exterior in the Sand Bed Area," Rev. 0	7/29/92
20	MPR Report 1322 – Results of Painting Process Qualification Tests for the Drywell Exterior in the Sand Bed Area at Oyster Creek, Rev. 0	8/7/92
	VOLUME 3	
21	Calculation C-1302-187-5300-021, "Statistical Analysis of Drywell Thickness Data Thru May 1992" Rev. 0	8/26/92
22	Letter from H.S. Mehta (GE) to Dr. S. Tumminelli (GPU), "Sandbed Local Thinning and Raising the Fixity Height Analyses (Line Items 1 and 2 in Contract # PC-0391407)"	12/11/92
23	SE No. 402950-011, "Clean and Coat Drywell Ext. in Sand Bed," Revision 2	1/5/93
24	NRC Letter, "Summary of May 5, 1993, Meeting with GPU Nuclear Corporation (GPUN) to Discuss Matters Related to the Oyster Creek Drywell Corrosion Mitigation Program	5/17/93
25	Calculation C-1302-187-5300-028, "Statistical Analysis of Drywell Thickness Data Thru September 1994" Rev. 0	12/2/94
26	SE No. 000243-002, "Drywell Steel Shell Plate Thickness Reduction," Rev. 14	8/2/95
27	Calculation C-1302-187-8610-030, "Statistical Analysis of Drywell Thickness Data Thru September 1996" Rev. 1	7/12/00
28	SE No. 320006-003, Application of Strippable Coating on Equipment Pool & Rx Cavity Liner, Rev. 2	8/16/00
29	S. Jäggi, H. Böhni and B. Elsener, "Macrocell Corrosion of Steel in Concrete - Experiments and Numerical Modeling," paper presented at Eurocorr 2001, Riva di Gardi, Italy	10/1/01
30	EPRI 1002950, "Aging Effects for Structures and Structural Components (Structural Tools), Revision 1	8/03
31	Calculation C-1302-187-E310-037, Revision 2 (includes raw data)	6/10/05

Ref. No.	Document	Document Date
	VOLUME 4	
32	Letter 2130-06-20289, Response to RAI 4.7.2-1	4/7/06
33	Response to NRC Aging Management Review Inspection Team Question No. AMR-164	4/19/06
34	Response to NRC Aging Management Review Inspection Team Question No. AMP-071	4/20/06
35	Response to NRC Aging Management Review Inspection Team Question No. AMP-210	4/20/06
36	NRC Letter, Summary of June 1, 2006 Meeting	6/9/06
37	Letter 2130-06-20353, Supplemental Information Related to the Aging Management Program for the Oyster Creek Drywell Shell, Associated with AmerGen's License Renewal Application	6/20/06
38	Letter 2130-06-20354, Updated FSAR Supplement Information Supporting the Oyster Creek Generating Station License Renewal Application	6/23/06
39	Letter 2130-06-20358, Additional Information Concerning FSAR Supplement Supporting the Oyster Creek Generating Station License Renewal Application	7/7/06
40	Letter 2130-06-20360 (CB&I drawing 9-0971 sheet 1)	7/7/06
41	IS-328227-004, "Functional Requirements for Drywell Containment Vessel Thickness Examination," Rev. 13	9/15/06
42	Calculation C-1302-187-5320-024, "OC Drywell Ext. UT Evaluation in Sandbed," Revision 1	9/21/06
43	Calculation C-1302-243-5320-071, Revision 2, "Drywell Thickness Margins"	9/21/06
44	ACRS Subcommittee Transcript Excerpts	10/3/06
45	Letter 2130-06-20414, AmerGen Response to Open Items Associated with the NRC Draft Safety Evaluation for the Oyster Creek Generating Station Application for License Renewal	10/20/06
46	Oyster Creek FSAR Section 3.8.2.8	Rev. 14
47	Letter 2130-06-20426, Information from October 2006 Refueling Outage Supplementing AmerGen Energy Company, LLC (AmerGen) Application for a Renewed Operating License for Oyster Creek Generating Station	12/3/2006
48	MNCR 92-0188, Sandbed Floor	12/28/92
49	MNCR 87-0240, Cavity Liner Defects	11/2/87

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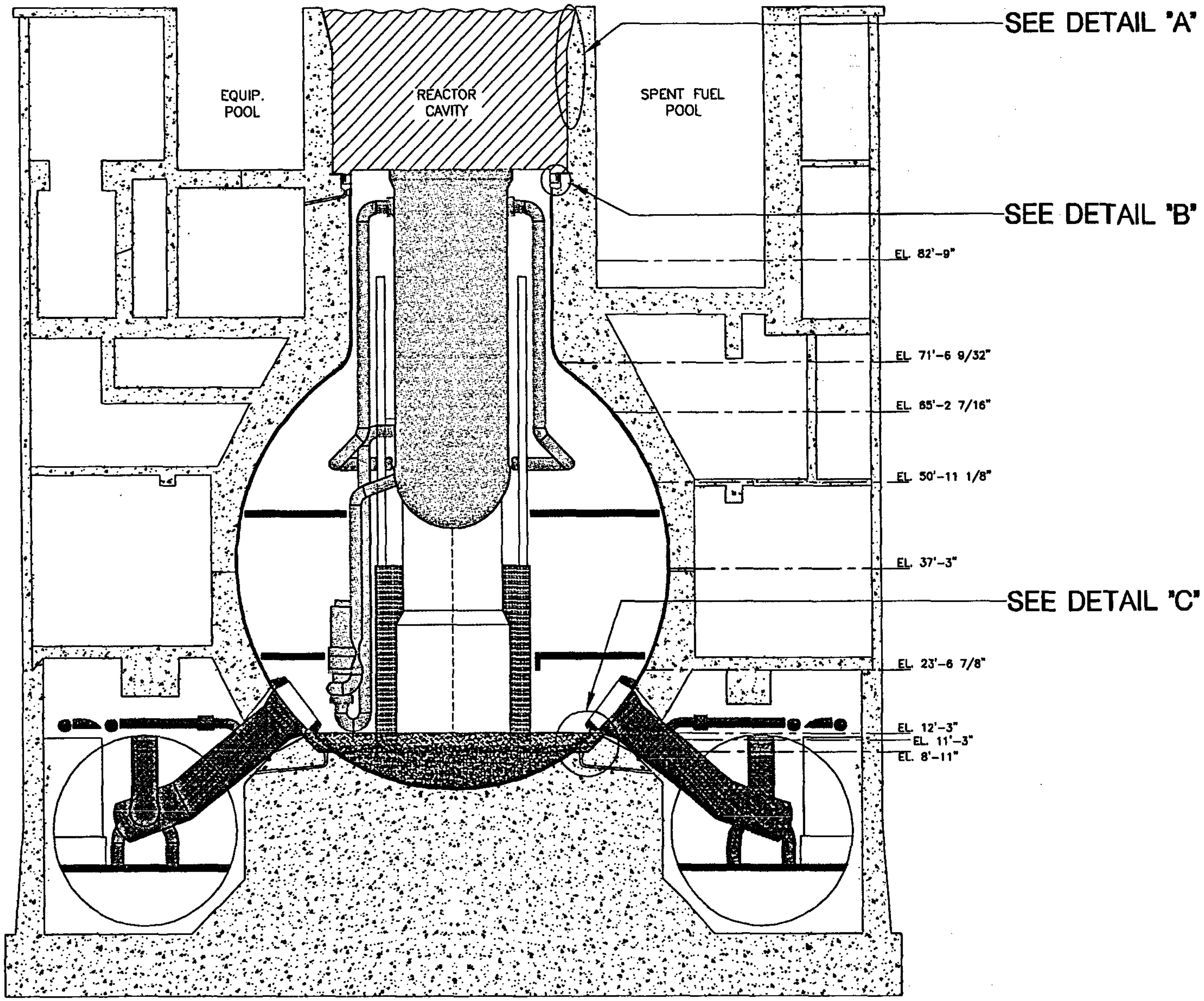
APPLICANT'S EXH. 4



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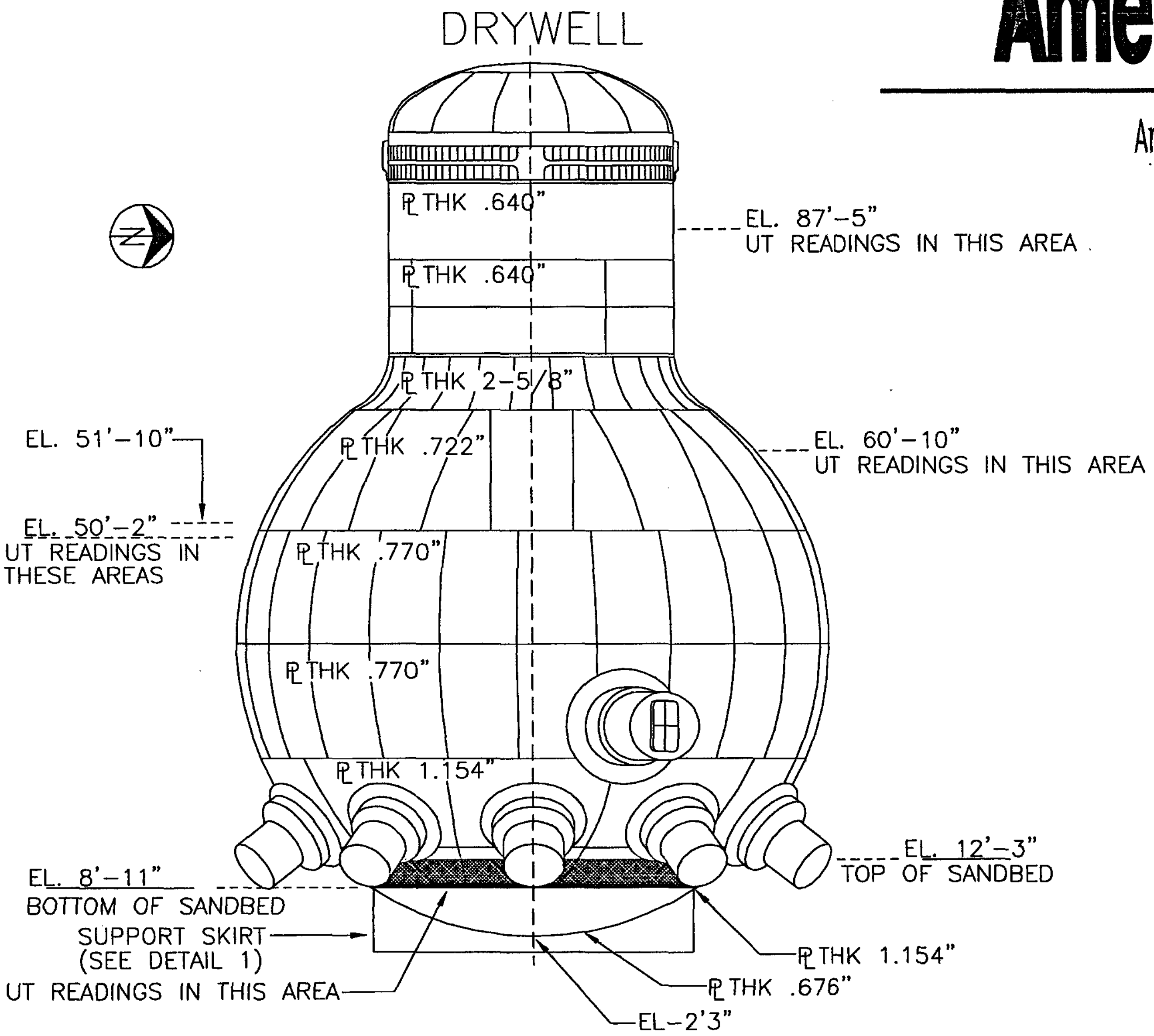

APPLICANT'S EXH. 6

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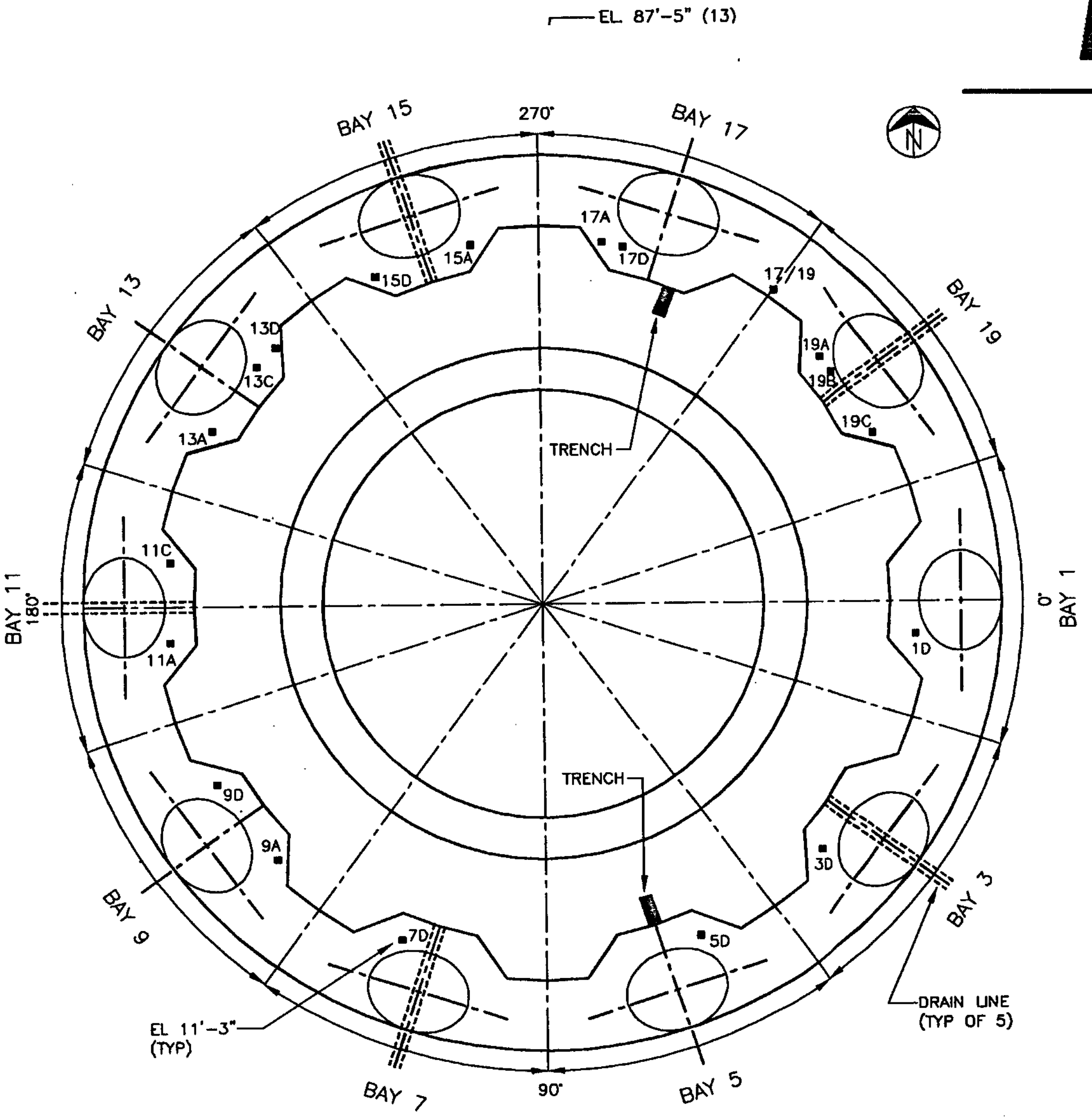

KEY PLAN

APPLICANT'S EXH. 7

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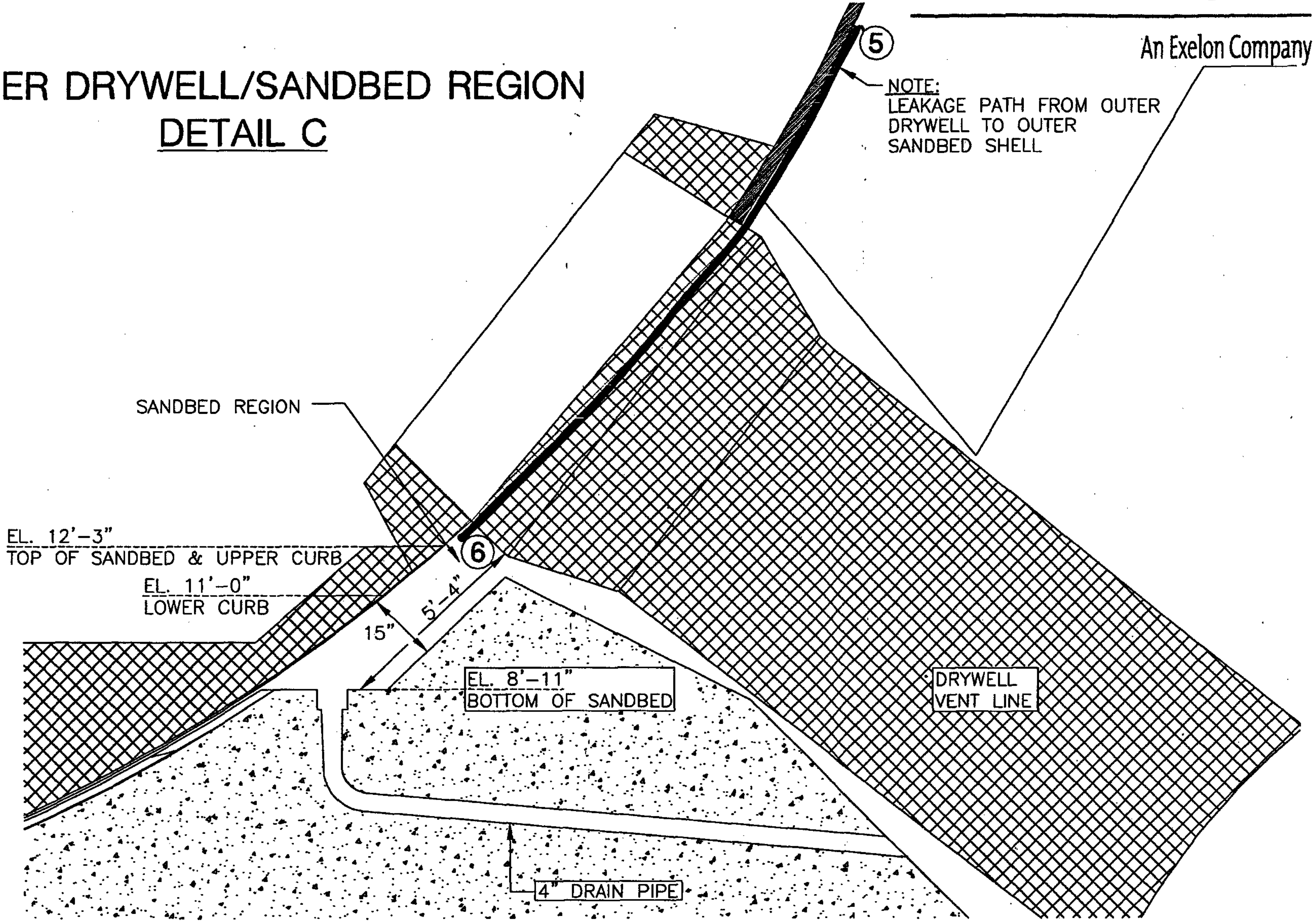
LOWER DRYWELL/SANDBED REGION
DETAIL C



APPLICANT'S EXH. 8

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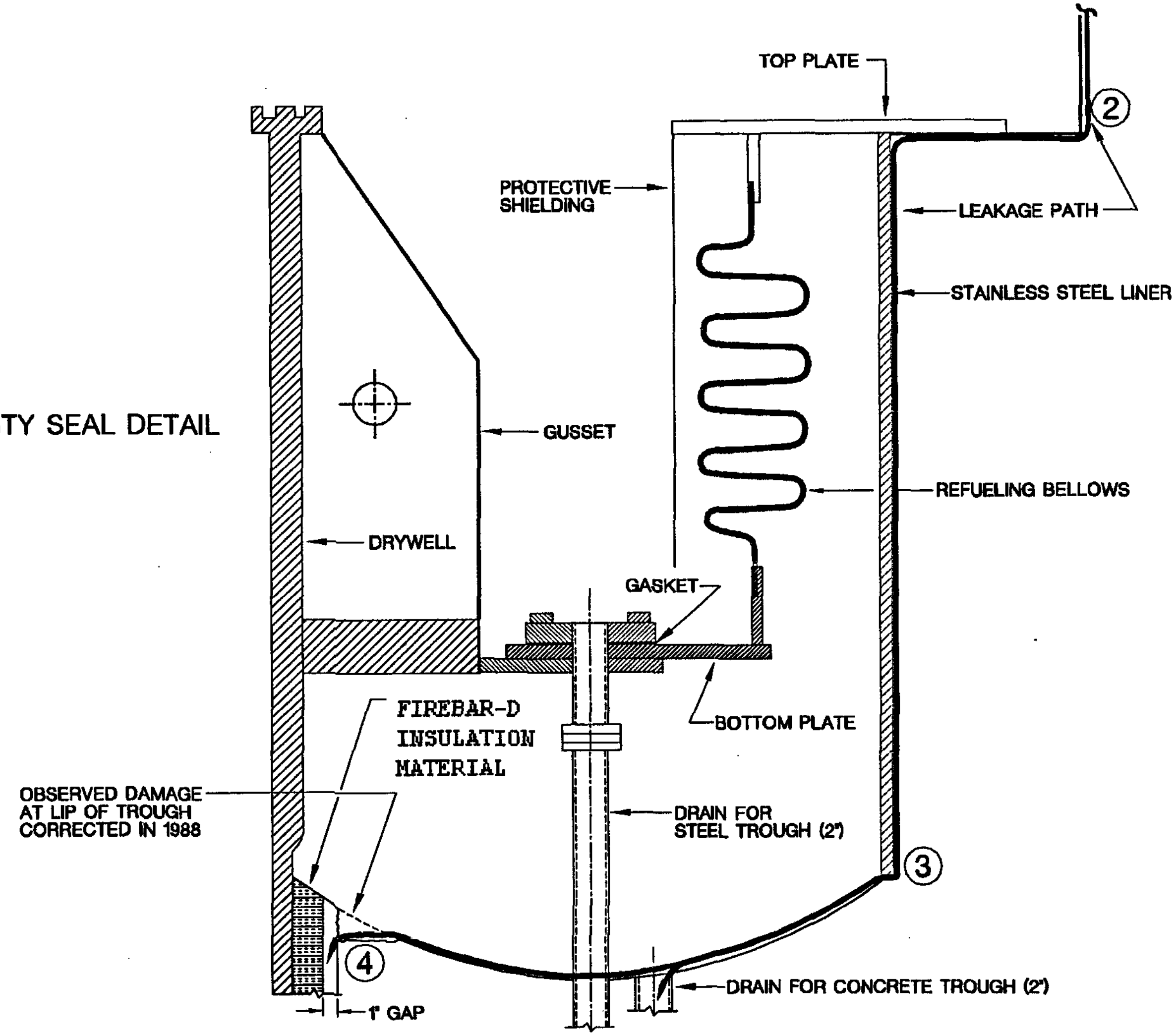
DRYWELL TO REACTOR CAVITY SEAL DETAIL
DETAIL "B"



APPLICANT'S EXH. 9

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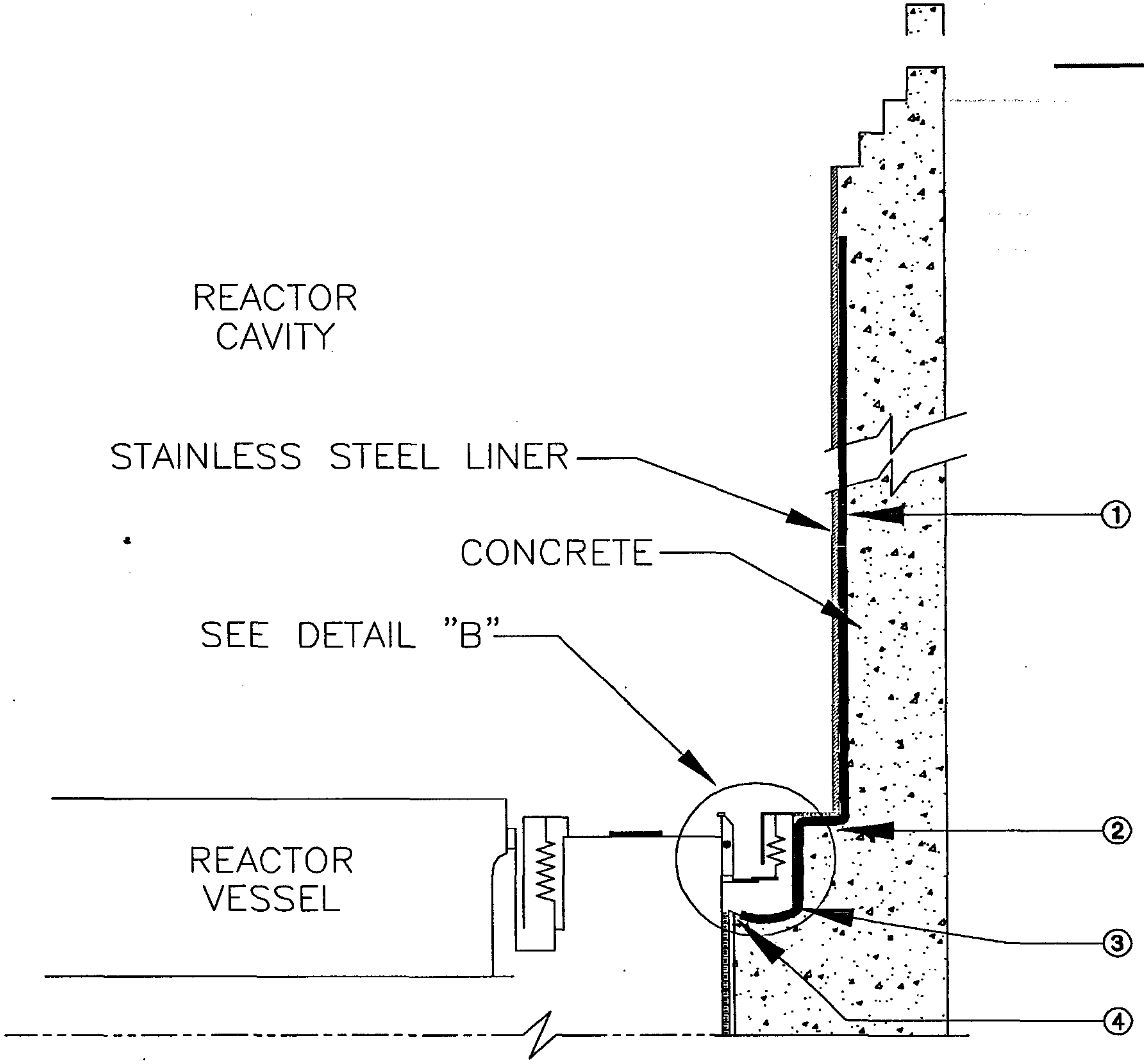

DRYWELL AND REACTOR CAVITY SECTION
DETAIL "A"

APPLICANT'S EXH. 10

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10 CFR 50
10 CFR 51
10 CFR 54

2130-07-20464
February 15, 2007

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Oyster Creek Generating Station
Facility Operating License No. DPR-16
NRC Docket No. 50-219

Subject: Additional Commitments Related to the Aging Management Program for the Oyster Creek Drywell Shell, Associated with AmerGen's License Renewal Application (TAC No. MC7624)

References:
1. January 18, 2007 Meeting Between ACRS License Renewal Subcommittee, AmerGen Energy Company, LLC and NRC Staff, related to License Renewal of Oyster Creek Generating Station
2. February 1, 2007 Meeting Between Full ACRS, AmerGen Energy Company, LLC and NRC Staff related to License Renewal of Oyster Creek Generating Station
3. ACRS Letter Dated February 8, 2007, Describing the Outcome of the February 1, 2007 ACRS Review of the Oyster Creek Generating Station License Renewal Application

In the Reference 1 meeting, AmerGen Energy Company, LLC (AmerGen) presented detailed information related to the condition of and aging management program activities for the primary containment drywell shell, as part of AmerGen's efforts to renew the operating license for the Oyster Creek Generating Station (OCGS). The Subcommittee identified several specific issues related to the drywell shell structural analysis and certain aspects of the program proposed by AmerGen to manage aging of the drywell shell for the extended period of operation.

During the full ACRS review of the Oyster Creek License Renewal Application (LRA) in the Reference 2 meeting, AmerGen presented its proposed responses to the issues identified by the Subcommittee in the January 18, 2007 meeting. In its February 1st presentation, AmerGen made three additional commitments to address these previous Subcommittee items. This letter documents these commitments.

In addition, AmerGen is making a commitment to perform the full scope of drywell sand bed region inspections, consistent with what was performed during the 2006 refueling outage, on a frequency of every other refueling outage. AmerGen believes that this commitment is

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responsive to a recommendation made by NRC Staff at the February 1, 2007 ACRS meeting, which was endorsed by the ACRS in its February 8, 2007 letter to the NRC Chairman.

The details of these four new commitments are provided in the Enclosure to this letter. The ASME Section XI, Subsection IWE Primary Containment Inspection aging management program (commitment 27) is modified to include these new commitments, and to clarify the effect of these new commitments on previously made IWE program commitments.

If you have any questions, please contact Fred Polaski, Manager License Renewal, at 610-765-5935.

I declare under penalty of perjury that the foregoing is true and correct.

Respectfully,

Executed on 02-15-07

Michael P. Gallagher
Michael P. Gallagher
Vice President, License Renewal
AmerGen Energy Company, LLC

Enclosure: Regulatory Commitments

cc: Regional Administrator, USNRC Region I
USNRC Project Manager, NRR - License Renewal, Safety
USNRC Project Manager, NRR - License Renewal, Environmental
USNRC Project Manager, NRR - Project Manager, OCGS
USNRC Senior Resident Inspector, OCGS
Bureau of Nuclear Engineering, NJDEP
File No. 05040

ENCLOSURE – REGULATORY COMMITMENTS

The following table identifies additions being made to item #27 of the License Renewal Commitment List, Table A.5 of the Oyster Creek LRA. Four commitments are being added to the ASME Section XI, Subsection IWE Primary Containment Inspection Program as part of this submittal. These new commitments are numbered to sequentially follow the commitments made in previous LRA correspondence as part of the IWE Inspection Program. The full set of commitments made as part of the IWE Program is repeated here for convenience. **Bold** font is used to highlight new information.

In addition, clarifications are made to certain previously made IWE Program commitments to indicate 1) commitments that were completed during the 2006 refueling outage and 2) the effects, if any, of the new commitments on the scope or frequency of previously made commitments. Again, **bold** font is used to highlight information introduced in this submittal.

ITEM NUMBER	COMMITMENT	UFSAR SUPPLEMENT LOCATION (LRA APP. A)	ENHANCEMENT OR IMPLEMENTATION SCHEDULE	SOURCE
27) ASME Section XI, Subsection IWE	Existing program is credited. The program will be enhanced to include: 1. Ultrasonic Testing (UT) thickness measurements of the drywell shell in the sand bed region will be performed on a frequency of every 10 years, except that the initial inspection will occur prior to the period of extended operation and the subsequent inspection will occur two refueling outages after the initial inspection, to provide early confirmation that corrosion has been arrested. The UT measurements will be taken from the inside of the drywell at the same locations where UT measurements were performed in 1996. The inspection results will be compared to previous results. Statistically significant deviations from the	A.1.27	Prior to the period of extended operation Prior to the period of extended operation **(completed during 2006 refueling outage); then every other refueling outage thereafter**	Section B.1.27

ITEM NUMBER	COMMITMENT	UFSAR SUPPLEMENT LOCATION (LRA APP. A)	ENHANCEMENT OR IMPLEMENTATION SCHEDULE	SOURCE
	1992, 1994, and 1996 UT results will result in corrective actions that include the following: • Perform additional UT measurements to confirm the readings. • Notify NRC within 48 hours of confirmation of the identified condition. • Conduct visual inspection of the external surface in the sand bed region in areas where any unexpected corrosion may be detected. • Perform engineering evaluation to assess the extent of condition and to determine if additional inspections are required to assure drywell integrity. • Perform operability determination and justification for operation until next inspection. These actions will be completed prior to restart from the associated outage. **Note: The frequency for the inspections described in commitment 1 (above) has been changed to every other refueling outage, in accordance with commitment 21 of the IWE Inspection Program.**			
	2. A strippable coating will be applied to the reactor cavity liner to prevent water intrusion into the gap between the drywell shield wall and the drywell shell during periods when the reactor cavity is flooded.		Refueling outages prior to and during the period of extended operation	

ITEM NUMBER	COMMITMENT	UFSAR SUPPLEMENT LOCATION (LRA APP. A)	ENHANCEMENT OR IMPLEMENTATION SCHEDULE	SOURCE
	3. The reactor cavity seal leakage trough drains and the drywell sand bed region drains will be monitored for leakage.		Periodically	
	• The sand bed region drains will be monitored daily during refueling outages. If leakage is detected, procedures will be in place to determine the source of leakage and investigate and address the impact of leakage on the drywell shell, including verification of the condition of the drywell shell coating and moisture barrier (seal) in the sand bed region and performance of UT examinations of the shell in the upper regions. UTs will also be performed on any areas in the sand bed region where visual inspection indicates the coating is damaged and corrosion has occurred. UT results will be evaluated per the existing program. Any degraded coating or moisture barrier will be repaired. These actions will be completed prior to exiting the associated outage.		Daily during refueling outages	
	• The sand bed region drains will be monitored quarterly during the plant operating cycle. If leakage is identified, the source of water will be investigated, corrective actions taken or planned as		Quarterly during non-outage periods	

ITEM NUMBER	COMMITMENT	UFSAR SUPPLEMENT LOCATION (LRA APP. A)	ENHANCEMENT OR IMPLEMENTATION SCHEDULE	SOURCE
	appropriate. In addition, if leakage is detected, the following items will be performed during the next refueling outage: • Inspection of the drywell shell coating and moisture barrier (seal) in the affected bays in the sand bed region • UTs of the upper drywell region consistent with the existing program • UTs will be performed on any areas in the sand bed region where visual inspection indicates the coating is damaged and corrosion has occurred • UT results will be evaluated per the existing program Any degraded coating or moisture barrier will be repaired.			
	4. Prior to the period of extended operation, AmerGen will perform additional visual inspections of the epoxy coating that was applied to the exterior surface of the Drywell shell in the sand bed region, such that the coated surfaces in all 10 Drywell bays will have been inspected at least once. In addition, the Inservice Inspection (ISI) Program will be enhanced to require inspection of 100% of the epoxy coating every 10 years during the period of		Prior to the period of extended operation **(completed during 2006 refueling outage); then every other refueling outage thereafter**	

ITEM NUMBER	COMMITMENT	UFSAR SUPPLEMENT LOCATION (LRA APP. A)	ENHANCEMENT OR IMPLEMENTATION SCHEDULE	SOURCE
	extended operation. These inspections will be performed in accordance with ASME Section XI, Subsection IWE. Performance of the inspections will be staggered such that at least three bays will be examined every other refueling outage. **Note: The scope and frequency for the inspections described in commitment 4 (above) has been changed to all 10 bays every other refueling outage, in accordance with commitment 21 of the IWE Inspection Program.**			
	5. A visual examination of the drywell shell in the drywell floor inspection access trenches will be performed to assure that the drywell shell remains intact. If degradation is identified, the drywell shell condition will be evaluated and corrective actions taken as necessary. In addition, one-time ultrasonic testing (UT) measurements will be taken to confirm the adequacy of the shell thickness in these areas. Beyond these examinations, these surfaces will either be inspected as part of the scope of the ASME Section XI, Subsection IWE inspection program or they will be restored to the original design configuration using concrete or other suitable material to prevent moisture collection in these areas. **Note: Commitment 5 (above) is supplemented by**		Prior to the period of extended operation **(completed during 2006 refueling outage)**	

ITEM NUMBER	COMMITMENT	UFSAR SUPPLEMENT LOCATION (LRA APP. A)	ENHANCEMENT OR IMPLEMENTATION SCHEDULE	SOURCE
	commitments 16 and 20 of the IWE Inspection Program.			
	6. The coating inside the torus will be visually inspected in accordance with ASME Section XI, Subsection IWE, per the Protective Coatings Program. The scope of each of these inspections will include the wetted area of all 20 torus bays. Should the current torus coating system be replaced, the inspection frequency and scope will, as a minimum, meet the requirements of ASME Section XI, Subsection IWE.		Every other refueling outage prior to **(completed during 2006 refueling outage)** and during the period of extended operation	
	7. AmerGen will conduct UT thickness measurements in the upper regions of the drywell shell every other refueling outage at the same locations as are currently measured.		Every other refueling outage prior to **(completed during 2006 refueling outage)** and during the period of extended operation	
	8. The IWE Program will be credited for managing corrosion in the Torus Vent Line and Vent Header exposed to an Indoor Air (External) environment.			
	9. During the next UT inspections to be performed on the drywell sand bed region (reference AmerGen 4/4/06 letter to NRC), an attempt will be made to locate and evaluate some of the locally thinned		Prior to the period of extended operation **(completed during 2006 refueling**	

ITEM NUMBER	COMMITMENT	UFSAR SUPPLEMENT LOCATION (LRA APP. A)	ENHANCEMENT OR IMPLEMENTATION SCHEDULE	SOURCE
	areas identified in the 1992 inspection from the exterior of the drywell. This testing will be performed using the latest UT methodology with existing shell paint in place. The UT thickness measurements for these locally thinned areas may be taken from either inside the drywell or outside the drywell (sand bed region) to limit radiation dose to as low as reasonably achievable (ALARA). **Note: Commitment 9 (above) is supplemented by commitments 14 and 21 of the IWE Inspection Program.**		**outage); then every other refueling outage thereafter**	
	10. AmerGen will conduct UT thickness measurements on the 0.770 inch thick plate at the junction between the 0.770 inch thick and 1.154 inch thick plates, in the lower portion of the spherical region of the drywell shell. These measurements will be taken at four locations using the 6"x6" grid. The specific locations to be selected will consider previous operational experience (i.e., will be biased toward areas that have had corrosion or leakage). These measurements will be performed prior to the period of extended operation and repeated at the second refueling outage after the initial inspection, at the same location. If corrosion in this transition area is greater than areas monitored in the upper drywell, UT inspections in the transition area will be performed on the same frequency as those in the		Prior to the period of extended operation and two refueling outages later	

ITEM NUMBER	COMMITMENT	UFSAR SUPPLEMENT LOCATION (LRA APP. A)	ENHANCEMENT OR IMPLEMENTATION SCHEDULE	SOURCE
	upper drywell (every other refueling outage).			
	11. AmerGen will conduct UT thickness measurements in the drywell shell "knuckle" area, on the 0.640 inch thick plate above the weld to the 2.625 inch thick plate. These measurements will be taken at four locations using the 6"x6" grid. The specific locations to be selected will consider previous operational experience (i.e., will be biased toward areas that have had corrosion or leakage). These measurements will be performed prior to the period of extended operation and repeated at the second refueling outage after the initial inspection, at the same location. If corrosion in this transition area is greater than areas monitored in the upper drywell, UT inspections in the transition area will be performed on the same frequency as those in the upper drywell (every other refueling outage).		Prior to the period of extended operation and two refueling outages later	
	12. When the sand bed region drywell shell coating inspection is performed **(item 27, commitments** 4 **and 21)**, the seal at the junction between the sand bed region concrete and the embedded drywell shell will be inspected per the Protective Coatings Program. **Note: The frequency for the inspections described in commitment 12 (above) has been changed to every other refueling outage, in**		**Prior to the period of extended operation (completed during 2006 refueling outage); then every other refueling outage thereafter**	

ITEM NUMBER	COMMITMENT	UFSAR SUPPLEMENT LOCATION (LRA APP. A)	ENHANCEMENT OR IMPLEMENTATION SCHEDULE	SOURCE
	accordance with commitment 21 of the IWE Inspection Program.			
	13. The reactor cavity concrete trough drain will be verified to be clear from blockage once per refueling cycle. Any identified issues will be addressed via the corrective action process.		Once per refueling cycle	
	14. UT thickness measurements will be taken from outside the drywell in the sandbed region during the 2008 refueling outage on the locally thinned areas examined during the October 2006 refueling outage. The locally thinned areas are distributed both vertically and around the perimeter of the drywell in all ten bays such that potential corrosion of the drywell shell would be detected. **Note: The frequency for the inspections described in commitment 14 (above) has been changed to every other refueling outage, in accordance with commitment 21 of the IWE Inspection Program.**		During the 2008 refueling outage **and every other refueling outage thereafter**	
	15. Starting in 2010, drywell shell UT thickness measurements will be taken from outside the drywell in the sandbed region in two bays per outage, such that inspections will be performed in all 10 bays		**All 10 bays will be inspected during the 2008 refueling outage and every other**	

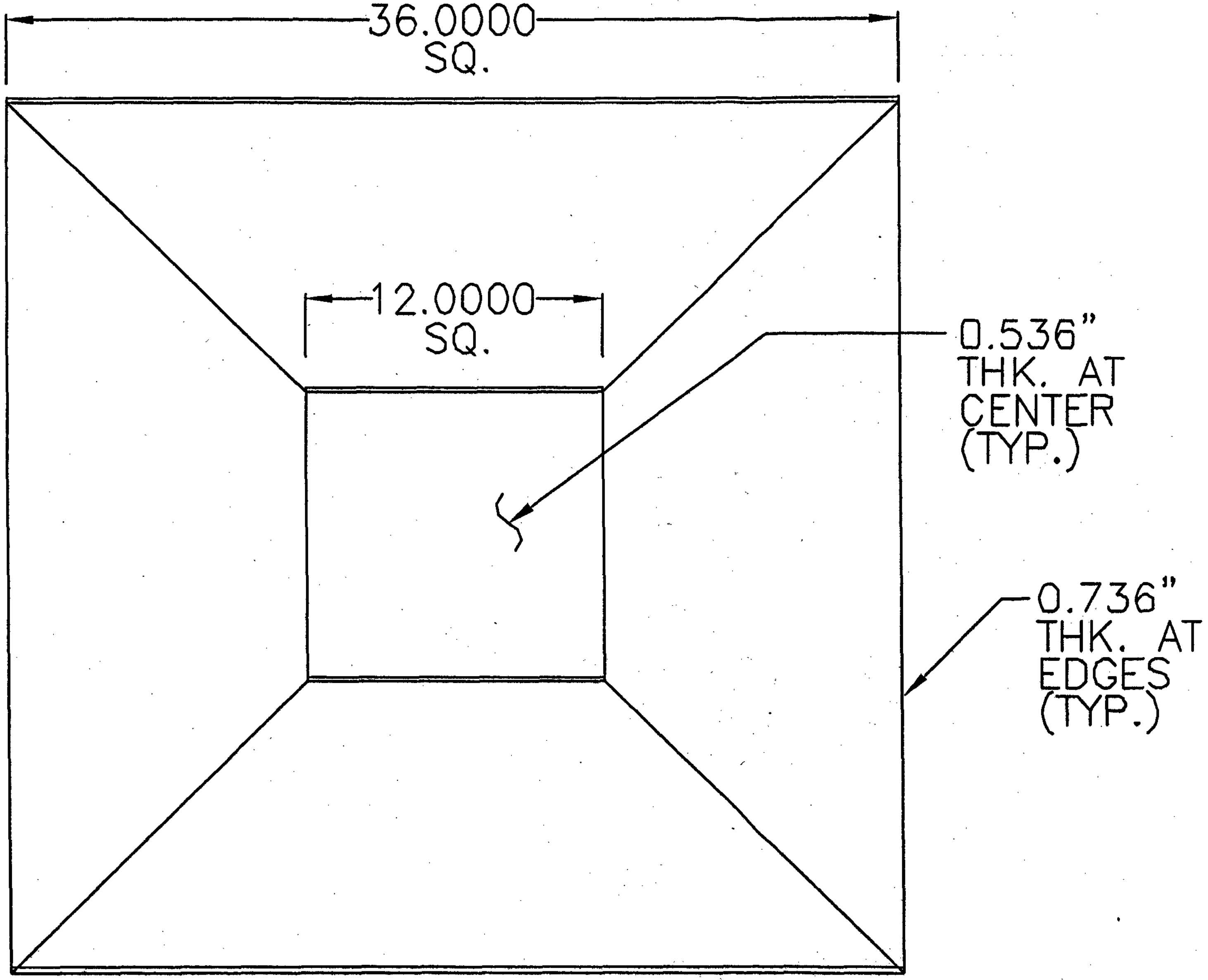
ITEM NUMBER	COMMITMENT	UFSAR SUPPLEMENT LOCATION (LRA APP. A)	ENHANCEMENT OR IMPLEMENTATION SCHEDULE	SOURCE
	within a 10-year period. The two bays with the most locally thinned areas (bay #1 and bay #13) will be inspected in 2010. If the UT examinations yield unacceptable results, then the locally thinned areas in all 10 bays will be inspected in the refueling outage that the unacceptable results are identified. **Note: The scope and frequency for the inspections described in commitment 15 (above) have been changed to all 10 bays every other refueling outage, in accordance with commitment 21 of the IWE Inspection Program.**		**refueling outage thereafter.**	
	16. Perform visual inspection of the drywell shell inside the trenches in bay #5 and bay #17 and take UT measurements inside these trenches in 2008 at the same locations examined in 2006. Repeat (both the UT and visual) inspections at refueling outages during the period of extended operation until the trenches are restored to the original design configuration using concrete or other suitable material to prevent moisture collection in these areas. **Note: Commitment 16 (above) is supplemented by commitment 20 of the IWE Inspection Program.**		During the 2008 refueling outage and subsequent **refueling** outages until trenches are restored to original configuration	

ITEM NUMBER	COMMITMENT	UFSAR SUPPLEMENT LOCATION (LRA APP. A)	ENHANCEMENT OR IMPLEMENTATION SCHEDULE	SOURCE
	17. Perform visual inspection of the moisture barrier between the drywell shell and the concrete floor/curb, installed inside the drywell during the October 2006 refueling outage, in accordance with ASME Section XI, Subsection IWE during the period of extended operation.		In accordance with ASME Section XI, Subsection IWE	
	18. AmerGen will perform a 3-D finite element structural analysis of the primary containment drywell shell using modern methods and current drywell shell thickness data to better quantify the margin that exists above the Code required minimum for buckling. The analysis will include sensitivity studies to determine the degree to which uncertainties in the size of thinned areas affect Code margins. If the analysis determines that the drywell shell does not meet required thickness values, the NRC will be notified in accordance with 10 CFR 50 requirements.		**Prior to the period of extended operation**	
	19. AmerGen will perform an engineering study to investigate cost-effective replacement or repair options to eliminate or reduce reactor cavity liner leakage.		**Prior to the period of extended operation**	
	20. AmerGen is committed to perform visual and UT inspections of the drywell shell in the inspection trenches in drywell bays 5 and 17 during the		**Every refueling outage until trenches are restored**	

ITEM NUMBER	COMMITMENT	UFSAR SUPPLEMENT LOCATION (LRA APP. A)	ENHANCEMENT OR IMPLEMENTATION SCHEDULE	SOURCE
	Oyster Creek 2008 refueling outage (see commitment 16 of AmerGen's IWE Program (item 27), made in its letter 2130-06-20426). AmerGen will extend this commitment and also perform these inspections during the 2010 refueling outage. In addition, AmerGen will monitor the two trenches for the presence of water during refueling outages. Visual and UT inspections of the shell within the trenches will continue to be performed until no water is identified in the trenches for two consecutive refueling outages, at which time the trenches will be restored to their original design configuration (e.g., refilled with concrete) to minimize the risk of future corrosion.			
	21. Perform the full scope of drywell sand bed region inspections prior to the period of extended operation and then every other refueling outage thereafter. The full scope is defined as: • UT measurements from inside the drywell (commitment 1) • Visual inspections of the drywell external shell epoxy coating in all 10 bays (commitment 4) • Inspection of the seal at the junction between the sand bed region concrete and the embedded drywell shell (commitment		During the 2008 refueling outage and every other refueling outage thereafter. If the analysis being performed under commitment 18 above establishes increased margin, or if ongoing inspections continue to demonstrate that drywell shell	

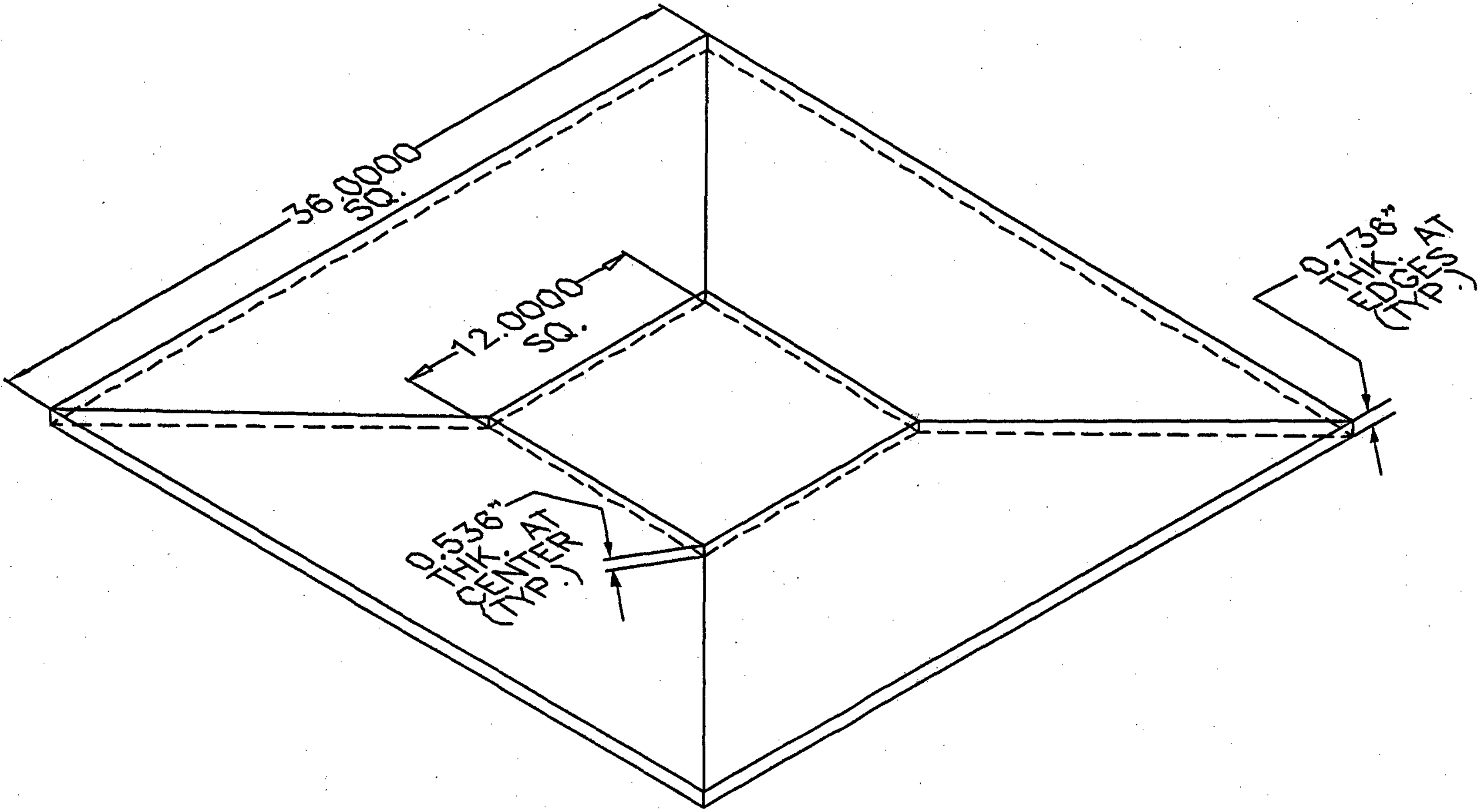
ITEM NUMBER	COMMITMENT	UFSAR SUPPLEMENT LOCATION (LRA APP. A)	ENHANCEMENT OR IMPLEMENTATION SCHEDULE	SOURCE
	12) • UT measurements at the external locally thinned areas inspected in 2006 (commitments 9 and 14)		corrosion has been sufficiently arrested, the period between inspections may be increased to minimize personnel radiation exposure.	

APPLICANT'S EXH. 11



"TRAY" FRONT VIEW

SCALE: 2" =1'-0"



"TRAY"
ISOMETRIC VIEW

APPLICANT'S EXH. 12

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10 CFR 50
10 CFR 51
10 CFR 54

2130-06-20426
December 3, 2006

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Oyster Creek Generating Station
Facility Operating License No. DPR-16
NRC Docket No. 50-219

Subject: Information from October 2006 Refueling Outage Supplementing AmerGen Energy Company, LLC (AmerGen) Application for a Renewed Operating License for Oyster Creek Generating Station (TAC No. MC7624)

References:

1. AmerGen's "Application for Renewed Operating License," Oyster Creek Generating Station, Letter 2130-05-20135, dated July 22, 2005
2. AmerGen's "Response to NRC Request for Additional Information, dated March 10, 2006, Related to Oyster Creek Generating Station License Renewal Application (TAC No. MC7624)," Letter 2130-06-20289, dated April 7, 2006
3. AmerGen's "Supplemental Information Related to the Aging Management Program for the Oyster Creek Drywell Shell, Associated with AmerGen's License Renewal Application (TAC No. MC7624)," Letter 2130-06-20353, dated June 20, 2006
4. AmerGen's "Additional Information Concerning FSAR Supplement Supporting the Oyster Creek Generating Station License Renewal Application (TAC No. MC7624)," Letter 2130-06-20358, dated July 7, 2006

In References 1 through 4, AmerGen provided detailed information describing aging management reviews, aging management programs and commitments for future actions associated with the primary containment drywell shell, as part of its license renewal application (LRA) for the Oyster Creek Generating Station (Oyster Creek). In its recently completed Oyster Creek refueling outage, AmerGen performed many of the drywell shell inspection activities that it had committed to perform prior to the period of extended operation.

Per 10 C.F.R. § 54.21, this submittal serves to update the LRA and the other referenced submittals with the results of the 2006 outage activities. For ease of review, various sections of the original LRA and related responses to NRC requests for additional information (RAIs) have been updated to reflect the latest information. To a great extent, the information learned during this outage confirmed the condition of the drywell as described in previous submittals.

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However, as a result of performing planned inspections of the internal surface of the drywell shell in the trenches excavated in the concrete floor in 1986, AmerGen identified an environment/material/aging effect combination that was not included in the LRA. Aging management reviews of this combination have been performed and, as a result, AmerGen has identified additional aging management activities that will be included in aging management programs associated with the drywell.

The Enclosure to this letter more fully describes these reviews and resultant aging management activities. Updates to the affected portions of the LRA are provided, including a revision to the License Renewal Commitment List (LRA Appendix A, Section A.5). The Commitment List update clearly indicates the activities that are being added as part of this submittal.

AmerGen has performed a review to determine whether any additional aspects of the LRA require updating, given the recent identification of a new environment requiring evaluation in support of license renewal. Based on its review, AmerGen concludes that there are no additional revisions required to the LRA. This review has been documented in the corrective action program.

In addition, a consolidated summary of key drywell-related inspections conducted during the outage, with a summary of the results, is provided in the Enclosure.

If you have any questions, please contact Fred Polaski, Manager License Renewal, at 610-765-5935.

I declare under penalty of perjury that the foregoing is true and correct.

Respectfully,

Executed on 12/03/2006

Michael P. Gallagher

Michael P. Gallagher
Vice President, License Renewal
AmerGen Energy Company, LLC

Enclosure: LRA Supplemental Information, Post-2006 Refueling Outage

cc: Regional Administrator, USNRC Region I, w/ Enclosures
USNRC Project Manager, NRR - License Renewal, Safety, w/Enclosures
USNRC Project Manager, NRR - License Renewal, Environmental, w/o Enclosures
USNRC Project Manager, NRR - Project Manager, OCGS, w/o Enclosures
USNRC Senior Resident Inspector, OCGS, w/ Enclosures
Bureau of Nuclear Engineering, NJDEP, w/Enclosures
File No. 05040

Enclosure

License Renewal Application
Supplemental Information
Post-2006 Refueling Outage

Oyster Creek Generating Station
License Renewal Application (TAC No. MC7624)

Note: **Bold font has been used to designate additions made by this submittal to previously submitted documents.**

Monitoring and Maintenance Program. These inspections would have documented any flaking, blistering, peeling, discoloration, and other signs of degradation of the coating. The VT-1 inspections found the coating to be in good condition with no degradation.

Based on these VT-1 inspections, AmerGen has confirmed that no further corrosion of the drywell shell is occurring from the exterior of the epoxy-coated sandbed region. Monitoring of the coating in accordance with the ASME Section XI, Subsection IWE and AmerGen's Protective Coating Monitoring and Maintenance Program will continue to ensure that the drywell shell maintains its intended function during the period of extended operation.

Also during the 2006 refueling outage (1R21), AmerGen performed UT of the drywell shell in the sandbed region from inside the drywell, at the same 19 grid locations where UT was performed in 1992, 1994, and 1996. Location of the UT grid is centered at elevation 11'-3" in an area of the drywell shell that corresponds to the sandbed region. The 2006 UT measurements were made and statistically analyzed in accordance with the enhanced Oyster Creek ASME Section XI, Subsection IWE (B1.27) Aging Management Program. The results of the statistical analysis of the 2006 UT data were compared to the 1992, 1994 and 1996 data statistical analysis results (see below). Some of the 1996 data contained anomalies that are not readily justifiable but the anomalies did not significantly change the results. The comparison confirmed that corrosion on the exterior surfaces of the drywell shell in the sandbed region has been arrested.

Analysis of the 2006 UT data, at the 19 grid locations, indicates that the minimum measured 95% confidence level mean thickness in any bay is 0.807" (bay #19). This is compared to the 95% confidence level minimum measured mean thickness in bay #19 of 0.806" and 0.800" measured in 1994 and 1992 respectively. Considering the instrument accuracy of ±0.010" these values are considered equivalent. Thus the minimum drywell shell mean thickness at the grid locations remains greater than 0.736" as required to satisfy the worst case buckling analysis, and the minimum available margin of 64 mils for any bay reported prior to taking 2006 UT thickness measurements remains bounded.

In addition to the UT measurements at the 19 grid locations, a total of 294 UT thickness measurements were taken in the bay #5 trench and 290 measurements were taken in the bay #17 trench during the 2006 refueling outage. The computed mean thickness value of the drywell shell taken within the two trenches is 1.074" for bay #5 and 0.986" for bay #17. These values, when compared to the 1986 mean thickness values of 1.112" for the bay #5 trench and 1.024" for the bay #17 trench, indicated that wall thinning of approximately 0.038" has taken place in each trench since 1986. Engineering evaluation of the results concluded that considering that the exterior surface of bay #5 had experienced a corrosion rate of up to 11.3 mils/yr between 1986 and 1992 and the exterior surface of bay #17 had experienced a corrosion rate of up to 21.1 mils/yr in the same period, the 0.038" wall thinning measured in 2006 is due to corrosion on the exterior surface of the drywell between 1986 and 1992.

Additionally the 95% confidence level minimum computed drywell shell mean thickness based on 2006 UT measurements within the two trenches is greater by a margin of 250 mils than the minimum required thickness of 0.736" for buckling. Also this margin is significantly greater than the minimum computed margin outside the trenches (64 mils). Individual points within the two trenches met the local thickness acceptance criterion of 0.490"for pressure computed based on ASME Section III, Subsection NE, Class MC Components, Paragraph 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 individual points also met a local buckling criterion of 0.536" previously established by engineering analysis.

The above UT thickness measurements were supplemented by additional UT measurements taken at 106 points from outside the drywell in the sandbed region, distributed among the ten bays. The locations of these measurements were established in 1992 as being the thinnest local areas based on visual inspection of the exterior surface of the drywell shell before it was coated. The thinnest location measured in 2006 is 0.602" versus 0.618" measured in 1992. The difference between the two measurements does not necessarily mean a wall thinning of 0.016" has taken place since 1992. This is because the 2006 UT data could not be compared directly with the 1992 data due to the difference in UT instruments and measurement technique used in 2006, and the uncertainty associated with precisely locating the 1992 UT points. A review of the 2006 data for the 106 external locations indicated that the measured local thickness is greater than the local acceptance criteria of 0.490" for pressure and 0.536" for local bucking.

As stated above, the 2006 UT data of the locally thinned areas (106 points) could not be correlated directly with the corresponding 1992 UT data. This is largely due to using a more accurate UT instrument and the procedure used to take the measurements, which involved moving the instrument within the locally thinned area in order to locate the minimum thickness in that area. In addition the inner drywell shell surface could be subject to some insignificant corrosion due to water intrusion onto the embedded shell (see discussion below). For these reasons the Oyster Creek ASME Section XI, Subsection IWE Program (B.1.27) will be further enhanced to require UT measurements of the locally thinned areas

APPLICANT'S EXH. 13

AmerGen.℠

An Exelon Company

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10 CFR 50
10 CFR 51
10 CFR 54

2130-06-20290
April 7, 2006

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Oyster Creek Generating Station
Facility Operating License No. DPR-16
NRC Docket No. 50-219

Subject: Response to NRC Request for Additional Information, dated March 10, 2006, Related to Oyster Creek Generating Station License Renewal Application (TAC No. MC7624)

Reference: "Request for Additional Information for the Review of the Oyster Creek Nuclear Generating Station, License Renewal Application (TAC No. MC7624)," dated March 10, 2006

In the referenced letter, the NRC requested additional information related to Sections B.1.12, B.2.3, 2.3, and 3.3 of the Oyster Creek Generating Station License Renewal Application (LRA). Enclosed are the responses to this request for additional information.

If you have any questions, please contact Fred Polaski, Manager License Renewal, at 610-765-5935.

I declare under penalty of perjury that the foregoing is true and correct.

Respectfully,

Executed on 04-07-06

Michael P. Gallagher
Vice President, License Renewal
AmerGen Energy Company, LLC

Enclosure: Response to 03/10/06 Request for Additional Information

cc: Regional Administrator, USNRC Region I, w/o Enclosure
USNRC Project Manager, NRR - License Renewal, Safety, w/Enclosure
USNRC Project Manager, NRR - License Renewal, Environmental, w/o Enclosure
USNRC Project Manager, NRR - OCGS, w/o Enclosure
USNRC Senior Resident Inspector, OCGS, w/o Enclosure
Bureau of Nuclear Engineering, NJDEP, w/Enclosure
File No. 05040

A114

Enclosure

Response to 3/10/06 Request for Additional Information
Oyster Creek Generating Station
License Renewal Application (TAC No. MC7624)

RAI B.1.12-1
RAI B.2.3-1
RAI 2.3.1.6-1
RAI 2.3.1.7-1
RAI 3.3.2.1.16-1
RAI 2.3.3.36-1

Corrosion in the sand bed region

The high rate of corrosion in the sand bed region was attributed to galvanic corrosion of the drywell shell caused by water retained in the sand because of lack of proper drainage. To reduce the corrosion rate, Oyster Creek initiated several corrective actions as described in item (c) below. Evaluation of these corrective actions concluded that the most effective action to reduce corrosion rate is to remove the sand from sand bed region and protect the drywell shell from additional corrosion by applying a protective coating.

Location of the UT measurements was not based on a sampling process. Instead the locations were based on UT measurements taken at all accessible locations that correspond to the sand bed region from inside the drywell to establish the thinnest area. After sand was removed in 1992, and prior to coating the shell, thickness measurements were taken in each of the 10 bays, from outside the drywell, to establish the minimum general and local thickness of the thinned shell. The measurements from inside the drywell showed that the minimum general thickness of the sand bed region is 0.800 inches, and the minimum local thickness is 0.618 inches. The measurements from outside the drywell in the sand bed region showed that the minimum general thickness is generally greater than 0.800 inches. There were local areas where the thickness is less than 0.800 inches. However the minimum average thickness in these areas is greater than 0.736 inches, which is required for satisfying ASME Code requirements. The minimum local thickness measured from outside the sand bed region is 0.603 inches. Considering measurement and instrument accuracies, it is concluded that locations examined from inside the drywell represent the condition of the sand bed region.

The results of these measurements and subsequent analysis, which considered all design basis loads and load combinations, confirmed that the "as found" condition of the drywell shell thickness satisfies ASME Section III minimum thickness requirements. Additional thickness measurements taken at all accessible locations (total of 19) from inside the drywell in 1992, 1994, and 1996 show no corrosion, or no significant corrosion (see Table -2). In addition, inspection of the protective coating on exterior surfaces of the drywell shell in the sand bed region, every other refueling outage, shows no degradation of the coating or the underlying shell.

Corrosion of the upper region, above the sand bed region

Based on the results of approximately 1000 UT measurements, Oyster Creek continued to monitor elevations 50'-2", and 87'-5" in the regions above the sand bed region. A third elevation, 51'-10", was added to the scope of inspection after it was determined that the supplied plate thickness is slightly less than the adjacent 50'-2". For each elevation, UT measurements spaced approximately 1" within a 6"x6" array were taken from inside the drywell around the entire perimeter of each elevation. Engineering evaluation of the UT results concluded that monitoring of 12 locations would represent the drywell shell condition and provide reasonable assurance that significant corrosion would be detected prior to a loss of an intended function. This is because the 12 locations were selected considering the degree of drywell shell thinning and the minimum required thickness to satisfy ASME stress requirements. The locations are, 7 locations 50'-2", 3 locations at elevation 87'-5", and 2 locations at elevation 51'-10". These locations are inspected from the inside of the drywell shell on a frequency of every other refueling outage.

In response to NRC Staff concern regarding whether the inspected locations represent the condition of the entire drywell, in 1990 GPU prepared a new random UT inspection plan (also known as augmented inspection) designed to address the concern. The plan was based on a non-parametric statistical approach using attribute sampling that assumes no prior knowledge of the distribution of corrosion above the sand bed region. It consisted of random UT testing of 57 plates using the 6"x6" grid. Acceptance criteria are that the mean and local thickness of the shell equals or exceeds the required minimum thickness plus a corrosion allowance necessary in order to reach the next inspection.

Inspection results using the new random inspection plan confirmed that previously monitored locations bound the condition of the drywell above the sand bed region; except one location at elevation 60'-10". This elevation was added to elevations 50'-2", 51'-10", and 87'-5" and monitored on the frequency of every other refueling outage since identified in 1992.

The augmented inspection plan, the original inspection plan, and justification for sampling techniques and statistical methodology were submitted to the NRC on November 26, 1990. In its Safety Evaluation dated November 1, 1995, the Staff noted that the licensee provided a table of UT measurement results from the 15th refueling outage inspection. This table shows the locations of the measurements, the nominal as-constructed thickness, the minimum as-measured thickness, the ASME Code required thickness and the corrosion margin available at the time. The Staff found the current program, based on the submitted information acceptable. The Staff also noted in the Safety Evaluation that since water leaking from the pools above the reactor cavity has been the cause of corrosion, the licensee should make a commitment to the effect that an additional inspection of the drywell will be performed about 3 months after discovery of significant water leakage onto the outside of the drywell shell. Oyster Creek is committed to inspect the drains for leakage during refueling outages and during plant operation. The source of water leakage will be investigated and appropriate corrective actions taken, including an evaluation of the drywell shell to ensure drywell integrity. A review of plant documentation did not provide objective evidence that the commitment has been implemented since 1998. Issue Report #348545 was issued in accordance with Oyster Creek corrective action process to document the lapse in implementing the commitment and to reinforce strict compliance with commitment implementation in the future.

During a recent walkdown of the torus by the system engineer, water was found in three 5-gallon containers that are installed to collect water leakage from the sand bed drains. Two of the 3 containers were found nearly full. The third container was approximately half full. Inspection of the drain lines shows that the lines are currently dry and that water in the containers is not due to a current water leakage.

The containers are closed such that their overflow is unlikely as confirmed by no water ponding on the floor. Thus it is concluded with reasonable assurance that the volume of water is limited to what is contained in the containers. This small amount of water is not expected to have significant impact on the drywell shell and on the coating of the shell since the coating is designed for submerged environment. Furthermore, inspection of sand bed region coating conducted in 2004 did not indicate coating degradation or indications of drywell shell corrosion. Similarly, UT examinations on the upper region of the drywell showed a decrease in the corrosion rate since the previous inspection in 2000. Thus, the small volume of water found in the bottles should not have created an environment that would result in significant corrosion to the drywell shell. Issue Report #00470325 was issued, in accordance with Oyster Creek corrective action process, to investigate the source of water and evaluate its impact on the drywell shell.

Based on the discussion above and as indicated in the tables supplied in response to item d) below, Oyster Creek concluded that drywell corrosion is effectively managed both during the current and proposed renewed terms of plant operation. The monitored locations under the current term were subject to extensive UT measurements conducted over several years. NRC Staff found the sampling methodology to identify these locations, and the results of inspections, acceptable for the current term. The same locations will be inspected during the extended period of operation.

In summary Oyster Creek has conducted extensive examinations to identify the cause of drywell corrosion, employed a robust sampling process, quantified with reasonable assurance the extent of drywell shell thinning due to corrosion, and assessed its impact on the drywell structural integrity.

Water intrusion into the gap between the drywell shell and the drywell shield wall was identified as the cause for corrosion. Corrective actions have been taken to mitigate corrosion in the sand bed region and in the upper region of the drywell. Corrosion of the drywell shell in the sand bed region has been arrested. These actions also have effectively reduced the rate of corrosion to a negligible amount in the upper region as demonstrated by UT thickness measurements (see Table-1, and Table-2). Oyster Creek and its consultants performed stress and buckling analyses considering all design basis loads and load combinations. The results of these analyses indicate that buckling controls the minimum drywell shell thicknesses in the sand bed region while areas above the sand bed region are controlled by accident pressure membrane stresses. In both cases, the minimum measured drywell shell thickness satisfies ASME Section III requirements.

(b) The factors considered in establishing the minimum required drywell thickness at various elevations of the drywell are described in detail in engineering analyses documented in two GE Reports, Index No. 9-1, 9-2, and 9-3, 9-4. Report Index No. 9-1, 9-2 was generated for the drywell condition with sand in the sand bed region and Report Index No. 9-3, 9-4 is for the drywell condition without sand in the sand bed region (see Attachment 2 &3) The two reports were transmitted to the NRC Staff in December 1990 and in 1991 respectively. Report Index No. 9-3, 9-4 was revised later to correct errors identified during an internal audit and was resubmitted to the Staff in January 1992. Analysis described in Report Index No. 9-3, 9-4 (i.e., without sand) is the current applicable analysis to the drywell.

The analysis is based on the original Code of record, ASME Code, Section VIII, and Code Cases 1270N-5, 1271, and 1272N-5. The Code and the Code Cases do not provide specific guidance in two areas. The first relates to the size of a region of increased membrane stress due to thickness reductions from local or general corrosion effects, and the second pertains to the allowable stresses for Service Level C or post-accident conditions. In the first case, guidance was sought from ASME Section III, NE-3213.10. For Service Level C or post-accident conditions, the Standard Review Plan was used as guidance to develop the allowable stresses.

The analysis is based on a 36-degrees section model that takes advantage of symmetry of the drywell with 10 vents. The model includes the drywell shell from the base of the sand bed region to the top of elliptical head and the vent and vent header. The torus is not included in this model because the vent bellows provide a very flexible connection, which does not allow significant structural interaction between the drywell and the torus. The analysis considered drywell geometry and materials, thickness reduction from corrosion, test loads, normal operating loads, design basis accident loads, seismic loads, refueling loads, and design basis load combinations. Pressure and temperature were in accordance with approved Technical Specification Amendment No. 165, which established a revised design bases accident pressure of 44 psig and accident temperature of 292°F. The results of the analysis show that the minimum required ASME Code thickness of the drywell shell above the sand bed region is controlled by membrane stresses and the minimum drywell shell thickness in the sand bed region is controlled by buckling. The minimum required ASME Code thicknesses above the sand bed region are shown in Table-1.

For the sand bed region, the analysis conservatively assumed that the shell thickness in the entire sand bed region has been reduced uniformly to a thickness of 0.736 inches. This thickness satisfies ASME Code requirements and considered the minimum required thickness.

As described above, the buckling analysis was performed assuming a uniform general thickness of the sand bed region of 0.736 inches. However the UT measurements identified isolated, localized areas where the drywell shell thickness is less than 0.736 inches. Acceptance for these areas was based on engineering calculation C-1302-187-5320-024.

The calculation uses a Local Wall Acceptance Criteria". This criterion can be applied to small areas (less than 12" by 12"), which are less than 0.736" thick so long as the small 12" by 12" area is at least 0.536" thick. However the calculation does not provide additional criteria as to the acceptable distance between multiple small areas. For example, the minimum required linear distances between a 12" by 12" area thinner than 0.736" but thicker than 0.536" and another 12" by 12" area thinner than 0.736" but thicker than 0.536" were not provided.

The actual data for two bays (13 and 1) shows that there are more than one 12" by 12" areas thinner than 0.736" but thicker than 0.536". Also the actual data for two bays shows that there are more than one 2 ½'" diameter areas thinner than 0.736" but thicker than 0.490". Acceptance is based on the following evaluation.

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 pressure and axial load. As described in chapter 11 of the Theory of Elastic Stability, Second Edition, by Timoshenko and Gere, thin cylindrical shells buckle in lobes in both the axial and circumferential directions. These lobes are defined as half wave lengths of sinusoidal functions. The functions are governed by the radius, thickness and length of the cylinder. If we look at a specific thin walled cylindrical shell both the length and radius would be essentially constants and if the thickness was changed locally the change would have to be significant and continuous 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 approach can be easily extrapolated to any shell of revolution that would experience both an axial load and lateral pressure as in the case of the drywell. This local lobe buckling is demonstrated in The GE Letter Report "Sandbed Local Thinning and Raising the Fixity Height Analysis" where a 12 x 12 square inch section of the drywell sand bed region is reduced by 200 mils and a local buckle occurred in the finite element eigenvalue extraction analysis of the drywell. Therefore, to influence the buckling of a shell the very local areas of reduced thickness would have to be contiguous and of the same thickness. This is also consistent with Code Case 284 in Section –1700 which indicates that the average stress values in the shell should be used for calculating the buckling stress. Therefore, an acceptable distance between areas of reduced thickness is not required for an acceptable buckling analysis except that the area of reduced thickness is small enough not to influence a buckling lobe of the shell. The very local areas of thickness are dispersed over a wide area with varying thickness and as such will have a negligible effect on the buckling response of the drywell. In addition, these very local wall areas are centered about the vents, which significantly stiffen the shell. This stiffening effect limits the shell buckling to a point in the shell sand bed region which is located at the midpoint between two vents.

The acceptance criteria for the thickness of 0.49 inches confined to an area less than 2½ inches in diameter experiencing primary membrane + 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 x (square root of Rt). Also Paragraph NE-3335.1 only applies to openings in shells that are closer than two times their average diameter.

The implications of these paragraphs are that shell failures at these locations from primary stresses produced by pressure cannot occur provided openings in shells have sufficient reinforcement. The current design pressure of 44 psig for drywell requires a

APPLICANT'S EXH. 14

From: <George.Beck@exeloncorp.com>
To: <dja1@nrc.gov>, <rkm@nrc.gov>
Date: 04/05/2006 5:02:53 PM
Subject: FW: Audit Q & A (Question Numbers AMP-141, 210, 356)

Note: As originally transmitted this email was undeliverable to the NRC; it exceeded the size limit. It is being retransmitted without the AMP-210.pdf. This file will be reconstituted and sent in smaller ".pdf"s; the first 11 pages are attached.

George

> -----Original Message-----
> From: Beck, George
> Sent: Wednesday, April 05, 2006 4:39 PM
> To: Donnie Ashley (E-mail); 'Roy Mathew (E-mail) ' (E-mail)
> Cc: Ouaou, Ahmed; Hufnagel Jr, John G; Warfel Sr, Donald B; Polaski, Frederick W
> Subject: Audit Q & A (Question Numbers AMP-141, 210, 356)
>
> Donnie/Roy,
>
> Attached are the responses to AMP-210 and AMP-356 in an updated version of the reports from the AMP/AMR Audit database. Also included is a revised version of AMP-141. These answers have been reviewed and approved by Technical Lead, Don Warfel.
>
> Regarding AMP-210, please note:
> As pointed out in our response to NRC Question AMP-210, (8a)(1), "The 0.806" minimum average thickness verbally discussed with the Staff during the AMP audit was recorded in location 19A in 1994. Additional reviews after the audit noted that lower minimum average thickness values were recorded at the same location in 1991 (0.803") and in September 1992 (0.800"). However, the three values are within the tolerance of +/- 0.010" discussed with the Staff."
>
> Regarding AMP-141, please note:
> Our response to AMP-141 has been revised to reflect additional information developed during the ongoing preparation of RAI responses.
>
> Please let John Hufnagel or me know if you have any questions.
>
> George
>
>
>
> >> <<Pages from AMP-210.pdf>>
> >> <<AMP-141.pdf>>
>
>> <<AMP-356.pdf>>
>
>

CC: <ahmed.ouaou@exeloncorp.com>, <john.hufnagel@exeloncorp.com>, <donald.warfel@exeloncorp.com>, <fred.polaski@exeloncorp.com>

Mail Envelope Properties (44343066.C5F : 19 : 7263)

Subject:	FW: Audit Q & A (Question Numbers AMP-141, 210, 356)
Creation Date:	04/05/2006 5:01:46 PM
From:	<George.Beck@exeloncorp.com>
Created By:	George.Beck@exeloncorp.com

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Pages from AMP-210.pdf	64593	
AMP-141.pdf	47353	
AMP-356.pdf	71556	
Mime.822	262768	

Options

Expiration Date:	None
Priority:	Standard
Reply Requested:	No
Return Notification:	None
Concealed Subject:	No
Security:	Standard

NRC Information Request Form

Item No
AMP-210

Date Received: 1/24/2006
Source AMP Audit

Topic:
IWE

Status: Open

Document References:
B.1.27

NRC Representative Morante, Rich

AmerGen (Took Issue): Hufnagel, Joh

Question

Pages 25 through 31 of the PBD present a discussion of the OCGS operating experience.

(8a)The following statements related to drywell corrosion in the sand bed region need further explanation and clarification:
As a result of the presence of water in the sand bed region, extensive UT thickness measurements (about 1000) of the drywell shell were taken to determine if degradation was occurring. These measurements corresponded to known water leaks and indicated that wall thinning had occurred in this region.
Please explain the underlined statement. Were water leaks limited to only a portion of the circumference? Was wall thinning found only in these areas?
After sand removal, the concrete surface below the sand was found to be unfinished with improper provisions for water drainage. Corrective actions taken in this region during 1992 included; (1) cleaning of loose rust from the drywell shell, followed by application of epoxy coating and (2) removing the loose debris from the concrete floor followed by rebuilding and reshaping the floor with epoxy to allow drainage of any water that may leak into the region. UT measurements taken from the outside after cleaning verified loss of material projections that had been made based on measurements taken from the inside of the drywell. There were, however, some areas thinner than projected; but in all cases engineering analysis determined that the drywell shell thickness satisfied ASME code requirements.
Please describe the concrete surface below the sand that is discussed in paragraph above.
Please provide the following information:
(1) Identify the minimum recorded thickness in the sand bed region from the outside inspection, and the minimum recorded thickness in the sand bed region from the inside inspections. Is this consistent with previous information provided verbally? (.806 minimum)
(2) What was the projected thickness based on measurements taken from the inside?
(3) Describe the engineering analysis that determined satisfaction of ASME code requirements and identify the minimum required thickness value. Is this consistent with previous information provided verbally? (.733 minimum)
(4) Is the minimum required thickness based on stress or buckling criteria?
(5) Reconcile and compare the thickness measurements provided in (1) and (3) above with the .736 minimum corroded thickness that was used in the NUREG-1540 analysis of the degraded Oyster

NRC Information Request Form

(1) Identify the minimum recorded thickness in the sand bed region from the outside inspection, and the minimum recorded thickness in the sand bed region from the inside inspections. Is this consistent with previous information provided verbally? (.806 minimum)
(2) What was the projected thickness based on measurements taken from the inside?
(3) Describe the engineering analysis that determined satisfaction of ASME code requirements and identify the minimum required thickness value. Is this consistent with previous information provided verbally? (.733 minimum)
(4) Is the minimum required thickness based on stress or buckling criteria?
(5) Reconcile and compare the thickness measurements provided in (1) and (3) above with the .736 minimum corroded thickness that was used in the NUREG-1540 analysis of the degraded Oyster Creek sand bed region.

Response:
1. The minimum recorded thickness in the sand bed region from outside inspection is 0.618 inches. The minimum recorded thickness in the sand bed region from inside inspections is 0.603. These minimum recorded thicknesses are isolated local measurement and represent a single point UT measurement. The 0.806 inches thickness provided to the Staff verbally is an average minimum general thickness calculated based on 49 UT measurements taken in an area that is approximately 6"x 6". Thus the two local isolated minimum recorded thicknesses cannot be compared directly to the general thickness of 0.806".

The 0.806" minimum average thickness verbally discussed with the Staff during the AMP audit was recorded in location 19A in 1994. Additional reviews after the audit noted that lower minimum average thickness values were recorded at the same location in 1991 (0.803") and in September 1992 (0.800"). However, the three values are within the tolerance of +/- 0.010" discussed with the Staff.

2. The minimum projected thickness depends on whether the trended data is before or after 1992 as demonstrated by corrosion trends provided in response to NRC Question #AMP-356. For license renewal, using corrosion rate trends after 1992 is appropriate because of corrosion mitigating measures such as removal of the sand and coating of the shell. Then, using corrosion rate trends based on 1992, 1994, and 1996 UT data; and the minimum average thickness measured in 1992 (0.800"), the minimum projected average thickness through 2009 and beyond remains approximately 0.800 inches. The projected minimum thickness during and through the period of extended operation will be reevaluated after UT inspections that will be conducted prior to entering the period of extended operation, and after the periodic UT inspection every 10 years thereafter.

3.The engineering analysis that demonstrated compliance to ASME code requirements was performed in two parts, Stress and Stability Analysis with Sand, and Stress and Stability Analyses without Sand. The analyses are documented in GE Reports Index No. 9-1, 9-2, 9-3, and 9-4, were transmitted to the NRC Staff in December 1990 and in 1991 respectively. Index No. 9-3 and 9-4, were revised later to correct errors identified during an internal audit and were resubmitted to the Staff in January 1992 (see attachment 1 & 2). The analyses are briefly described below.

The drywell shell thickness in the sand bed region is based on Stability Analysis without Sand. As described in detail in attachment 1 & 2, the analysis is based on a 36-degree section model that takes advantage of symmetry of the drywell with 10 vents. The model includes the drywell shell from the base of the sand bed region to the top of elliptical head and the vent and vent header. The torus is not included in this model because the bellows provide a very flexible connection, which does not allow significant structural interaction between the drywell and the torus. The analysis conservatively assumed that the shell thickness in the entire sand bed region has been reduced uniformly to a thickness of 0.736 inches.

As discussed with the Staff during the AMP audit, the basic approach used in the buckling evaluation follows the methodology outlined in ASME Code Case N-284 revision 0 that was reconciled later with revision 1 of the Code Case. Following the procedure of this Code Case, the allowable compressive stress is evaluated in three steps. In the first step, a theoretical buckling stress is determined, and secondly modified using appropriate capacity and plasticity reduction factors. In the final step, the allowable compressive stress is obtained by dividing the buckling stress calculated in the second step by a safety factor of 2.0 for Design and Level A & B service conditions and 1.67 Level C service conditions.

Using the approach described above, the analysis shows that for the most severe design basis load combinations, the limits of ASME Section III, Subsection NE 3213.10 are fully met. For additional details refer to Attachment 1 & 2.

As described above, the buckling analysis was performed assuming a uniform general thickness of the sand bed region of 0.736 inches. However the UT measurements identified isolated, localized areas where the drywell shell thickness is less than 0.736 inches. Acceptance for these areas was based on engineering calculation C-1302-187-5320-024.

The calculation uses a Local Wall Acceptance Criteria". This criterion can be applied to small areas (less than 12" by 12"), which are less than 0.736" thick so long as the small 12" by 12" area is at least 0.536" thick. However the calculation does not provide additional criteria as to the acceptable distance between multiple small areas. For example, the minimum required linear distances between a 12" by 12" area thinner than 0.736" but thicker than 0.536" and another 12" by 12" area thinner than 0.736" but thicker than 0.536" were not provided.

The actual data for two bays (13 and 1) shows that there are more than one 12" by 12" areas thinner than 0.736" but thicker than 0.536". Also the actual data for two bays shows that there are more than one 2 ½'" diameter areas thinner than 0.736" but thicker than 0.490". Acceptance is based on the following evaluation.

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 pressure and axial load. As described in chapter 11 of the Theory of Elastic Stability, Second Edition, by Timoshenko and Gere, thin cylindrical shells buckle in lobes in both the axial and circumferential directions. These lobes are defined as half wave lengths of sinusoidal functions. The functions are governed by the radius, thickness and length of the cylinder. If we look at a specific thin walled cylindrical shell both the length and radius would be essentially constants and if the thickness was changed locally the change would have to be significant and continuous 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 approach can be easily extrapolated to any shell of revolution that would experience both an axial load and lateral pressure as in the case of the drywell. This local lobe buckling is demonstrated in The GE Letter Report "Sandbed Local Thinning and Raising the Fixity Height Analysis" where a 12 x 12 square inch section of the drywell sand bed region is reduced by 200 mils and a local buckle occurred in the finite element eigenvalue extraction analysis of the drywell. Therefore, to influence the buckling of a shell the very local areas of reduced thickness would have to be contiguous and of the same thickness. This is also consistent with Code Case 284 in Section –1700 which indicates that the average stress values in the shell should be used for calculating the buckling stress. Therefore, an acceptable distance between areas of reduced thickness is not required for an acceptable buckling analysis except that the area of reduced thickness is small enough not to influence a buckling lobe of the shell. The very local areas of thickness are dispersed over a wide area with varying thickness and as such will have a negligible effect on the buckling response of the drywell. In addition, these very local wall areas are centered about the vents, which significantly stiffen the shell. This stiffening effect limits the shell buckling to a point in the shell sand bed region which is located at the midpoint between two vents.

The acceptance criteria for the thickness of 0.49 inches confined to an area less than 2½ inches in diameter experiencing primary membrane + 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 x (square root of Rt). Also Paragraph NE-3335.1 only applies to openings in shells that are closer than two times their average diameter.

The implications of these paragraphs are that shell failures at these locations from primary stresses produced by pressure cannot occur provided openings in shells have sufficient reinforcement. The current design pressure of 44 psig for drywell requires a thickness of 0.479 inches in the sand bed region of the drywell. A review of all the UT data presented in Appendix D of the calculation indicates that all thicknesses in the drywell sand bed region exceed the required pressure thickness by a substantial margin. Therefore, the requirements for pressure reinforcement specified in the previous paragraph are not required for the very local wall thickness evaluation presented in Revision 0 of Calculation C-1302-187-5320-024.

Reviewing the stability analyses provided in both the GE Report 9-4 and the GE Letter Report Sand bed Local Thinning and Raising the Fixity Height Analysis and recognizing that the plate elements in the sand bed 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 indicates that these areas will have no impact on the buckling margins in the shell. It is also clear from the GE Letter Report that a uniform reduction in thickness of 27% to 0.536" over a one square foot area would only create a 9.5% reduction in the load factor and theoretical buckling stress for the whole drywell resulting in the largest reduction possible. In addition, to the reported result for the 27% reduction in wall thickness, a second buckling analysis was performed for a wall thickness reduction of 13.5% over a one square foot area which only reduced the load factor and theoretical buckling stress by 3.5% for the whole drywell resulting in the largest reduction possible. To bring these results into perspective a review of the NDE reports indicate there are 20 UT measured areas in the whole sand bed region that have thicknesses less than the 0.736 inch thickness used in GE Report 9-4 which cover a conservative total area of 0.68 square feet of the drywell surface with an average thickness of 0.703" or a 4.5% reduction in wall thickness. Therefore, to effectively change the buckling margins on the drywell shell in the sand bed region a reduced thickness would have to cover approximately one square foot of shell area at a location in the shell that is most susceptible to buckling with a reduction in thickness greater than 25%. This leads to the conclusion that the buckling of the shell is unaffected by the distance between the very local wall thicknesses, in fact these local areas could be contiguous provided their total area did not exceed one square foot and their average thickness was greater than the thickness analyzed in the GE Letter Report and provided the methodology of Code Case N284 was employed to determine the allowable buckling load for the drywell. Furthermore, all of these very local wall areas are centered about the vents, which significantly stiffen the shell. This stiffing effect limits the shell buckling to a point in the shell sand bed region, which is located at the midpoint between two vents.

The minimum thickness of 0.733" is not correct. The correct minimum thickness is 0.736".

4. The minimum required thickness for the sand bed region is controlled by buckling.

5. We cannot reconcile the difference between the current (lowest measured) of 0.736" in NUREG-1540 and the minimum measured thickness of 0.806 inches we discussed with the Staff. Perhaps the value in NUREG-1540 should be labeled minimum required by the Code, as documented in several correspondences with the Staff, instead of lowest measured. In a letter dated September 15, 1995, GPU provided the Staff a table that lists sand bed region thicknesses. The table indicates that nominal thickness is 1.154". the minimum measured thickness in 1994 is 0.806", and the minimum thickness required by Code is 0.736". These thicknesses are consistent with those discussed with the Staff during the AMP/AMR audit.

Question: NUREG-1540, published in April 1996, includes the following statements related to corrosion of the Oyster Creek sand bed region: (page vii) However, to assure that these measures are effective, the licensee is required to perform periodic UT measurements. and (page 2) As assurance that the corrosion rate is slower than the rate obtained from previous measurements, GPU is committed to make UT measurements periodically. Please reconcile the aging management commitment (one-time UT inspection and monitoring of the condition of the coating) with the apparent requirement/commitment documented in NUREG-1540.Please reconcile the aging management commitment (one-time UT inspection and monitoring of the condition of the coating) with the apparent requirement/commitment documented in NUREG-1540.

APPLICANT'S EXH. 15

Safety Evaluation Report

Related to the License Renewal of Oyster Creek Generating Station

Docket No. 50-219

AmerGen Energy Company, LLC

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

March 2007

the drywell shell in the inspection trenches in drywell bays #5 and #17. AmerGen will monitor the two trenches for the presence of water during each refueling outage. The staff identified this commitment item as a license condition.

Ultrasonic Testing Measurement Issues

In the sand pocket region of the drywell shell, the most susceptible bays are incorporated in the sampling. However, the staff believes that readings should be taken at vulnerable locations and that UT techniques are reliable. The first issue is addressed as part of Open Item 4.7.2-1.2 and the second issue is addressed below.

The second item is that a review of UT data indicates that the UT measurements taken from inside the drywell after 1992 show a general increase in the metal thickness. In some cases, the average increase is as much as 40 mils in a 2-year timeframe. In general, it appears that the UT measurements taken after 1992 require proper calibration, considering the coatings on both sides of the drywell shell. The staff requested that the applicant address this issue during a public meeting held June 1, 2006.

In its response dated June 20, 2006, the applicant provided the following discussion of sensitivities involved with the UT measurement process and how they will be minimized in the future:

UT Instrumentation Uncertainties. The UT instrumentation, which includes the transducer, cable and ultrasonic unit, will be calibrated to within approximately +/- 0.010 inches. Exelon Procedure (ER-AA-335-004) step 4.1.3 requires that he UT instruments must be checked within 2% of the calibration standard (block) prior to use. For the sand bed region, which is nominally 1" thick, a 1-inch thick calibration standard block is used. This results in checking the UT instrument to within 0.020" inches or +/- 0.010". UT instrumentation accuracy is verified under controlled conditions where UT thickness readings are performed on calibration blocks. The calibration blocks have been precisely machined to prescribed thicknesses, which are then verified by micrometer readings.

Actual Drywell Surface Roughness and UT Probe Location Repeatability. Due to the corrosion, the outside surface of the Drywell Vessel is not smooth and uniform. The surface condition is indicative of general corrosion, which is rough with high and low points spaced very closely together. This profile was verified when the sand was removed in 1992. The UT Instrumentation probes are 7/16" in diameter and are dual element transducers (i.e. half transmits sound and the other half receives). The probes emit a focused beam that measures an area significantly smaller than 7/16" diameter and will record the thinnest reading within that area.

Because the surface roughness of the drywell within this 7/16" diameter can vary, the probe must be placed at precisely the same location to precisely repeat a thickness reading. A slight shift of the probe will result in a reading which is correct, but different from a previous reading.

The variability associated with this factor is reduced by the use of the stainless steel template. The template has been manufactured with holes in a 7 by 7 pattern on 1 inch centers. Each of the 49 holes has been machined with a diameter so that the UT probe fits within each hole snugly. The templates are machined with 1/16" wide slits on each edge of the template at 0, 90, 180, and 270 degrees. During inspections the slits in the template are lined up with permanent marks that were placed on the drywell shell when the location was originally inspected. The UT readings are then taken by placing the probe inside each hole in the template.

Inspection procedures require that NDE personnel performing the inspection place the template precisely on the permanent markings.

Actual Drywell Surface Roughness and UT Probe Rotation. The UT probe sends the signal from one side of the probe and receives the signal on the other side. The probe must be oriented in the same plane in order to measure exactly the same point. Test data taken on a mock up with similar roughness showed that a variance up to 0.016 inch was noted when rotating the probe 360 degrees over the same spot. Therefore, a slight rotation of the probe will result in a reading, which is correct, but different from a previous reading.

Inspection procedures require that NDE personnel performing the inspection place the probe in the same orientation.

Temperature Effects. Significant temperature differences between inspections may result in a shift in the material thickness. Therefore, the inspection specification will require that NDE personnel performing the inspection record the surface temperature of the area that is inspected.

Batteries. Inspection specifications require the installation of new batteries prior to each series of inspections.

NDE Technician. Inspection specifications require that personnel conducting UT examinations be qualified in accordance with Exelon Procedure ER-AA-335-004.

Calibration Block. Exelon Procedure ER-AA-335-004 requires that calibration blocks used during the inspection be inspected to verify that the ultrasonic response equals the physical measurement.

Internal Surface Cleanliness. The inspection areas are covered with a qualified grease to protect the examination surface from rusting between inspection periods. The grease must be removed prior to the inspection and reapplied after the inspection. Tests performed in April and May of 2006 show that the presence of the grease will increase the readings as much as 12 mils. In 1996, the governing specification did not clearly specify the requirement to remove the grease prior to the inspection. Therefore it is possible that the requirement to remove the grease was not communicated to the contractor, and that the contractor who performed the 1996 inspection may have not removed the grease.

The inspection procedures will clearly require that personnel conducting UT examinations remove the grease prior to performing the examination.

UT Unit Settings. It is possible that the ultrasonic unit can be set in a "high gain" setting which may bias the machine into including the external coating as part of the thickness. Future inspections will use modern "state of the art" UT units that do not have gain settings.

Identification of the Physical Inspection Location. There is a potential that inspection locations may be mislabeled on the data sheets. The inspection procedures uniquely and clearly identify each inspection location and provide the specific instruction as to the area's location.

Data Analysis. The above potential variables will be considered in the analysis of the data. The analysis not only determines a mean for each grid or sub-grid, but also the variance of the means. These variances will be compared to past inspections to ensure consistency. The mean and the variance are compared to the acceptance criteria.

In addition, the mean UT thickness values for a current inspection will be computed and compared to the previous inspection prior to restarting from an outage. If data anomalies similar to 1996 are identified corrective actions will be taken, including new UT measurements, as necessary, to ensure accuracy of measurements.

Based on the applicant's discussion of the variables involved in the UT results, the staff finds it reasonable to conclude that the anomalous readings of 1994 and 1996 could be attributed to one or more of the factors enumerated in the discussion. The staff was concerned about systematic corrections to the UT measurements and could not determine the basis for the applicant's use of the anomalous readings nor systematic corrections. The applicant could not isolate the factors that contributed to these anomalous results; therefore, it plans to utilize the lessons learned from the experience for the future UT examinations. On the basis of the applicant's written response, the staff determined that its concerns have been resolved.

4.7.2.2.2 Minimum Drywell Thickness

In RAI 4.7.2-1 dated March 10, 2006, the staff requested that the applicant provide a summary of the factors considered in establishing the minimum required drywell thickness.

In its response dated April 7, 2006, the applicant explained that the factors considered in establishing the minimum required drywell thickness at various elevations of the drywell are described in detail in engineering analyses documented in two GE reports, Index Nos. 9-1, 9-2, and 9-3, 9-4. Report Index No. 9-1, 9-2 was generated for the drywell condition with sand in the sand bed region and Report Index No. 9-3, 9-4 addressed the drywell condition without sand in the sand bed region. The two reports were transmitted to the staff in December 1990 and 1991, respectively. Report Index No. 9-3, 9-4 was revised later to correct errors identified during an internal audit and was resubmitted to the staff in January 1992. The analysis described in Report Index No. 9-3, 9-4 (i.e., without sand) is the current applicable analysis for the drywell.

In its response the applicant also noted that it based the analysis on the original code of record, ASME Code, Section VIII, and Code Cases 1270N-5, 1271-N, and 1272N-5. The ASME Code and its Code Cases do not provide specific guidance in two areas. The first relates to the size of a region of increased membrane stress due to thickness reductions from local or general corrosion effects, and the second pertains to the allowable stresses for Service Level C or post-accident conditions. In the first case, guidance was sought from ASME Code Section III, NE-3213.10. For Service Level C or post-accident conditions, the SRP-LR was used as guidance to develop the allowable stresses. Additionally, the applicant summarized the analysis efforts in the following paragraphs:

The analysis is based on a 36-degree section model that takes advantage of symmetry of the drywell with 10 vents. The model includes the drywell shell from the base of the sand bed region to the top of elliptical head and the vent and vent header. The torus is not included in this model because the vent bellows provide a very flexible connection, which does not allow significant structural interaction between the drywell and the torus. The analysis considered drywell geometry and materials, thickness reduction from corrosion, test loads, normal operating loads, design basis accident loads, seismic loads, refueling loads, and design basis load combinations. Pressure and temperature were in accordance with approved Technical Specification Amendment No. 165, which established a revised design bases accident pressure of 44 psig and accident temperature of 292°F. The results of the analysis show that the minimum required ASME Code thickness of the drywell shell above the sand bed region is controlled by membrane stresses and the minimum drywell shell thickness in the sand bed region is controlled by buckling. The minimum required ASME Code thicknesses above the sand bed region are shown in Table 1 (attached to the response). For the sand bed region, the analysis conservatively assumed that the shell thickness in the entire sand [illegible] required thickness.

As described above, the buckling analysis was performed, assuming a uniform general thickness of the sand bed region of 0.736 inches. However, the UT measurements identified isolated, localized areas where the drywell shell thickness is less than 0.736 inches. Acceptance for these areas was based on engineering calculation C-1 302-1 87-5320-024. The calculation uses a "Local Wall Acceptance Criteria." This criterion can be applied to small areas (less than length and radius would be essentially constants and if the thickness was changed locally, the change would have to be significant and continuous 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 approach can be easily extrapolated to any shell of revolution that would experience both an axial load and lateral pressure as in the case of the drywell. This local lobe buckling is demonstrated in the GE Letter Report "Sandbed Local Thinning and Raising the Fixity Height Analysis" where a 12 x 12 square inch section of the drywell sand bed region is reduced by 200 mils and a local buckle occurred in the finite element eigenvalue extraction analysis of the drywell. Therefore, to influence the buckling of a shell, the very local areas of reduced thickness would have to be contiguous and of the same thickness. This is also consistent with Code Case 284 in Section-1700 which indicates 'that the average stress values in the shell should be used for calculating the buckling stress. Therefore, an acceptable distance between areas of reduced thickness is not required for an acceptable buckling analysis except that the area of reduced thickness is small enough not to influence a buckling lobe of the shell. The very local areas of thickness are dispersed over a wide area with varying thickness and as such will have a negligible effect on the buckling response of the drywell. In addition, these very local wall areas are centered about the vents, which significantly stiffen the shell. This stiffening effect limits the shell buckling to a point in the shell sand bed region which is located at the midpoint between two vents.

The acceptance criteria for the thickness of 0.49 inches confined to an area less than 2½ inches in diameter experiencing primary membrane + bending stresses is based on ASME Boiler and Pressure Vessel (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 x (square root of Rt). Also, Paragraph NE-3335.1 only applies to openings in shells that are closer than two times their average diameter. The implications of these paragraphs are that shell failures at these locations from primary stresses produced by 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 sand bed region of the drywell. A review of all the UT data presented in Appendix D of the calculation indicates that all thicknesses in the drywell sand bed region exceed the required pressure thickness by a substantial margin. Therefore, the requirements for pressure reinforcement specified in the previous paragraph are not required for the very local wall thickness evaluation presented in Revision 0 of Calculation C-1302-187-5320-024.

Reviewing the stability analyses provided in both the GE Report 9-4 and the GE Letter Report, "Sand bed Local Thinning and Raising the Fixity Height Analysis," and recognizing that the plate elements in the sand bed region of the model are 3" x 3", it is clear that the circumferential buckling lobes for the drywell are

> substantially larger than the 2½ inch diameter very local wall areas. This, combined with the local reinforcement surrounding these local areas, indicates that these areas will have no impact on the buckling margins in the shell. It is also clear from the GE Letter Report that a uniform reduction in thickness of 27 percent to 0.536" over a one square foot area would only create a 9.5 percent reduction in the load factor and theoretical buckling stress for the whole drywell resulting in the largest reduction possible. In addition to the reported result for the 27 percent reduction in wall thickness, a second buckling analysis was performed for a wall thickness reduction of 13.5 percent over a one square foot area which only reduced the load factor and theoretical buckling stress by 3.5 percent for the whole drywell, resulting in the largest reduction possible. To bring these results into perspective, a review of the nondestructive examination (NDE) reports indicates that there are 20 UT measured areas in the whole sand bed region that have thicknesses less than the 0.736 inch used in GE Report 9-4, which cover a conservative total area of 0.68 square feet of the drywell surface with an average thickness of 0.703" or a 4.5 percent reduction in wall thickness.
>
> Therefore, to effectively change the buckling margins on the drywell shell in the sand bed region a reduced thickness would have to cover approximately one square foot of shell area at a location in the shell that is most susceptible to buckling with a reduction in thickness greater than 25 percent. This leads to the conclusion that the buckling of the shell is unaffected by the distance between the very local wall thicknesses, in fact these local areas could be contiguous provided their total area did not exceed one square foot and their average thickness was greater than the thickness analyzed in the GE Letter Report, and provided the methodology of Code Case N284 was employed to determine the allowable buckling load for the drywell. Furthermore, all of these very local wall areas are centered about the vents, which significantly stiffen the shell. This stiffening effect limits the shell buckling to a point in the shell sand bed region, which is located at the midpoint between two vents.

In summary, the applicant noted that the minimum required drywell shell thickness is based on an analysis conducted in accordance with ASME Code. Factors considered include drywell geometry, material of construction, reduced wall thickness due to corrosion, and applicable design-basis loads and load combinations. Accident pressure and temperature are 44 psig and 292 °F, respectively, in accordance with the approved technical specification amendment No. 165.

In a letter dated April 7, 2006, the applicant responded to RAI 4.7.2-1. In its response the applicant stated that the minimum required thicknesses of the drywell shell above the sand bed region shown in Table-1 of the response are controlled by membrane stresses. The minimum required general drywell shell thickness in the sand bed region of 0.736 inch is controlled by buckling. Localized areas in the sand bed region where the thickness is less than 0.736 inch are evaluated against a local thickness acceptance criteria (0.49 inch) developed based on ASME 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." Application of these ASME Code sections is justified as discussed above, and specific buckling sensitivity analysis results support the conclusion that, on an average wall thickness basis, buckling of the shell is unaffected by local wall thickness areas as these are distributed over the sand bed region.

The staff reviewed the cited analysis reports to ensure that the parameters used and the assumptions made in the analysis are valid for the period of extended operation. However, based on the review conducted, the staff requested that the applicant provide additional information to address certain gross assumptions.

Attachment 1A of the GPU letter dated November 26, 1990, makes a statistical evaluation of the UT measurement data taken up to 1990. On the cover page of the report, GPU Nuclear Corporation states a disclaimer, "the work is conducted by an individual(s) for use by GPU. Neither GPU nor the authors of the report warrant that the report is complete of accurate ...." In view of this disclaimer, the staff at a public meeting on June 1, 2006, asked the applicant to provide a detailed description of the way the UT measurement data, whether taken as part of the 6-inch by 6-inch grid, or isolated readings, were evaluated and used in performing the analysis.

In its response dated June 20, 2006, the applicant clarified the use of the statistical evaluation as follows:

> The disclaimer noted by the NRC staff is on the cover page of Technical Data Report (TDR) No. 948 Revision 1, "Statistical Analysis of the Drywell Thickness Data." The disclaimer statement is a standard clause that was placed on TDRs developed in accordance with the applicable GPUN procedure at the time. AmerGen points out that TDR No. 1027, which is also a part of Attachment 1A includes the same disclaimer. The disclaimer was intended to reinforce that TDRs are not design basis documents and were not design verified in accordance with the GPUN QA Program. In this case TDR 948 was developed to summarize the initiative that surveyed the drywell and that assessed initial corrosion rates based on data collected from 1986 through December 1988. However this TDR did not serve as the design basis document, which demonstrated the drywell shell met design basis requirements. The TDR in Section 1 (Introduction/Background) explains that the TDR documents the assumptions, methods and results of the statistical analysis used to evaluate the corrosion rates. The section then states that the complete analysis is documented in calculation C-1302-187-5300-005.
>
>> Calculation C-1302-187-5300-005, "Statistical Analysis of Drywell Thickness Data Thru 12-31-88" did serve as the design basis document, which demonstrated the drywell shell met design basis requirements. This calculation was developed and design verified in accordance with the GPUN QA Program and is approximately 200 pages long. A review of the information contained in the TDR Section 4.6 (Summary of Conclusion) shows that it is consistent with the information in Section 2 (Summary of Results) in calculation C-1302-0187-5300-005. Thus, the information in the TDR No. 948 represents design quality information.
>
> In response to the NRC's question on how the UT measurement data were evaluated and used in the drywell analysis, AmerGen provided a description of how the 49-point array statistical analysis was performed in response to NRC Q&A #AMP-356, item (4). In that response, AmerGen stated that the methodology and acceptance criteria that are applied to each grid of point thickness readings, including both global (entire array) evaluation and local (subregion of array) are

described in engineering specification IS-328227-004 and in calculation No. C-1302-187-5300-011, "Statistical Analysis of Drywell Thickness Data Thru 4-24-90". This calculation is the more recent version of calculation C-1302-187-5300 and has been submitted by AmerGen to the NRC.

These two documents were submitted to the NRC in a letter dated November 26, 1990 and provided to the Staff during the AMP/AMR audit. A brief summary of the methodology and acceptance criteria is described below.

The initial locations identified in 1986 and 1987 where corrosion loss was most severe were selected for repeat inspection over time to measure corrosion rates. For locations where the initial investigations found significant wall thinning, UT inspection consisted of 49 individual UT data points equally spaced over a 6"x 6" area. Each new set of 49 values was then tested for normal distribution. If the data was normally distributed, then the mean value of the 49 points was calculated and used to represent the general drywell shell thickness in the tested area. If the 49 points were not normally distributed, then the grid was subdivided into datasets (usually 2, top and bottom) that were normally distributed. The mean value for each dataset was then calculated. The minimum mean value was compared to the minimum required thickness as described below.

The mean values of each grid were then compared to the required minimum uniform thickness criteria of 0.736 inches. In addition each individual reading was compared to the local minimum required criteria of 0.490 inches. The basis for the required minimum uniform thickness criteria and the local minimum required criteria is provided in response to NRC Question #AMP-210. A decrease in the mean value over time is representative of corrosion. If corrosion does not exist, the mean value will not vary with time, although random variations in the UT measurements as a result of such factors as variables in the inspection process and in environmental conditions may occur. If corrosion is continuing, the mean thickness will decrease linearly with time. Therefore the curve fit of the data is tested to determine if linear regression is appropriate, in which case the corrosion rate is equal to the slope of the line. If a slope exists, then upper and lower 95% confidence intervals of the curve fit are calculated. The lower 95% confidence interval is then projected into the future and compared to the required minimum uniform thickness criteria of 0.736 inches.

A process similar to that described above is applied to the thinnest individual reading in each grid. The lowest reading taken is also verified against the local minimum thickness requirement. Then the curve fit of the data is tested to determine if linear regression is appropriate. If a slope exists, then the lower 95% confidence interval is then projected into the future and compared to the required minimum local thickness criteria of 0.490 inches.

The staff finds that the applicant has provided an explanation of the documents used for the design basis calculations. Furthermore, the applicant provided the process used in establishing the minimum thickness of the drywell used in the 1991 GE analysis. Based on the discussion provided above, the staff finds the applicant's historical method of determining the minimum required wall thickness acceptable because these processes use recognized industry standards for performance and evaluation of results. On the basis of the applicant's written response, the

APPLICANT'S EXH. 16

Exelon
Nuclear

CC-AA-309-1001
Revision 2

Design Analysis (Major Revision)

Last Page No.: 1 of ~~181~~ 183 PT 3/21/07

Analysis No.: C-1302-187-5320-024 **Revision:** 2

Title: O.C. Drywell Ext. UT Evaluation in Sandbed

EC/EGR No.: 06-01078 **Revision:** 0

Station(s): Oyster Creek
Unit No.: 1
Discipline: Mechanical
Descrip. Code/Keyword:
Safety/QA Class: Q
System Code: 187
Structure: Drywell

Component(s):

CONTROLLED DOCUMENT REFERENCES

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? Yes ☐ No ☒ If yes, see SY-AA-101-106
Does this Design Analysis contain Unverified Assumptions? Yes ☐ No ☒ If yes, ATI/AR#:
This Design Analysis SUPERCEDES: N/A In its entirety.

Description of Revision (list affected pages for partials):
See the Summary of Change Sheet, which is attached.

Preparer: Peter Tamburro (Print Name) P. A. Tamburro (Sign Name) 3/26/07 (Date)

Method of Review: Detailed Review ☒ Alternate Calculations (attached) ☐ Testing ☐
Reviewer: JULIEN ABRAMOVICI (ENERCON) E.H. Ray (Print Name) (Sign Name) 3-29-07 5/17/07 (Date)
Review Notes: 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: NA (Print Name) (Sign Name) (Date)
Exelon Reviewer: NA (Print Name) (Sign Name) (Date)

Is a Supplemental Review Required? Yes ☐ No ☒ If yes, complete Attachment 3
Exelon Approver: E.H. Ray (Print Name) (Sign Name) 5/18/07 (Date)

Page 2 of 183

DOCUMENT NO.
C-1302-187-5320-024

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.	Pete Tamburro	3/28/07
		J Abramovici	3-29-07
	Revision bars are not shown since revision 2 affects most pages of Revision 1.	Howie Ray	5/18/07

N0036 (1/99)

Table of Contents

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).

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

Drywell	6.1 Uniform Sandbed Thickness		6.2 Local Buckling Thickness		6.3 Very Local Wall Thickness		Acceptable
Bay	Thickness Criteria Inches	Actual Representative [illegible] Thickness (1) [illegible]	Thickness Criteria (Inches)	Actual Thickness [illegible]	Thickness Criteria (Inches)	Actual Thickness [illegible]	Measurements [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.

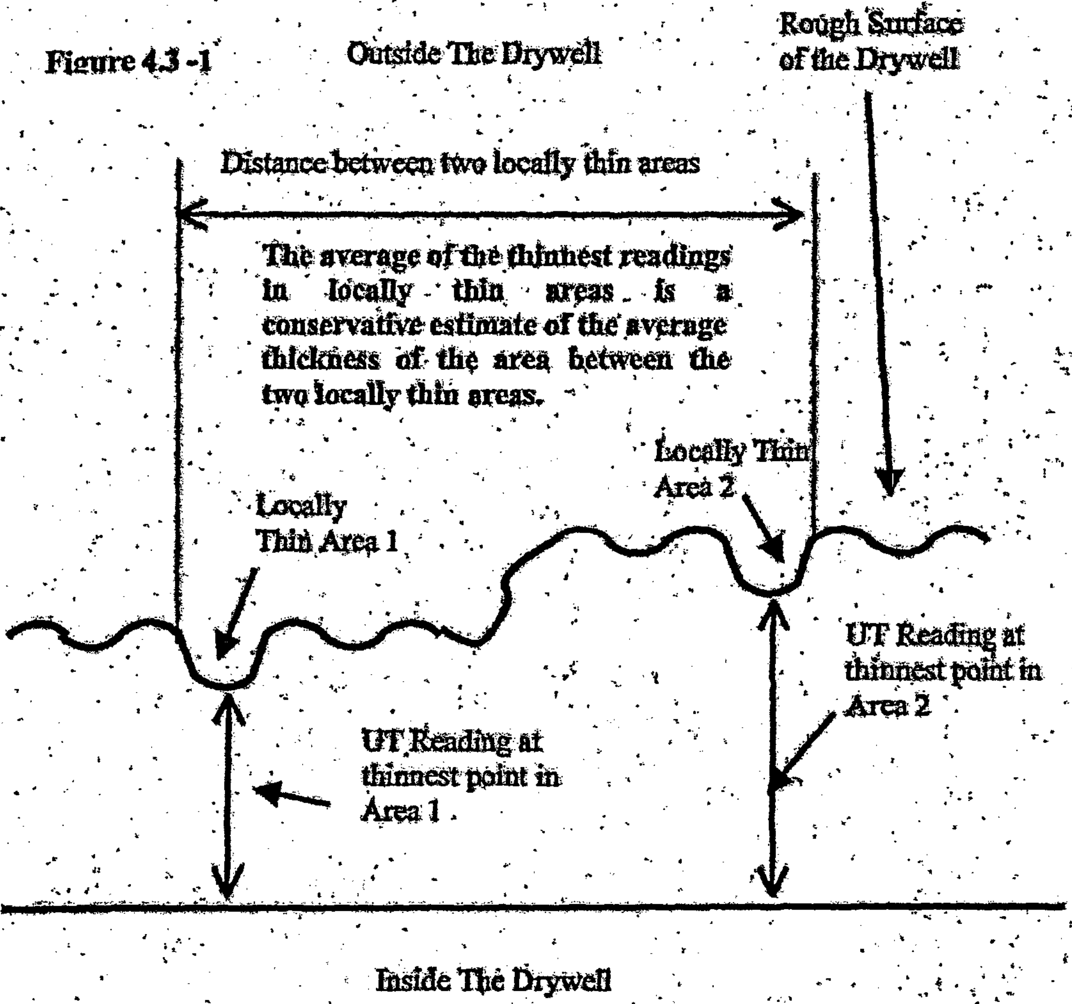
4.0 ASSUMPTIONS AND BASIC DATA:

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



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.

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".

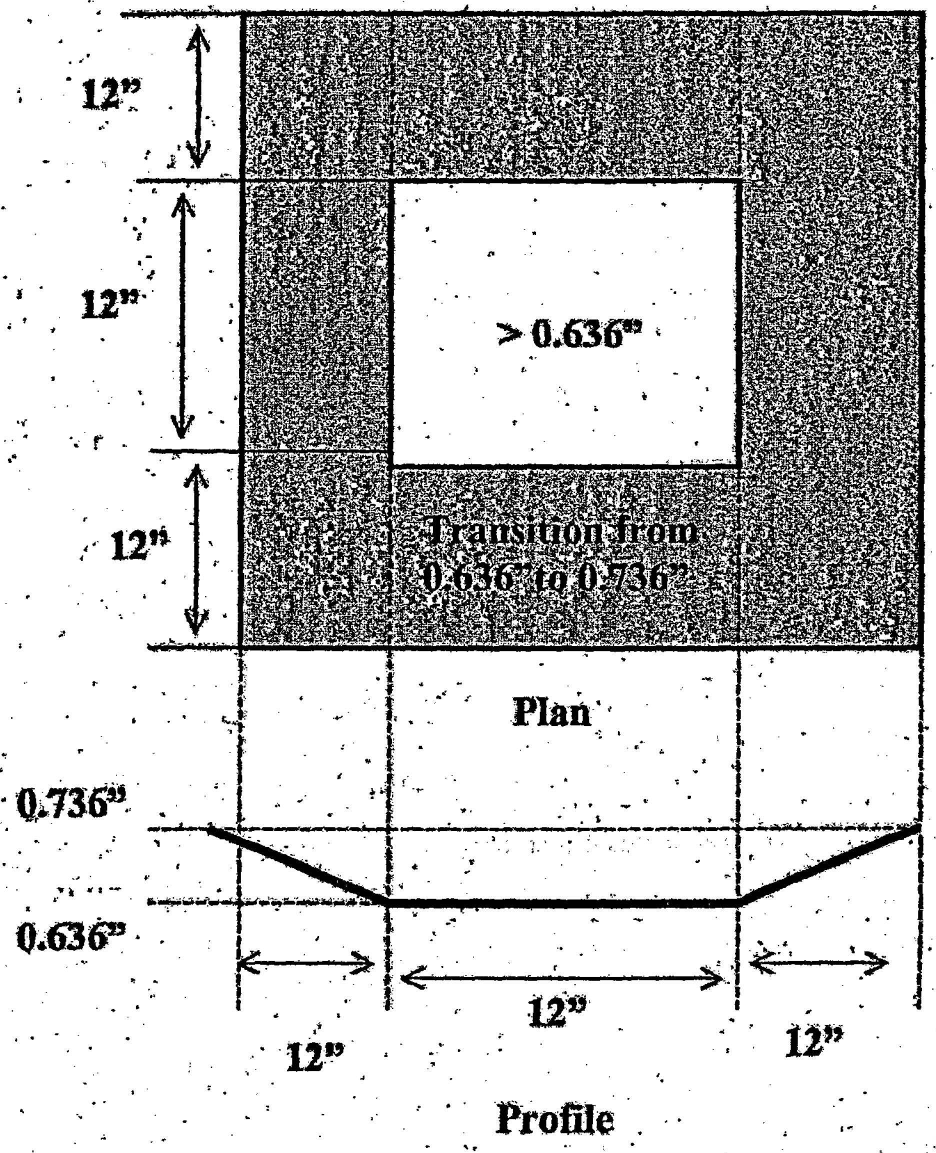
Where the above evaluation methods cannot meet this acceptance criteria, a more detailed evaluation for local buckling shall be performed per section 6.2.

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.

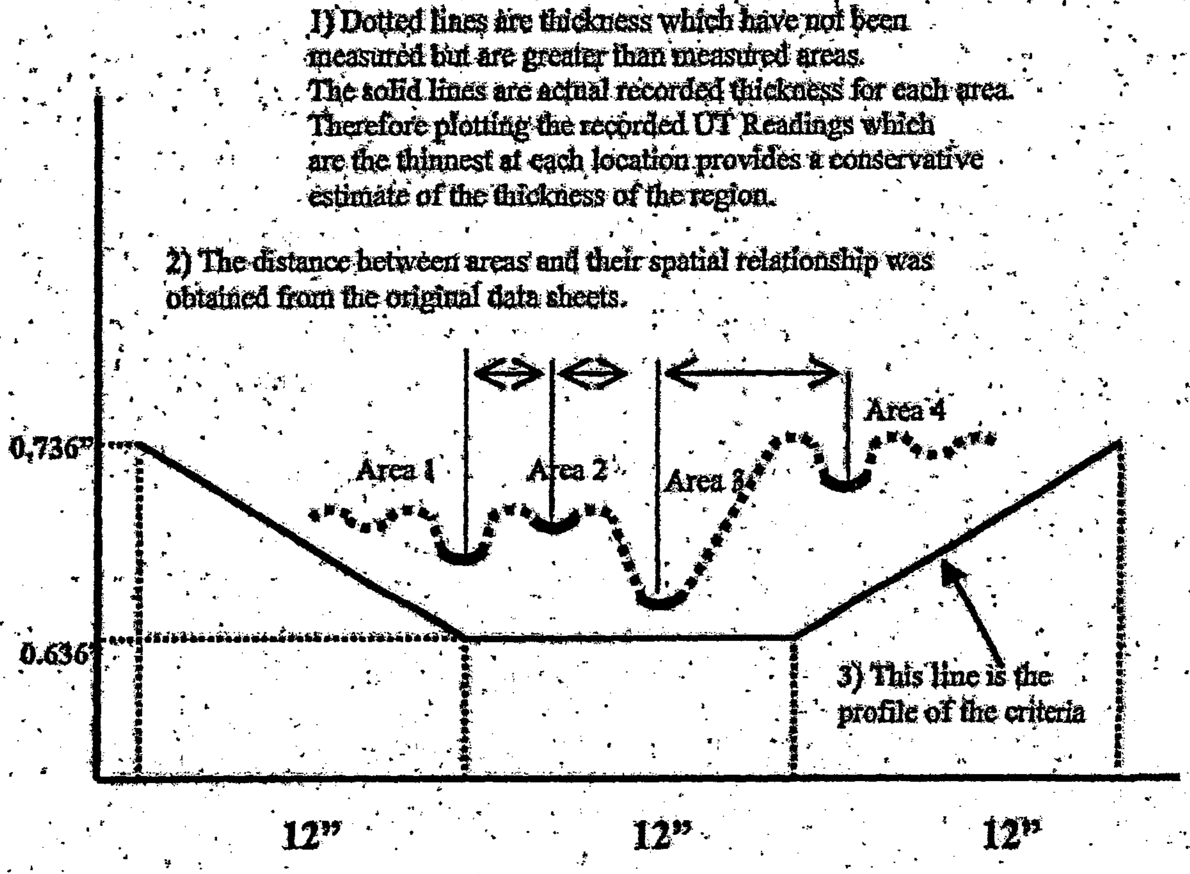
In addition, a second buckling analysis was performed for a wall thickness reduction of 0.636 inches over the one square foot area. The results of this case reduced the load factor and theoretical buckling stress by 3.9% in Reference 3.5. The center of the thinned area was located close to the maximum 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



1) Dotted lines are thickness which have not been measured but are greater than measured areas. The solid lines are actual recorded thickness for each area. Therefore plotting the recorded UT Readings which are the thinnest at each location provides a conservative estimate of the thickness of the region.

2) The distance between areas and their spatial relationship was obtained from the original data sheets.

3) This line is the profile of the criteria

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.

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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)

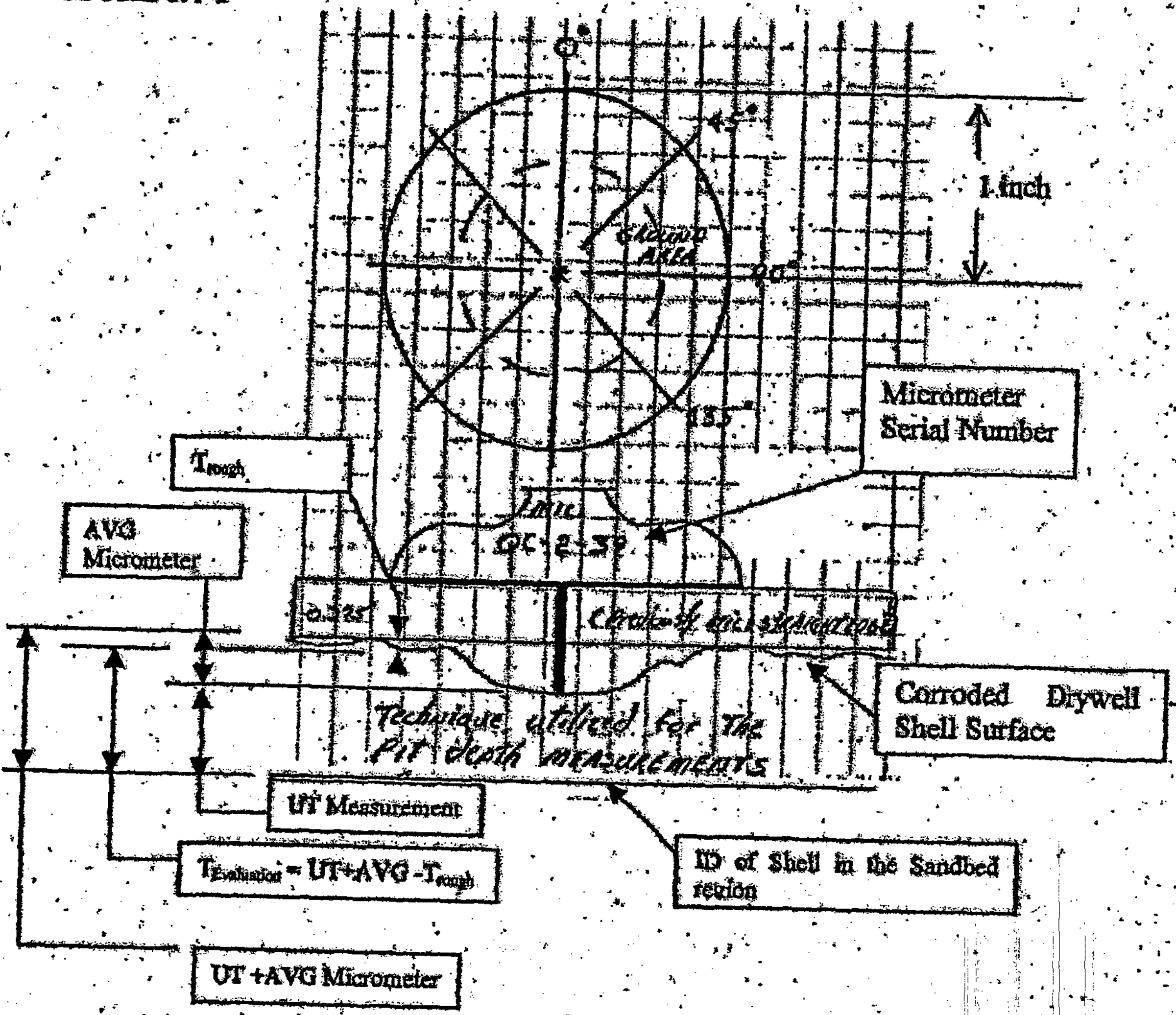
AVG (micrometer) = average depth of the area relative to its immediate surroundings

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°
Ground Area
1 inch
Micrometer Serial Number
Mic
OC-2-39
0.325
Circle of micrometer
Trough
AVG Micrometer
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

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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

Location	1992 UT Measurements (inches)	2006 UT Measurements (inches)
1	0.720	0.710
2	0.716	0.690
3	0.705	0.665
4	0.760	0.738
5	0.710	0.680
6	0.760	0.731
7	0.700	0.669

Location [illegible]	1992 UT Measurements (inches)	2006 UT Measurements (inches)
8	0.805	0.783
9	0.805	0.754
10	0.839	0.824
11	0.714	0.711
12	0.724	0.722
13	0.792	0.719
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	0.726	0.712
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

Location	Azimuth				AVG
	0°	45°	90°	135°	
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"

[illegible]	[illegible]	[illegible]	Micrometer [illegible]	[illegible]	[illegible]	Evaluation [illegible]	[illegible]
1	0.720"	0.710"	0.217"	0.200"	0.737"	0.727"	7.1.3.3
2	0.716"	0.690	0.143"	0.200"	0.659"	0.633	7.1.3.5
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"	0.721					7.1.3.3
7	0.700"	0.669"	0.266"	0.200"	0.766"	[illegible]	7.1.3.3
11	0.714"	0.711"	0.212"	0.200"	0.726"	0.723	7.1.3.1
12	0.724"	0.722	0.301"	0.200"	0.825"	0.823	7.1.3.1
15	0.792"	0.719"					7.1.3.3
21	0.726"	0.712	0.211"	0.200"	0.737"	0.719	7.1.3.3

Example of Calculation in Table 1-3

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

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).

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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.

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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".

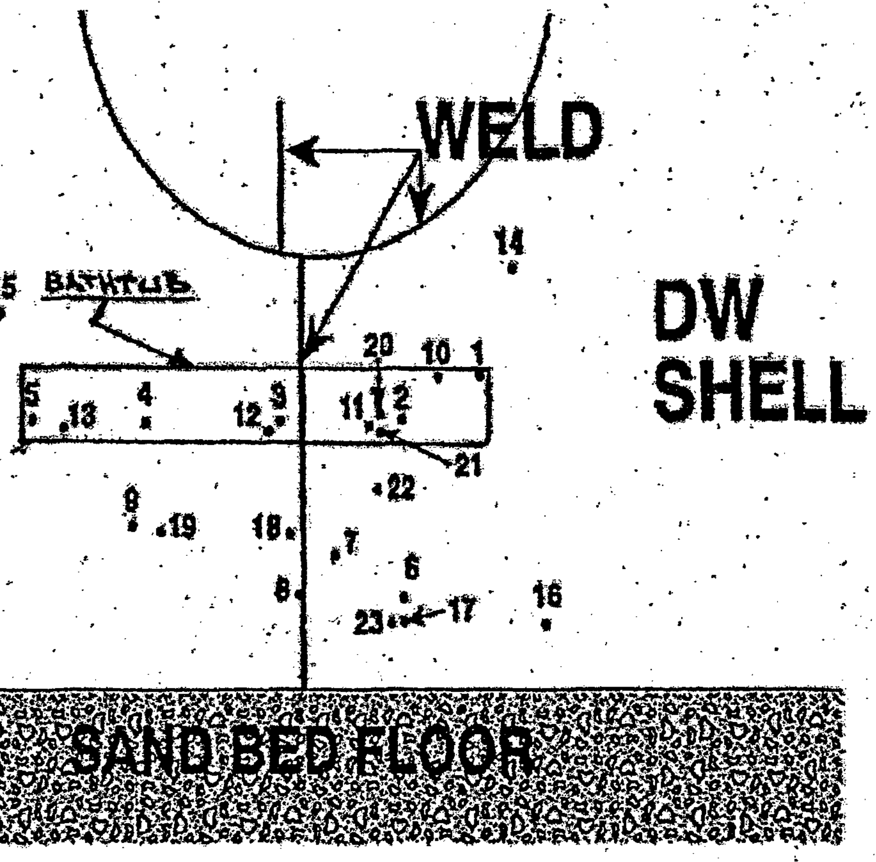

Figure 1-2

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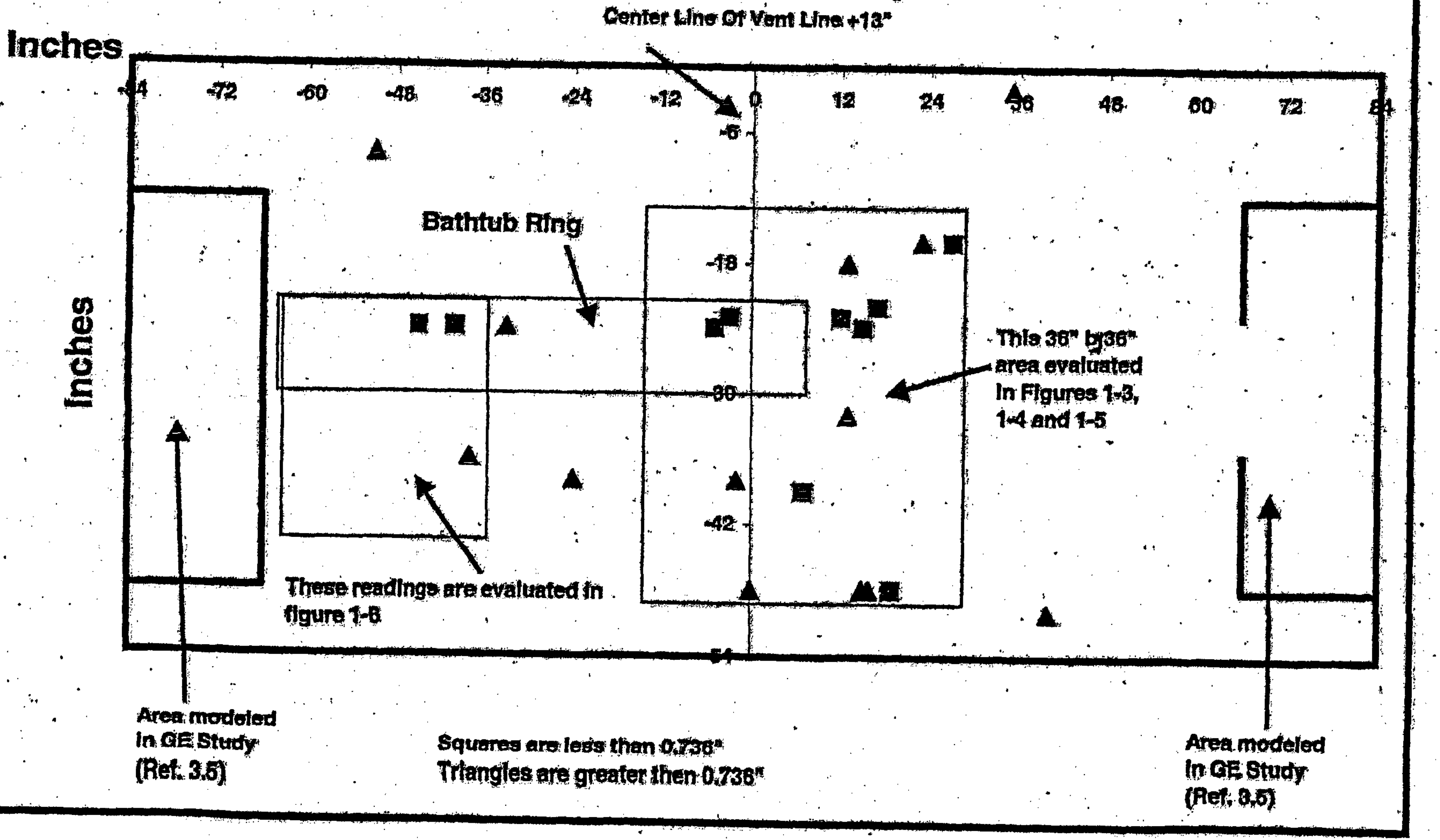
Bay 1 2006
Spatial Relationship Of Locally Thin Areas



Center Line Of Vent Line +13"

Bathtub Ring

This 36" by 36" area evaluated in Figures 1-3, 1-4 and 1-5

These readings are evaluated in figure 1-6

Area modeled in GE Study (Ref. 3.5)

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

Area modeled in GE Study (Ref. 3.5)

Figure 1-3

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

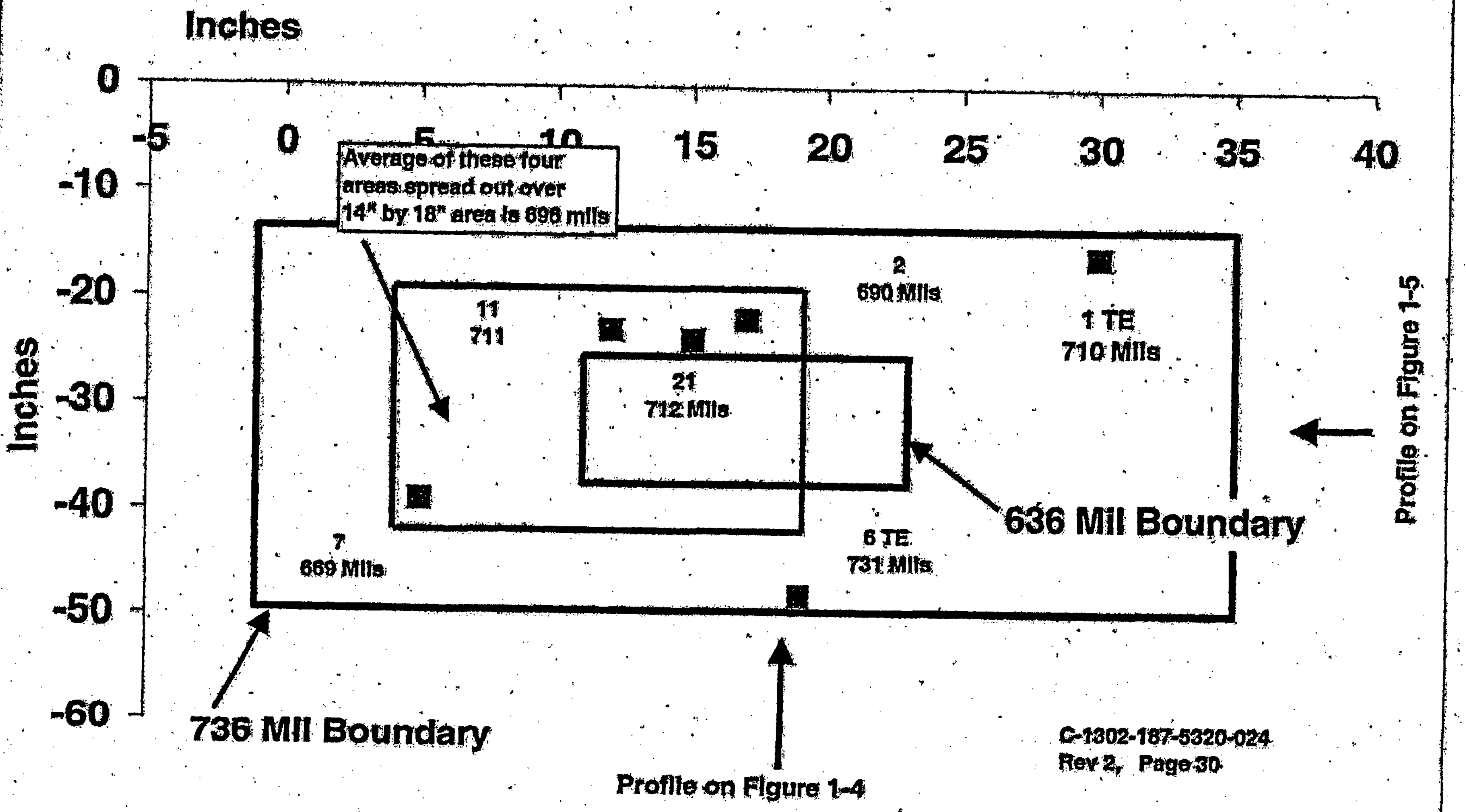


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Figure 1-4

Bay 1 Horizontal Profile
(Evaluation Thickness versus Local Buckling Criteria)

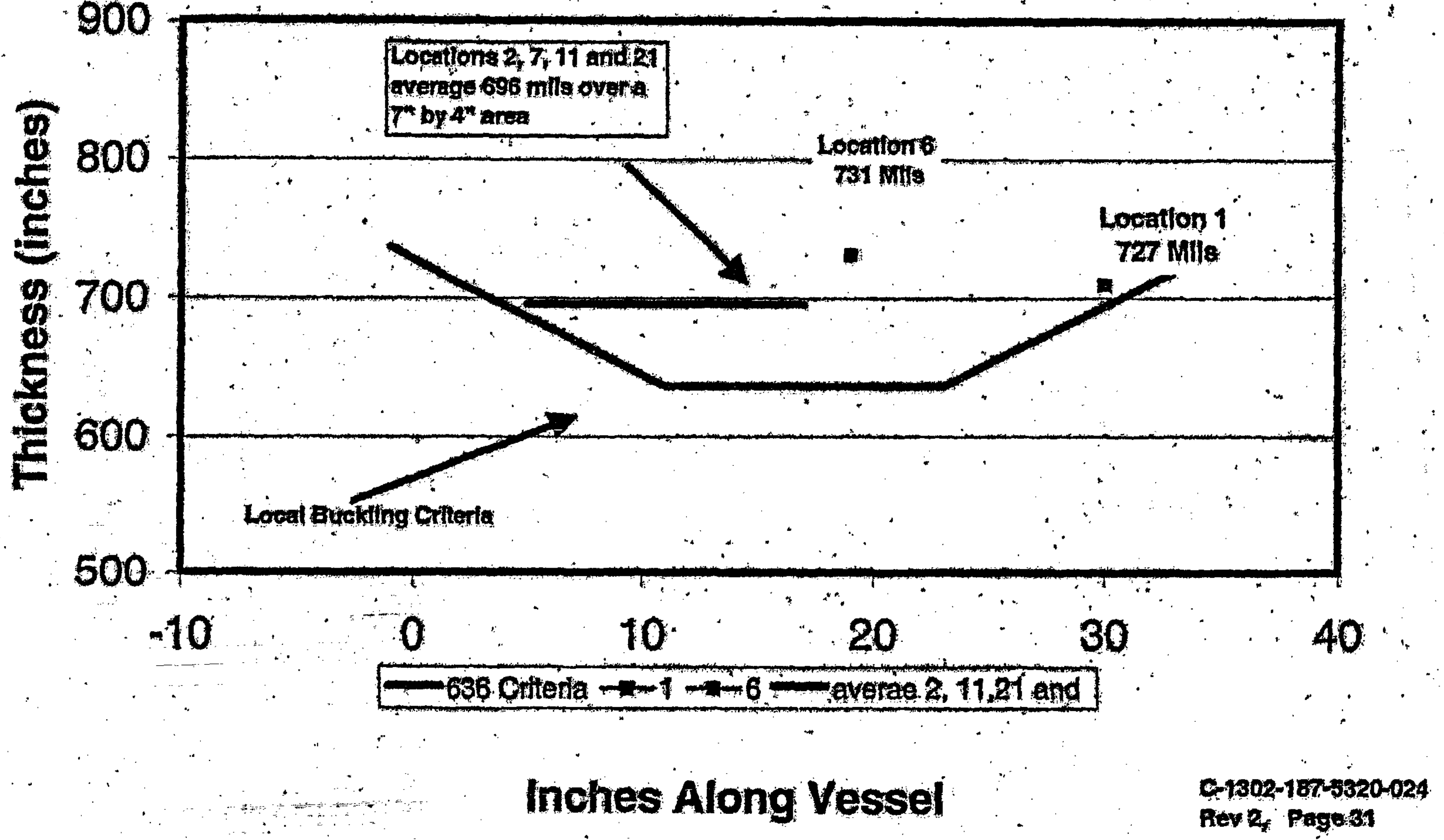

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Figure 1-5

Bay 1 Vertical Profile
(Evaluation Thickness versus Local Buckling Criteria)

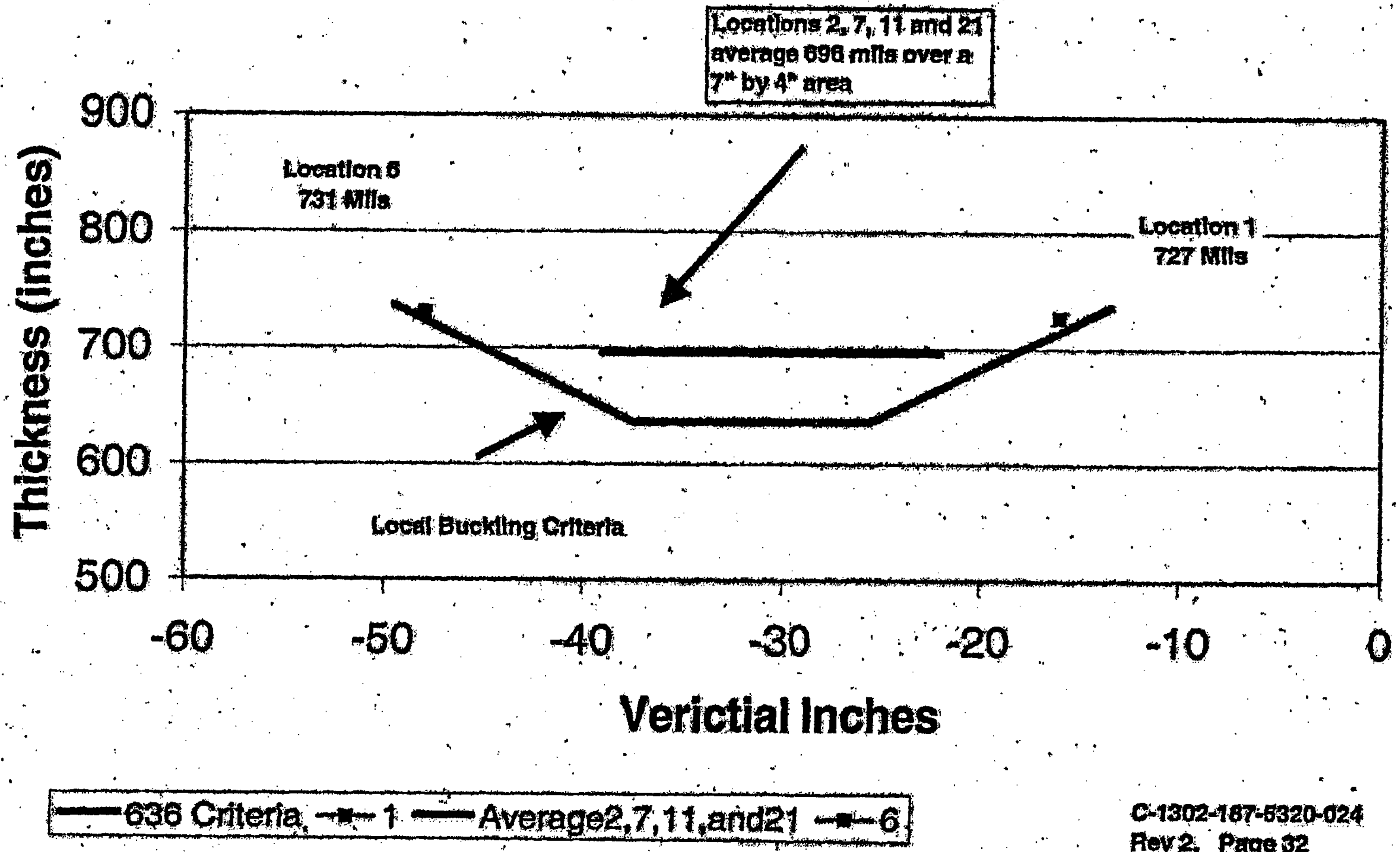
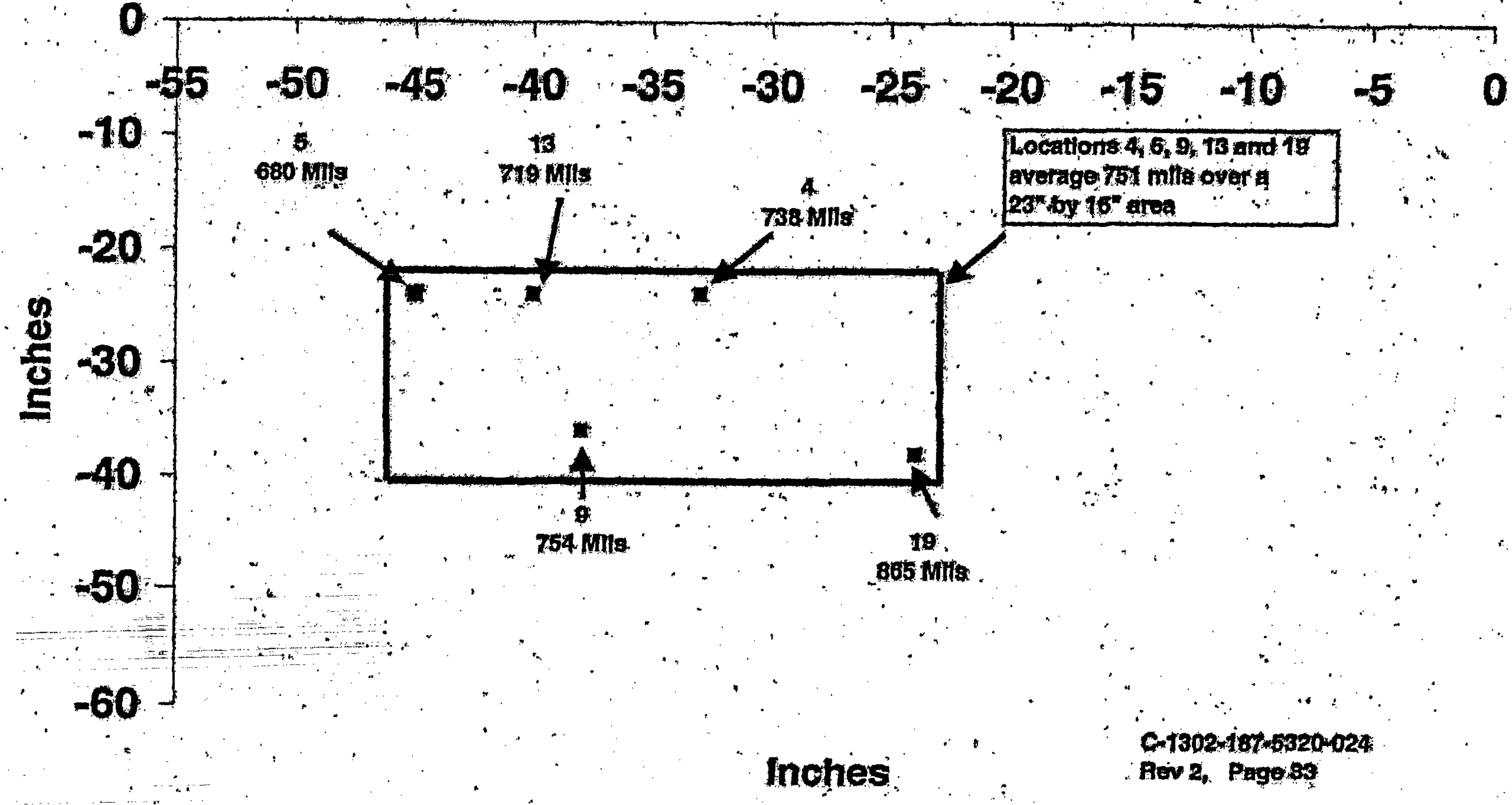


Figure 1-6

Bay 1 locations 5 and 13 Evaluation Thickness



Locations 4, 5, 9, 13 and 19 average 751 mils over a 23" by 16" area

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Figure 1-7

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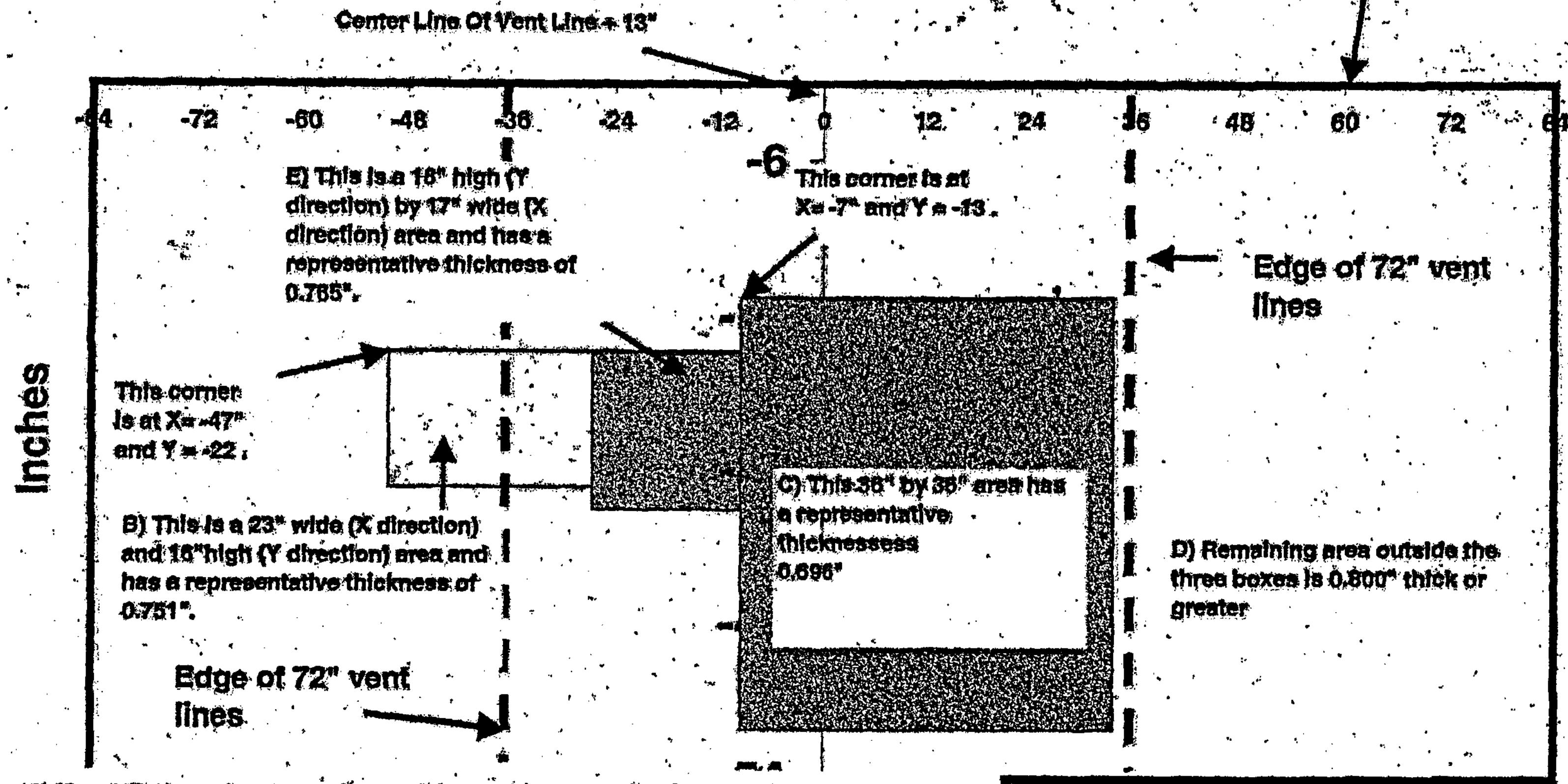
Bay 1 2006
Representative Thickenesses



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

Location	1992 UT Measurements (inches)	2006 UT Measurements (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.

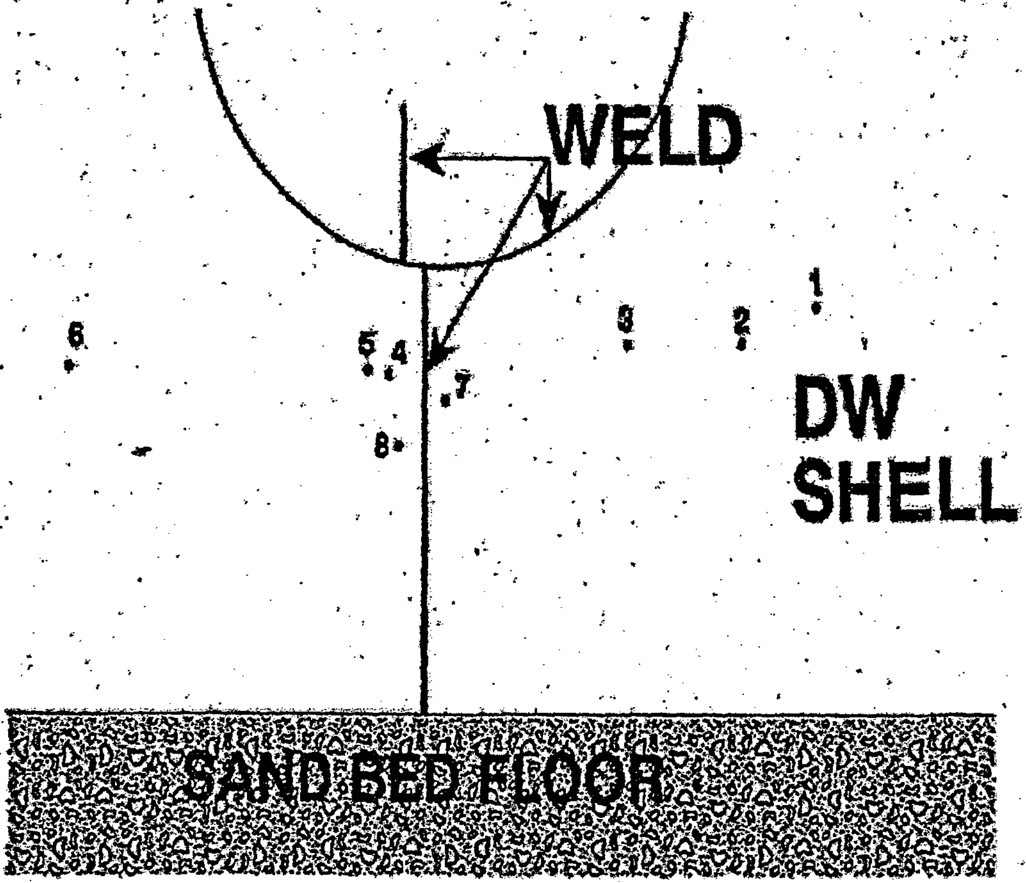
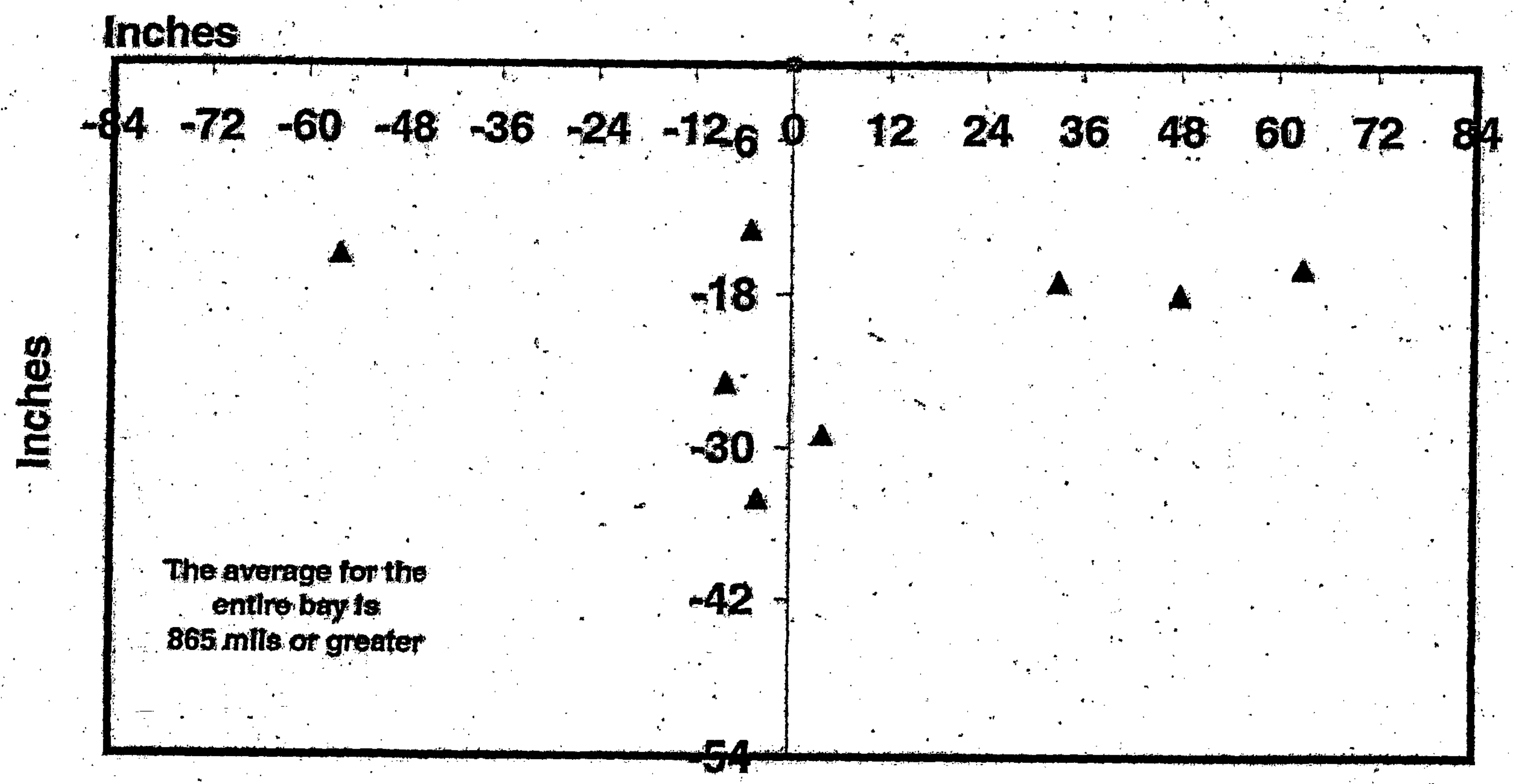


FIGURE (3)

Figure 3-2

Bay 3 2006
Spatial Relationship Of Locally Thin Areas



The average for the entire bay is 865 mils or greater

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

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

BAY #5 DATA

NOTES:

1. In this bay DW shell (butt) weld is about 8" to the right of C/L of vent tube. Therefore - all measurements were taken from a line drawn on shell which approx. coincide with vent tube C/L.

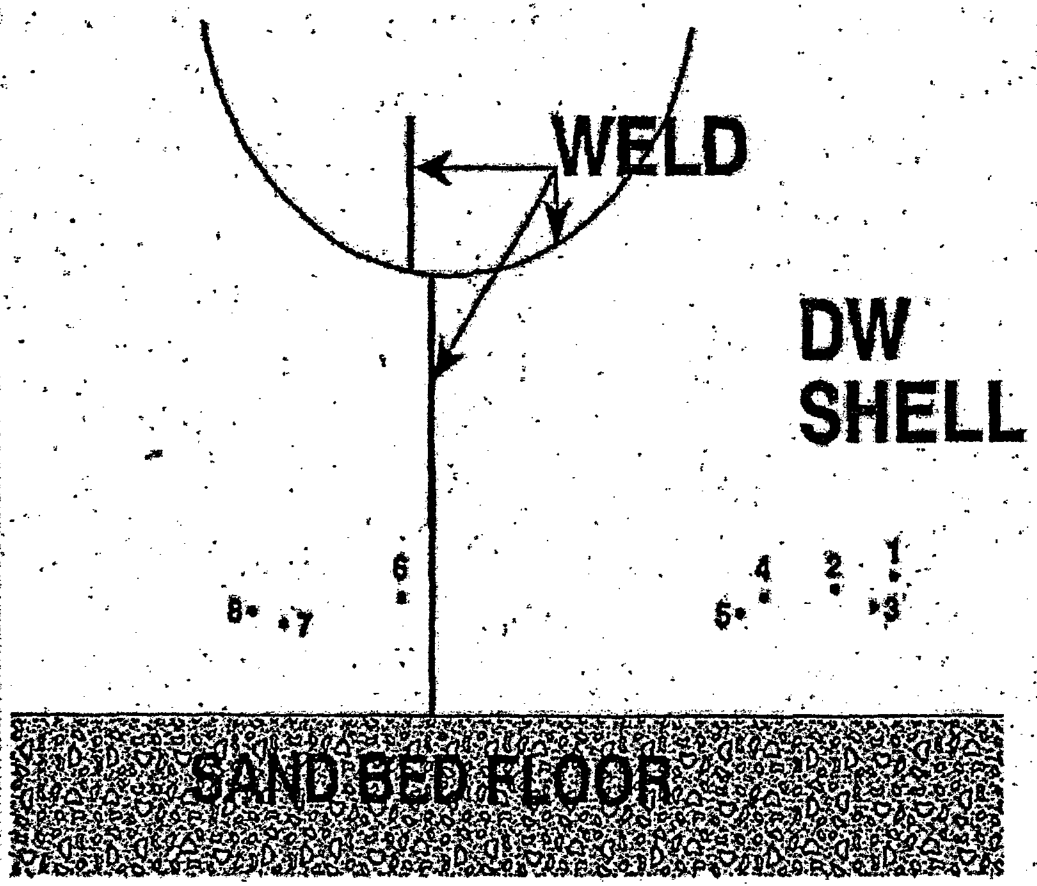
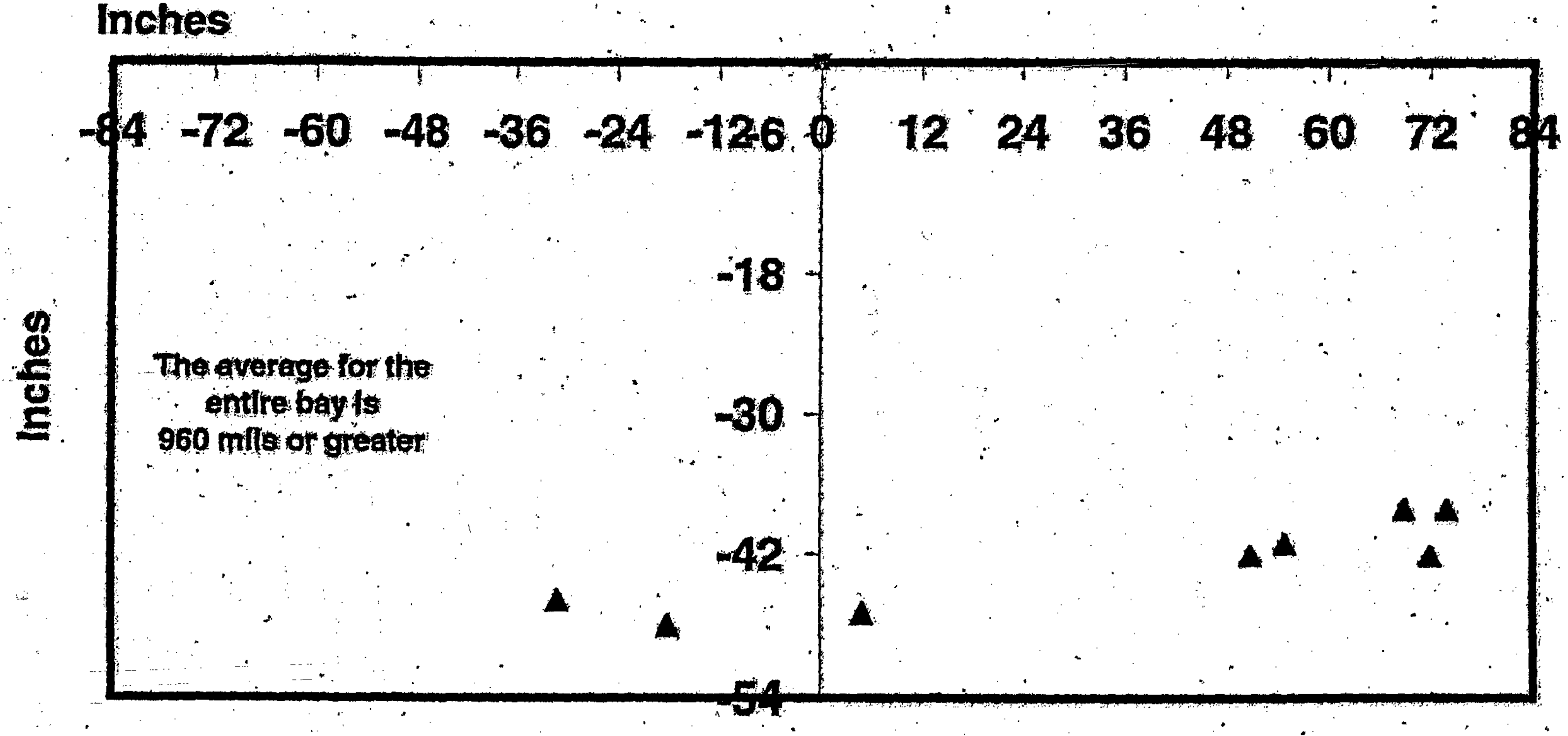


FIGURE (5)

Figure 5-2

Bay 5 2006
Spatial Relationship Of Locally Thin Areas



The average for the entire bay is 960 mils or greater

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 Measurements (inches)	2006 UT Measurements (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

BAY #7 DATA

NOTES:

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

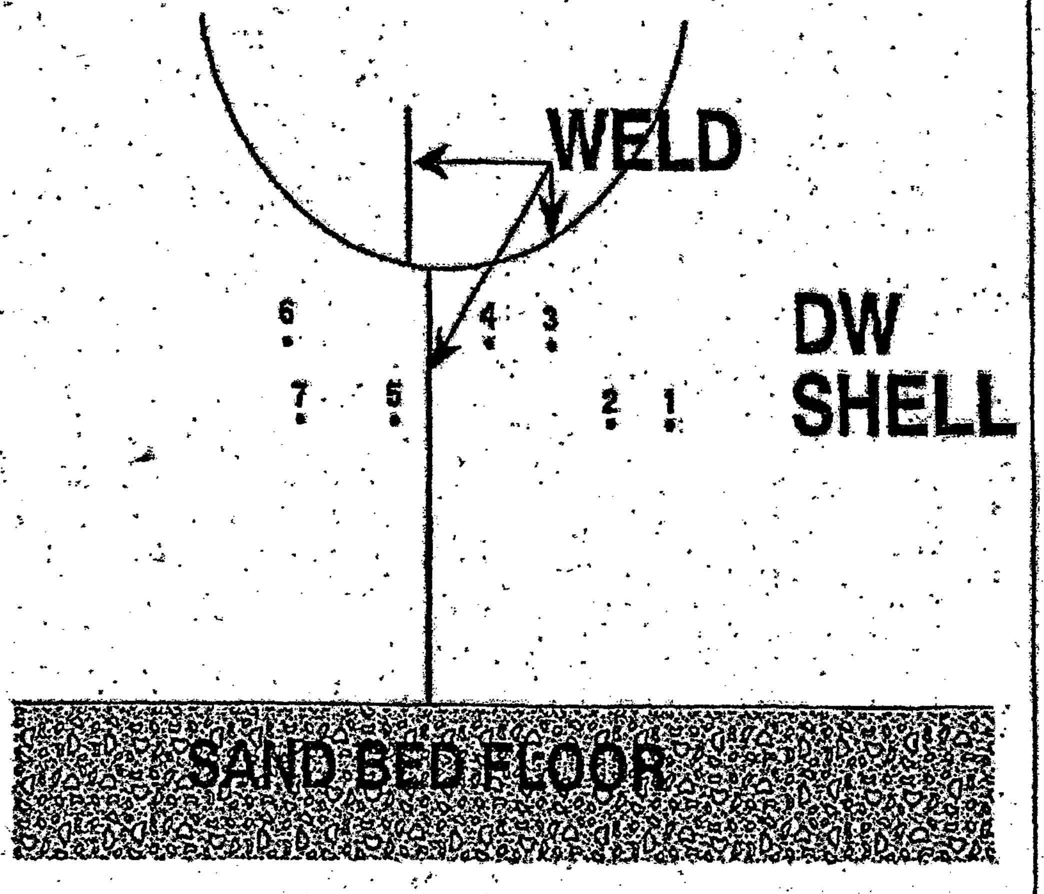
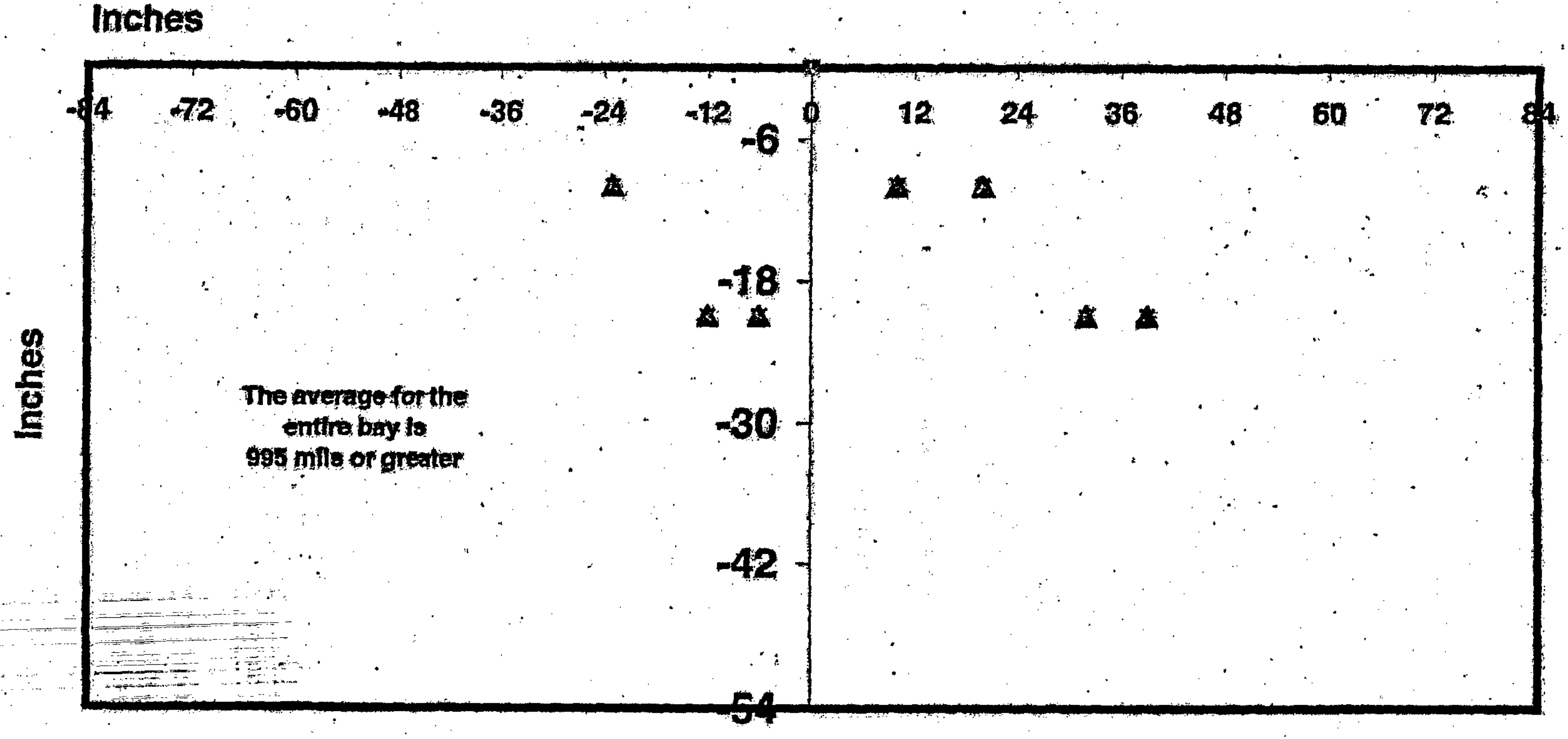


FIGURE (7)

Figure 7-2

Bay 7 2006
Spatial Relationship Of Locally Thin Areas



The average for the entire bay is 995 mils or greater

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

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).

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Figure 9-1

BAY #9 DATA

NOTES:

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

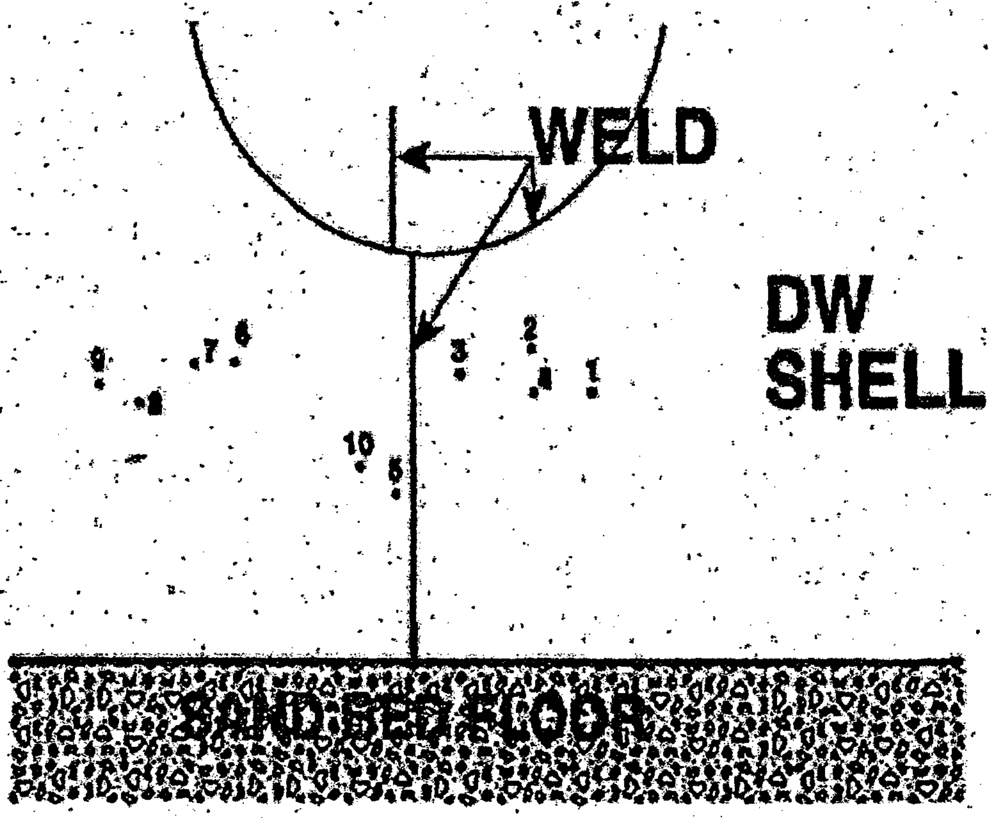
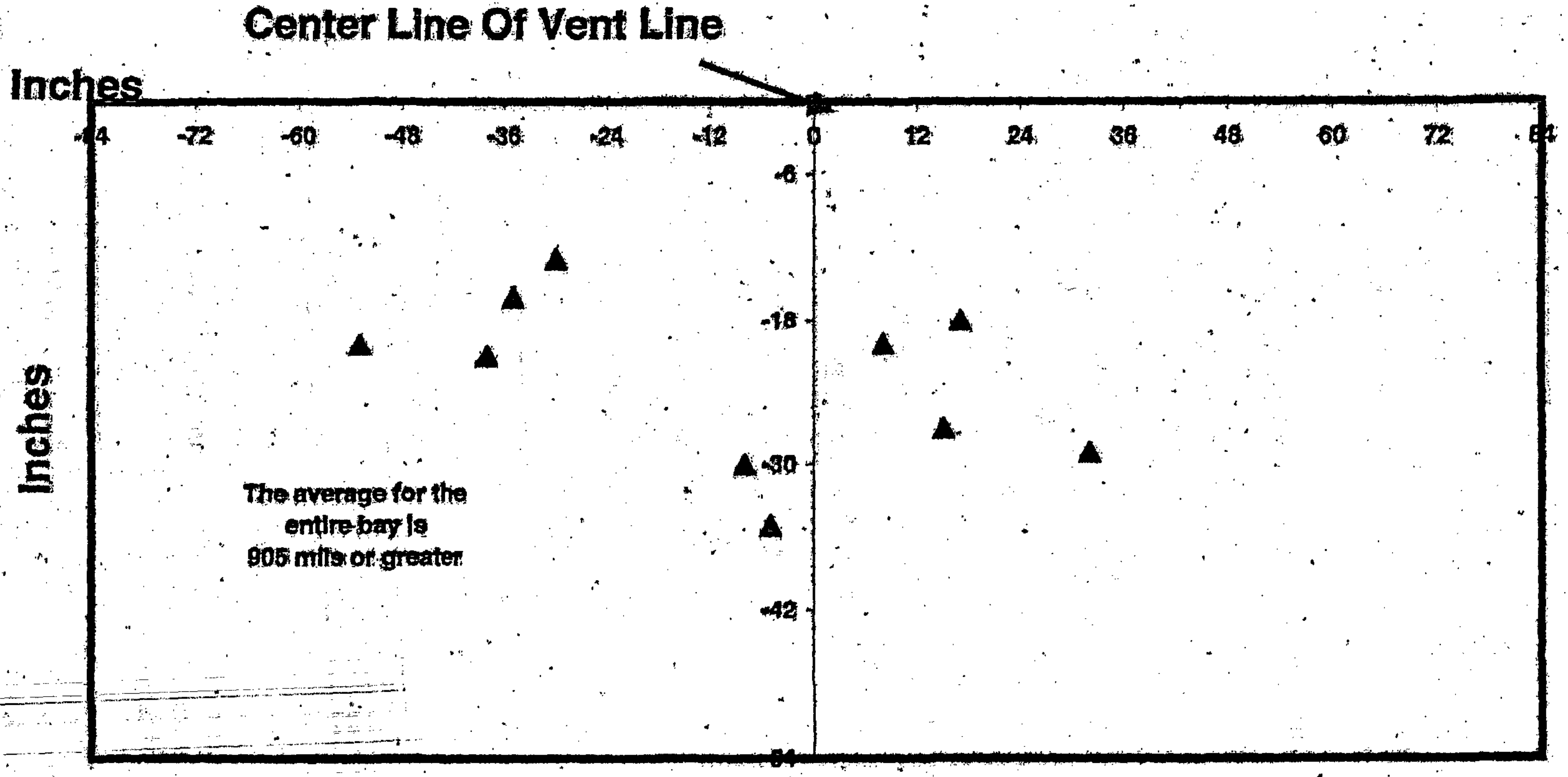


FIGURE (9)

Figure 9-2

Bay 9 2006
Spatial Relationship Of Locally Thin Areas



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

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 round 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 UT Measurements (inches)	2006 UT Measurements (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

Location	1992 UT Measurement (A) [illegible]	2006 UT Measurement (B)	Avg Pit Micrometer [illegible]	Mean Depth [illegible]	1992 Evaluation [illegible]	2006 Evaluation [illegible]	Remarks
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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Figure 11-1 **BAY #11 DATA**

NOTES:

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

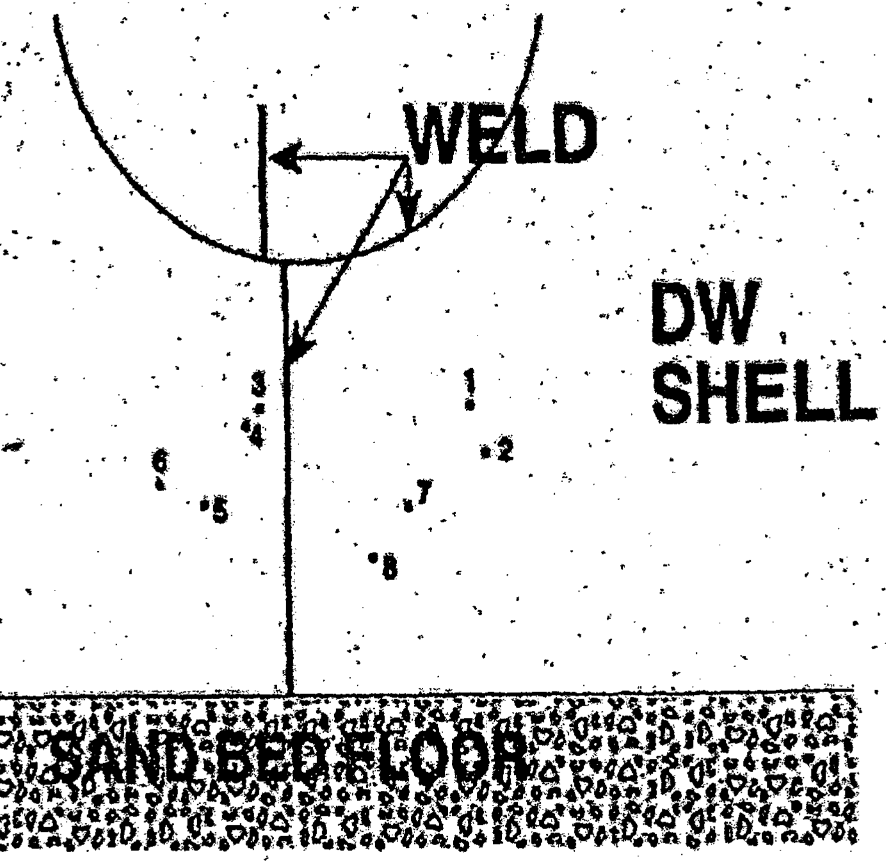
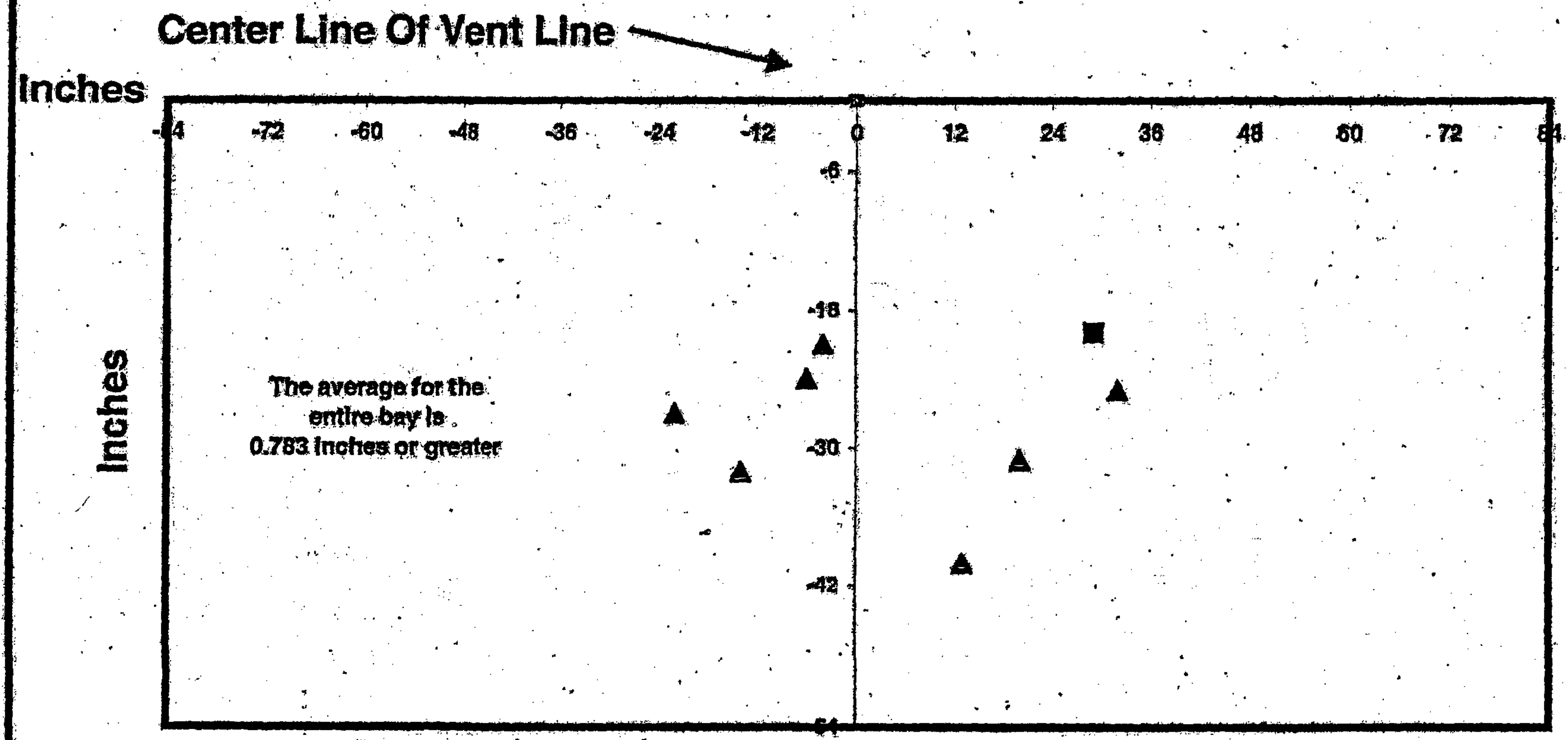


FIGURE (11)

Figure 11-2

Bay 11 2006
Spatial Relationship Of Locally Thin Areas



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

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	1992 UT Measurements (inches)	2006 UT Measurements (inches)
1/1A	0.672/0.890*	NA
2/2A	0.722/0.943*	NA
3	0.941	0.923
4	0.915	0.873
5/5A	0.718/0.851*	0.708
6/6A	0.655/0.976*	0.658
7/7A	0.618/0.752*	0.602
8/8A	0.718/0.900*	0.704
9	0.924	0.915
10/10A	0.728/0.810*	0.741
11/11A	0.685/0.854*	0.699
12	0.885	0.886
13	0.932	0.814
14	0.868	0.87

Location	1992 UT Measurements (inches)	2006 UT Measurements (inches)
15/15A	0.683/0.859*	0.666
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 #13 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

Locations	Avg at Azimuth Angles				AVG
	AVG 0°	AVG 45°	AVG 90°	AVG 135°	
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"

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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

Location No.	1992 UT Measurement (1A)	2006 UT Measurement (1B)	Avg. Micrometer (2)	Mean Depth (3)	1992 Evaluation (1A)+(2)-(3)	2006 Evaluation (1B)+(2)-(3)	Remarks
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.

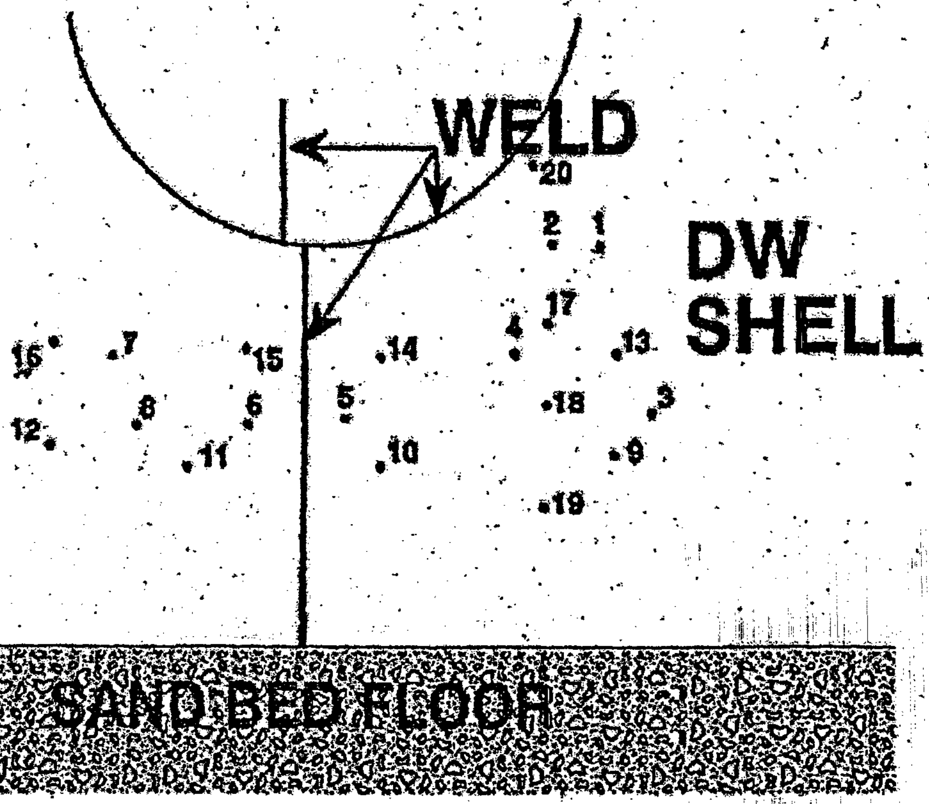
3) Area C (which is limited to an area of 12" by 12") meets the acceptance criteria in section 6.2.

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. IA 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".



Bay 13 - 2006
Spatial Relationship Of Locally Thin Areas

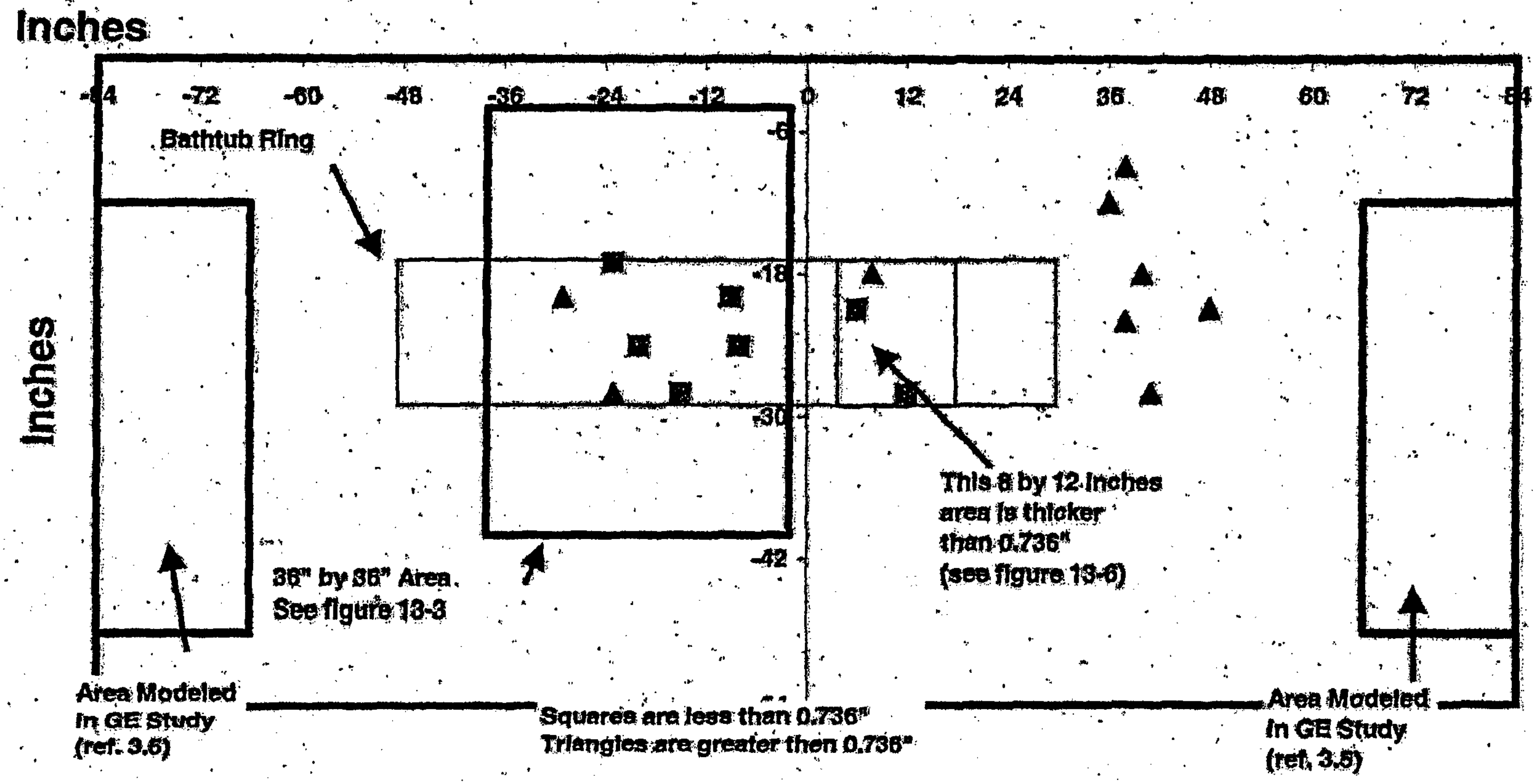


Figure 13-3

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Bay 13
Points 7, 8 and 11

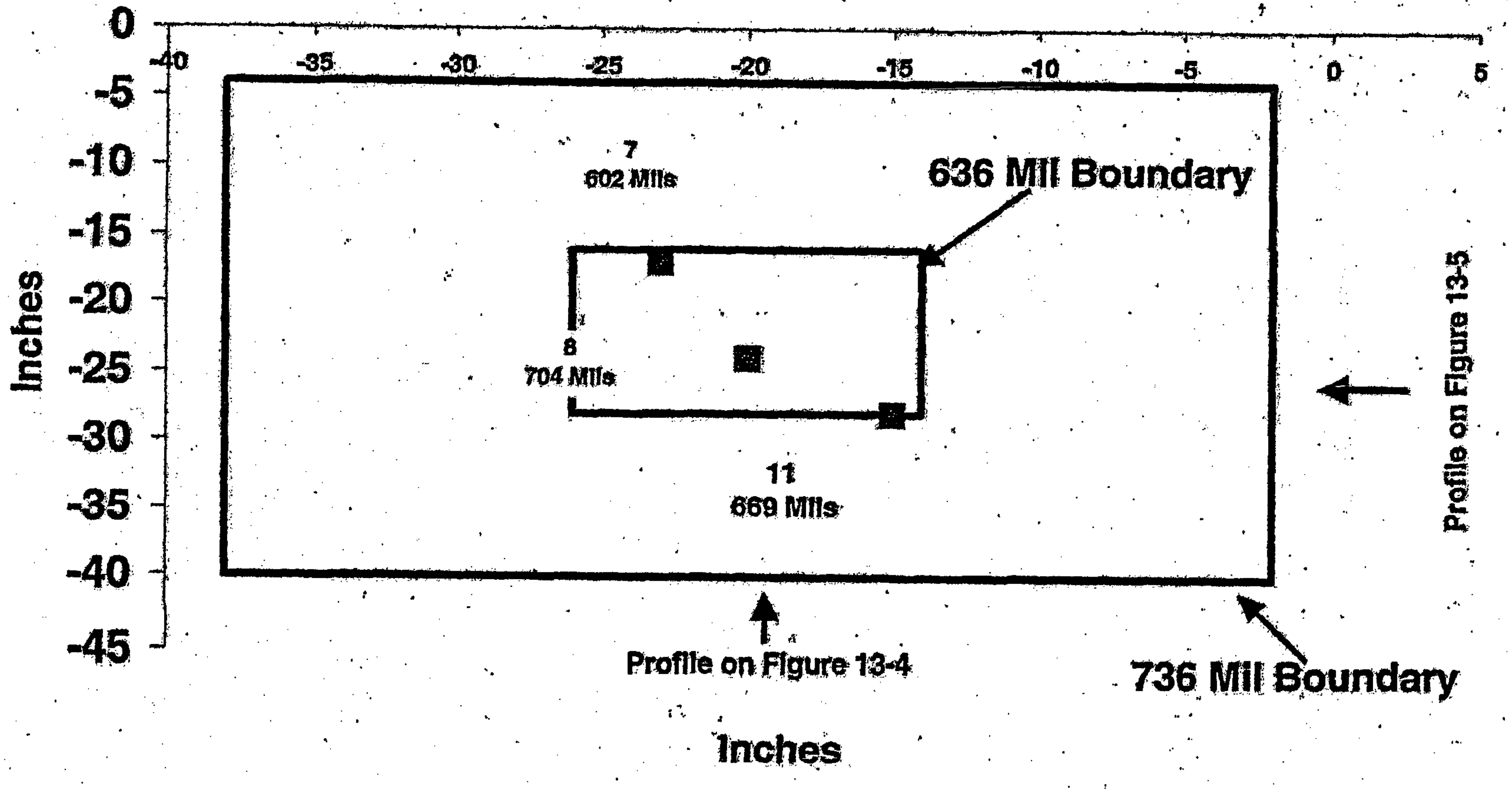

Figure 13 -4

Bay 13 Points 7, 8 and 11 Horizontal Profile

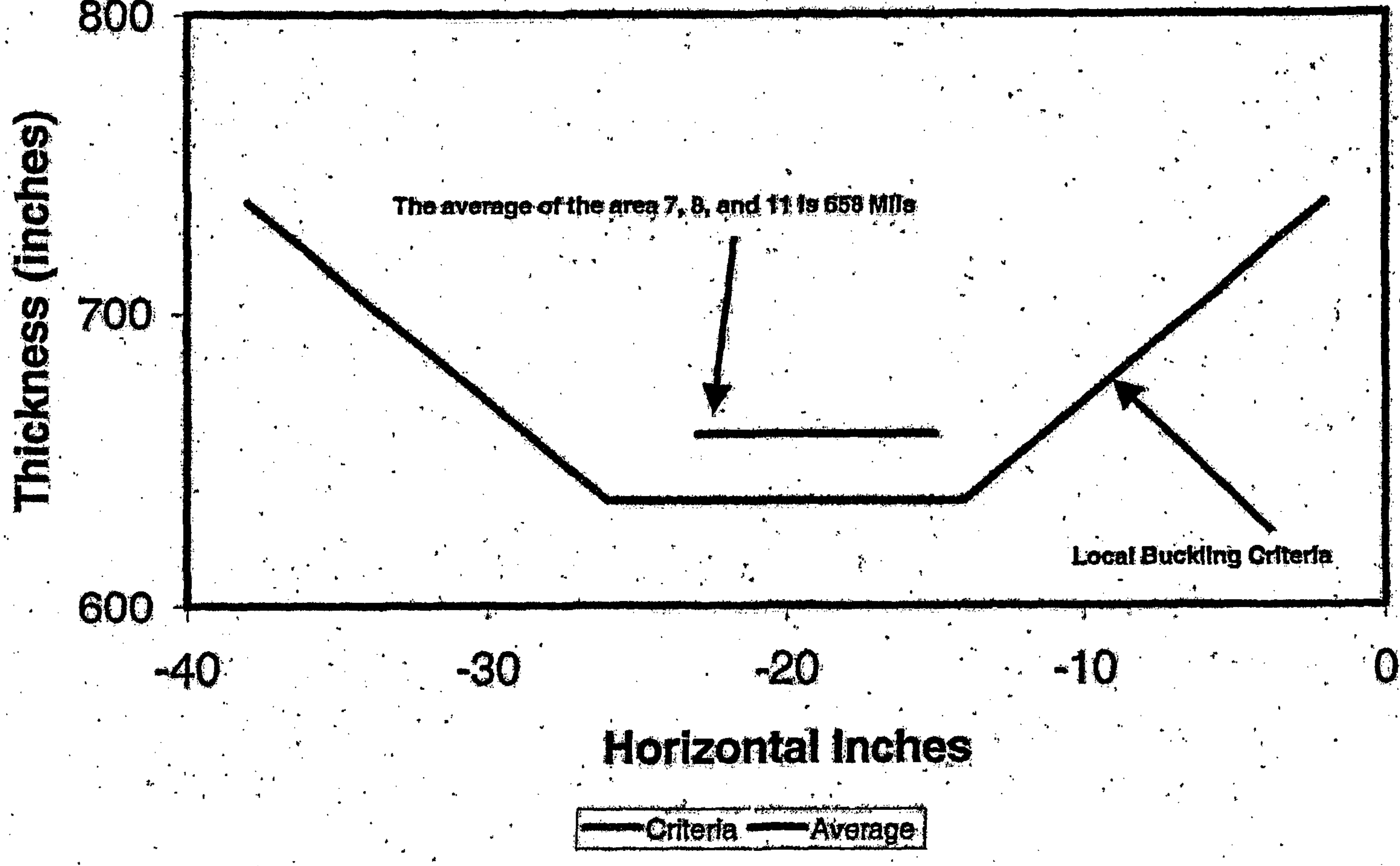

Figure 13 -5

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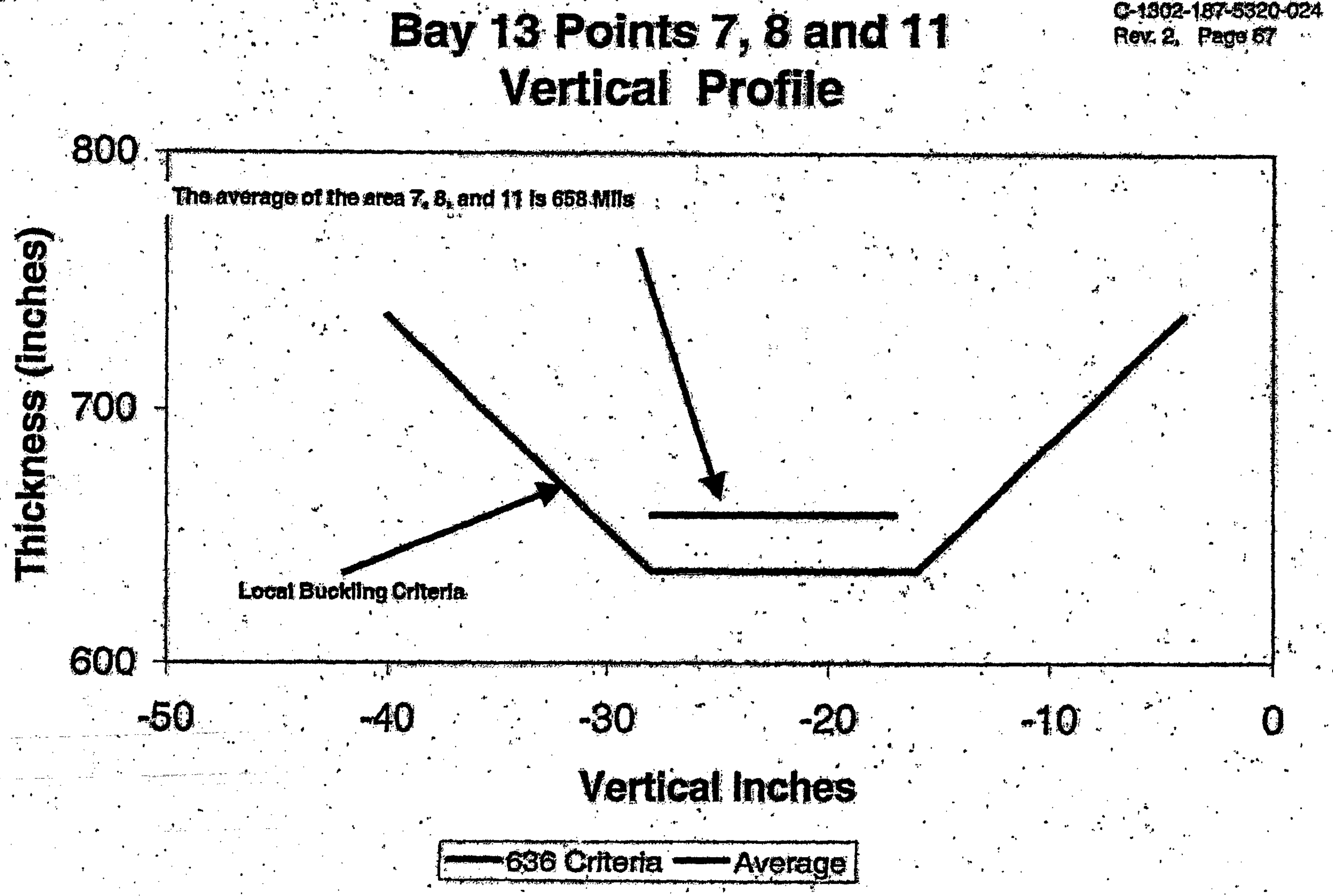
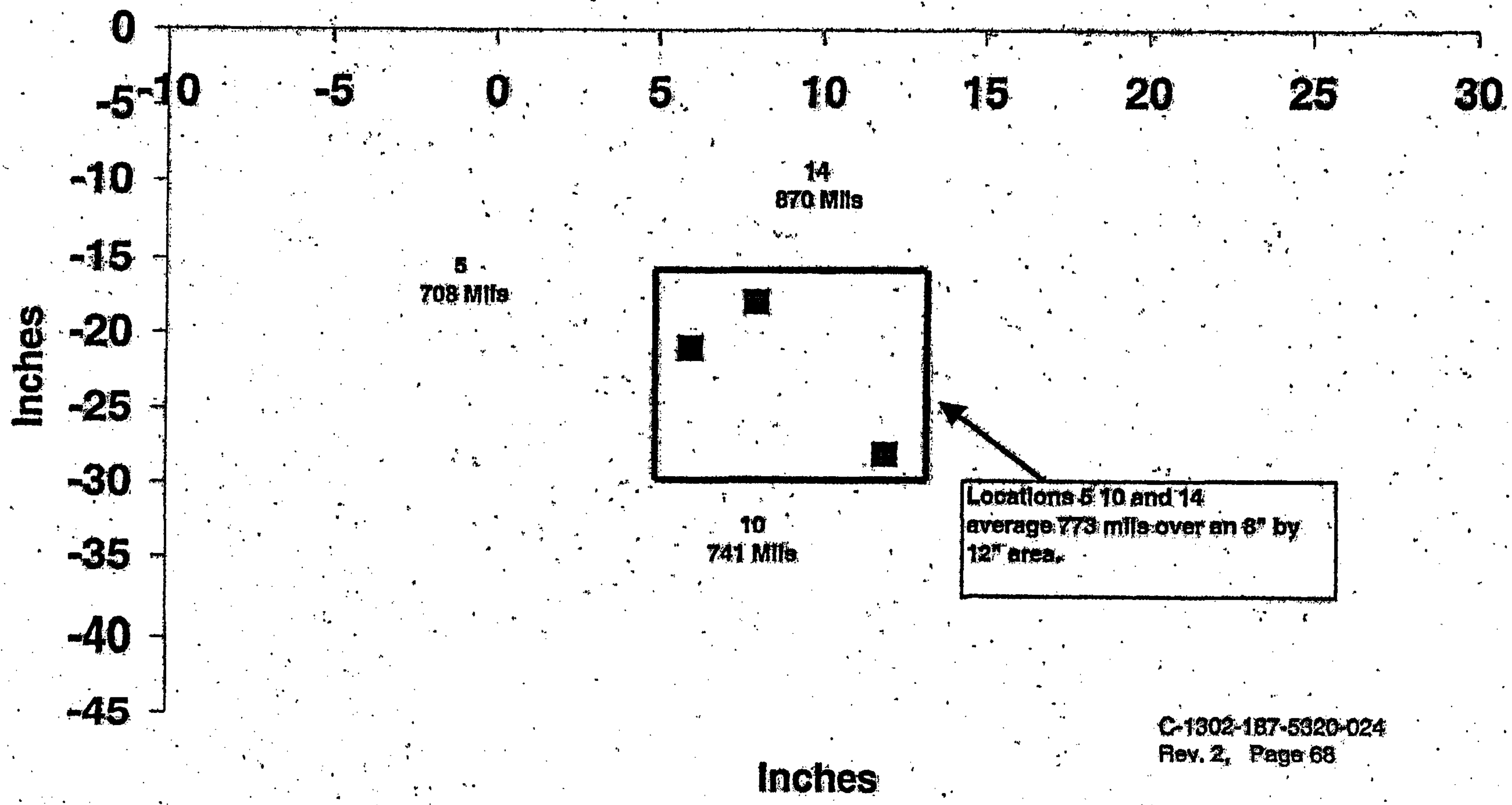


Figure 13-6

Bay 13 2006
Representative Thicknesses



Locations 5 10 and 14 average 773 mils over an 6" by 12" area.

Figure 13-7

Bay 13 - 2006
Locally Thin Areas

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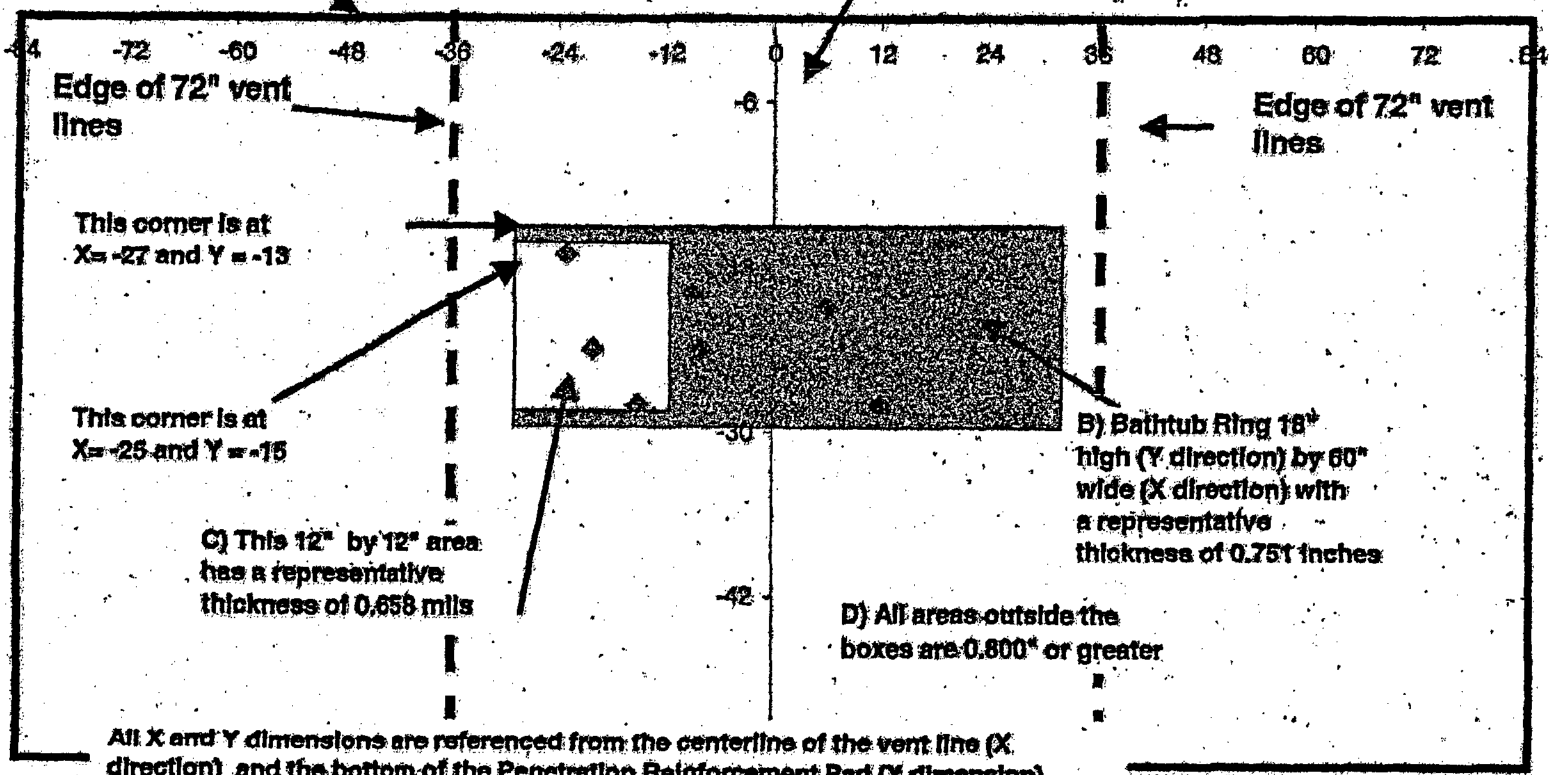

Bottom of Penetration Reinforcement Pad

Center Line Of Vent Line

Edge of 72" vent lines

Edge of 72" vent lines

This corner is at X= -27 and Y = -13

This corner is at X= -25 and Y = -15

C) This 12" by 12" area has a representative thickness of 0.658 mils

B) Bathtub Ring 18" high (Y direction) by 60" wide (X direction) with a representative thickness of 0.751 inches

D) All areas outside the boxes are 0.800" or greater

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 92-072-24 page 1 of 2 and 1LR-010 page 2 of 2.

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

Location	1992 UT Measurements (inches)	2006 UT Measurements (inches)
1	0.786	0.711
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	0.722	0.720
10	0.860	0.837
11	0.825	0.798
Average	0.816	0.788

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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

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	0.722"	0.720	0.337"	0.200"	0.859"	0.857"	7.15.3.1
1	0.786"	0.711"					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 15-4 and 15-5 shows the profile of the 36" by 36" area with the area thickness overlaid on the curve depicting the acceptance criteria. Figure 15-4 shows the profile along the horizontal axis and figure 15-5 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	0.218

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.

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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.

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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".

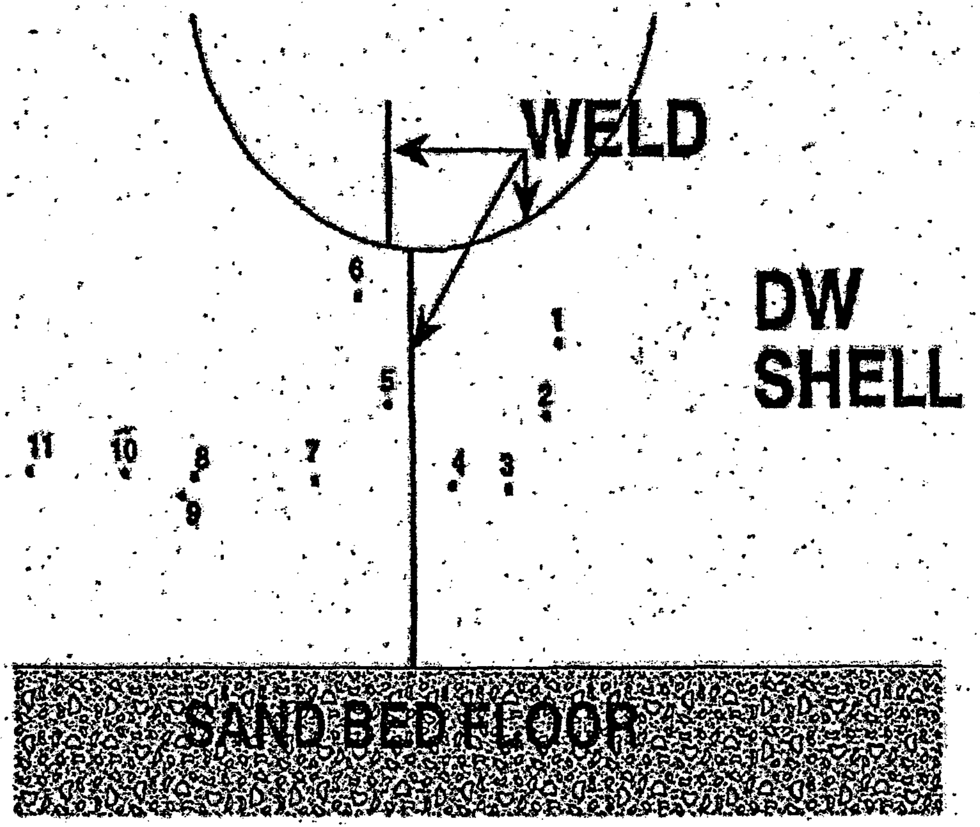
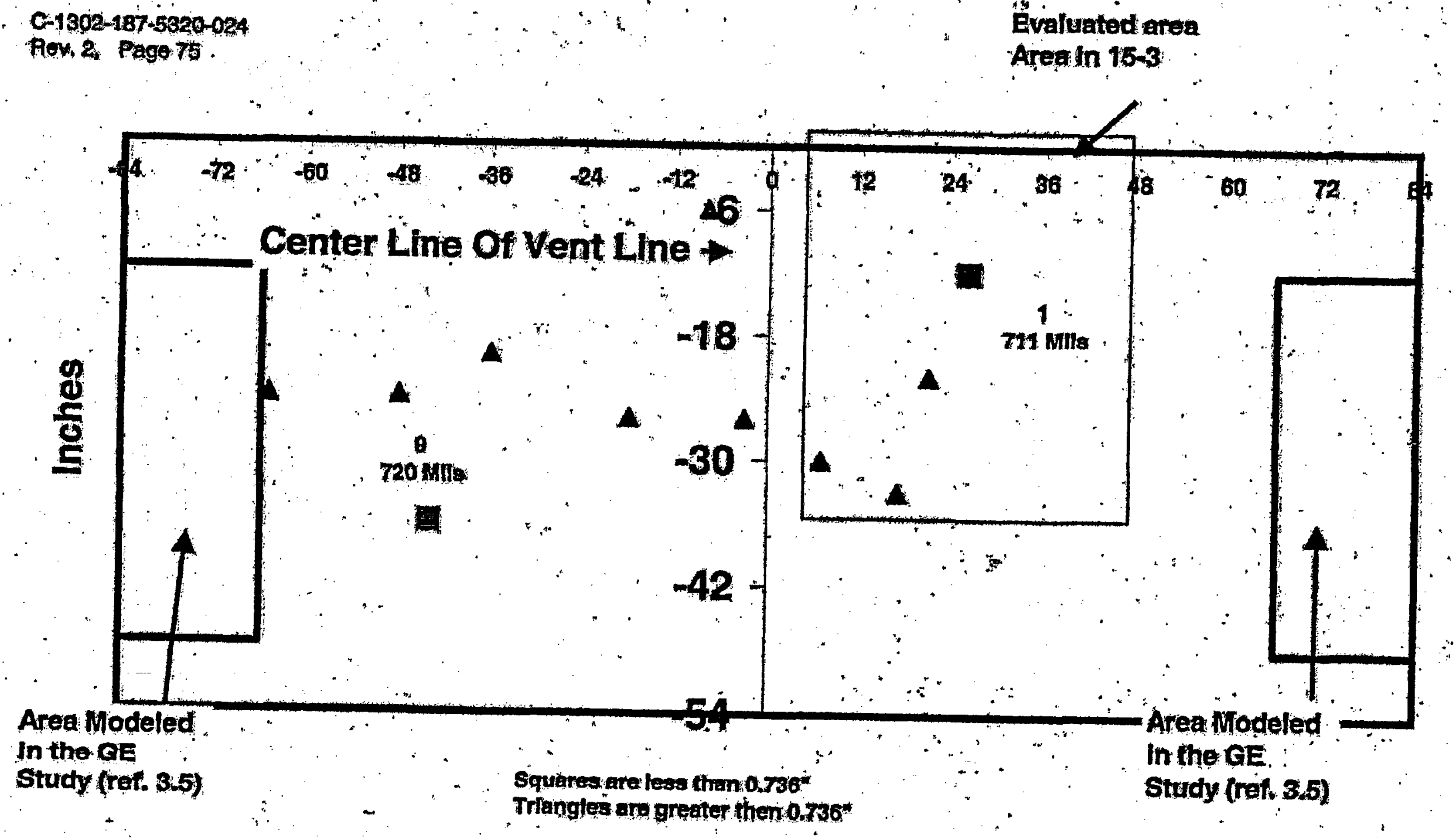


FIGURE (15)

Figure 15-2

Bay 15 2006
Spatial Relationship Of Locally Thin Areas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Squares are less than 0.736"
Triangles are greater then 0.736"

Figure 15-3

Bay 15 Locations 1, 2, 6, 7, 11 and 21 Evaluation Thickness

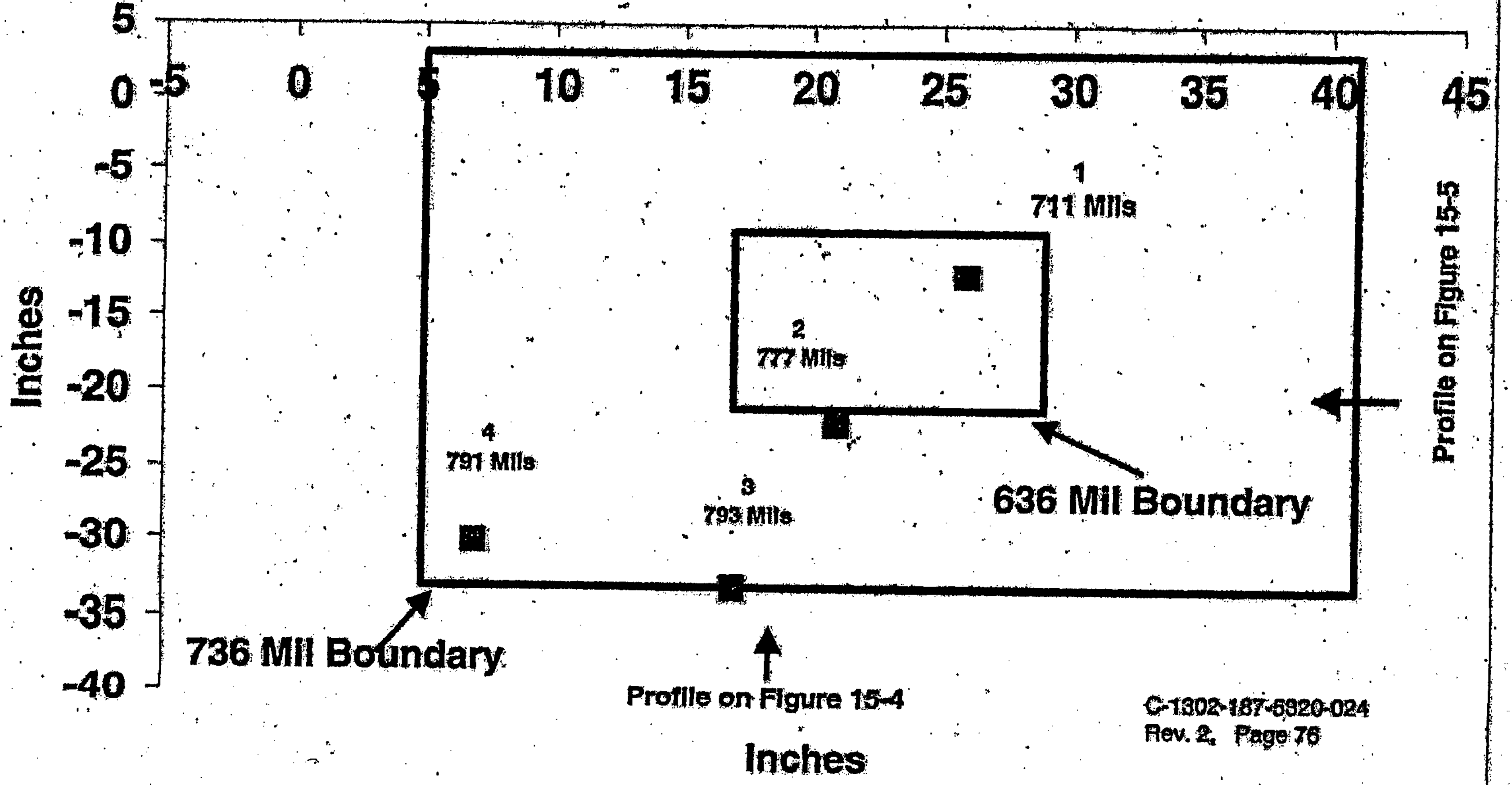

Figure 15-4

Bay 1 Horizontal Profile
(Evaluation Thickness versus Local Buckling Criteria)

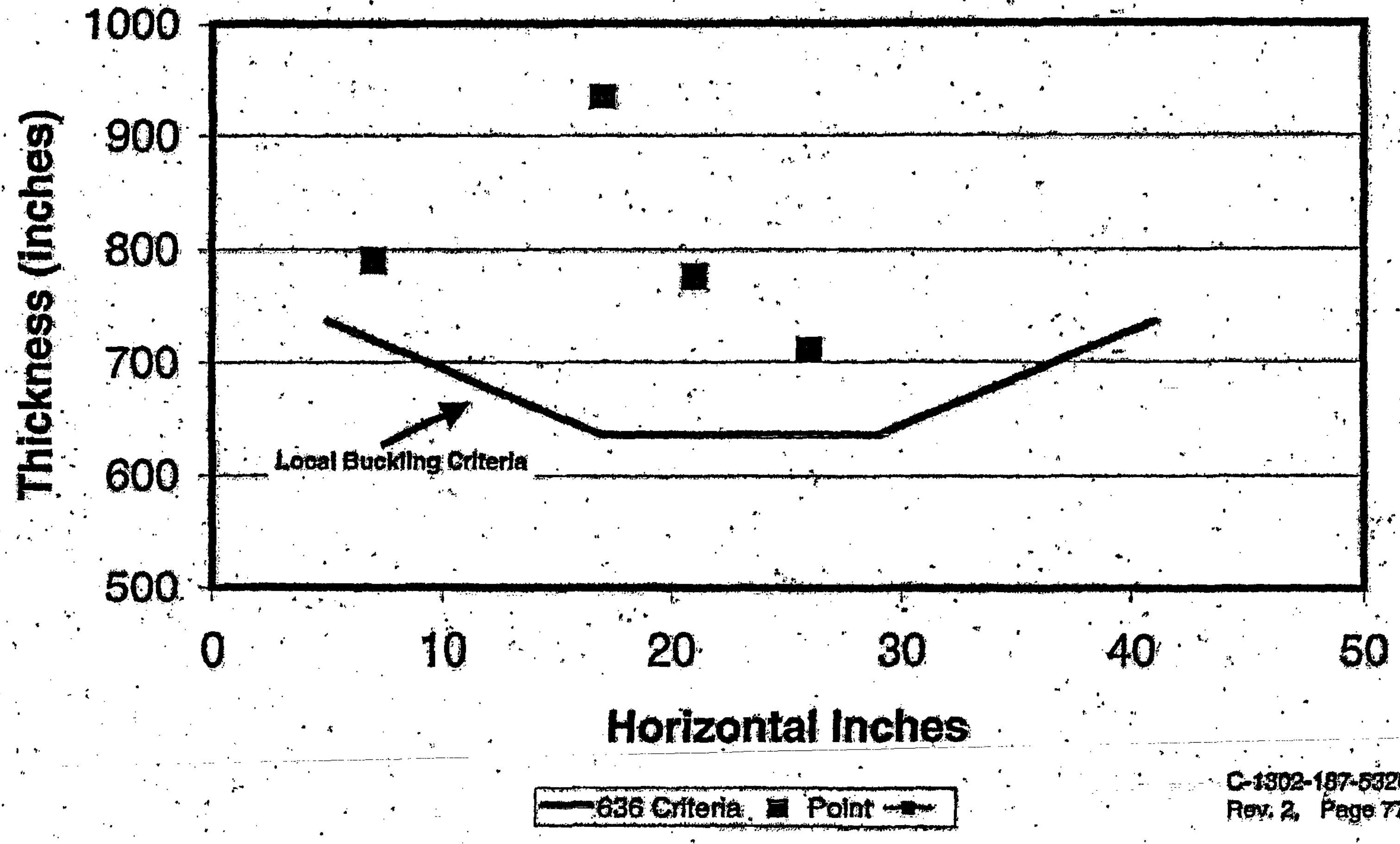

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Figure 15-5

Bay 1 Vertical Profile (Evaluation Thickness versus Local Buckling Criteria)

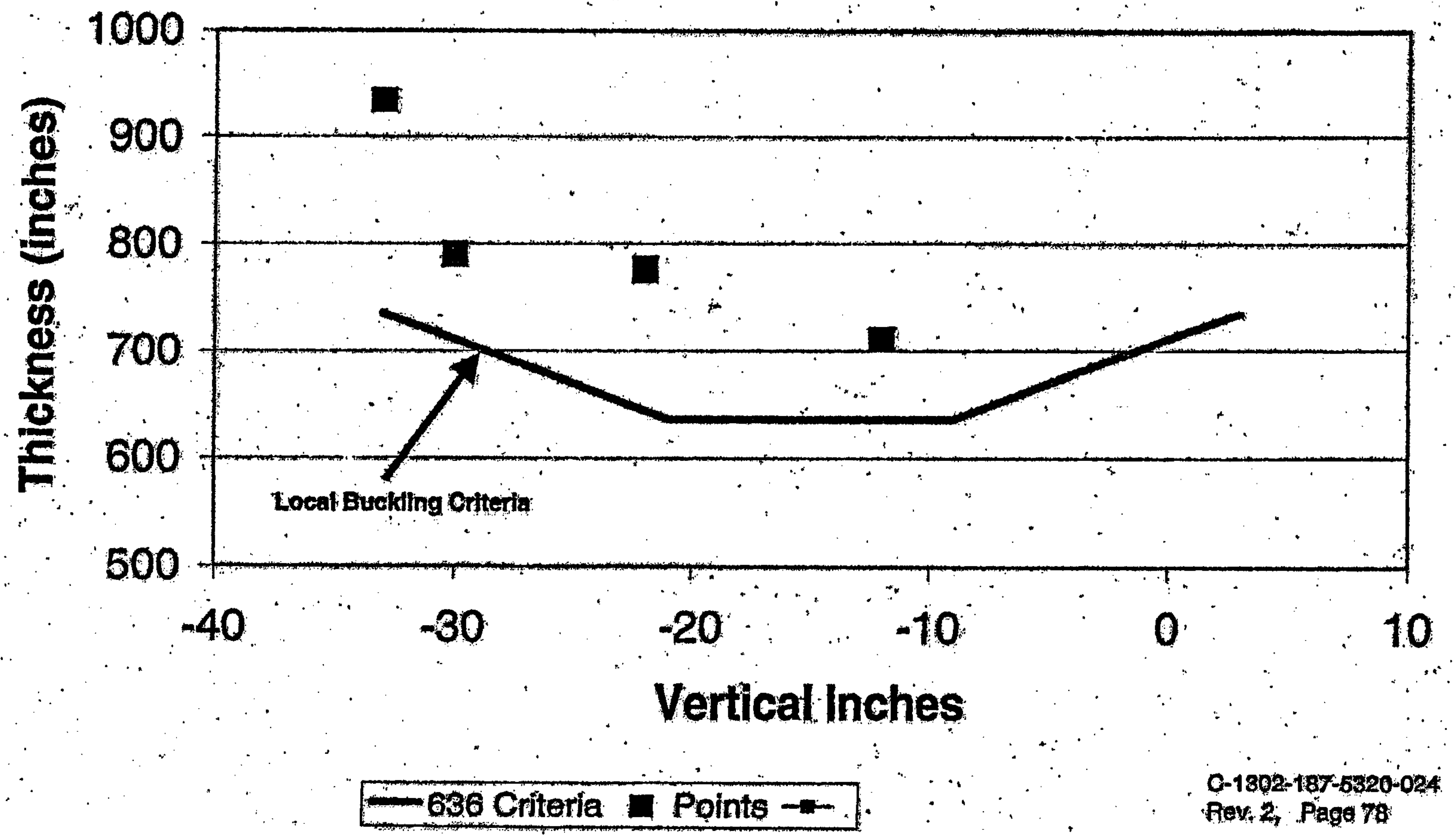

Figure 15-6

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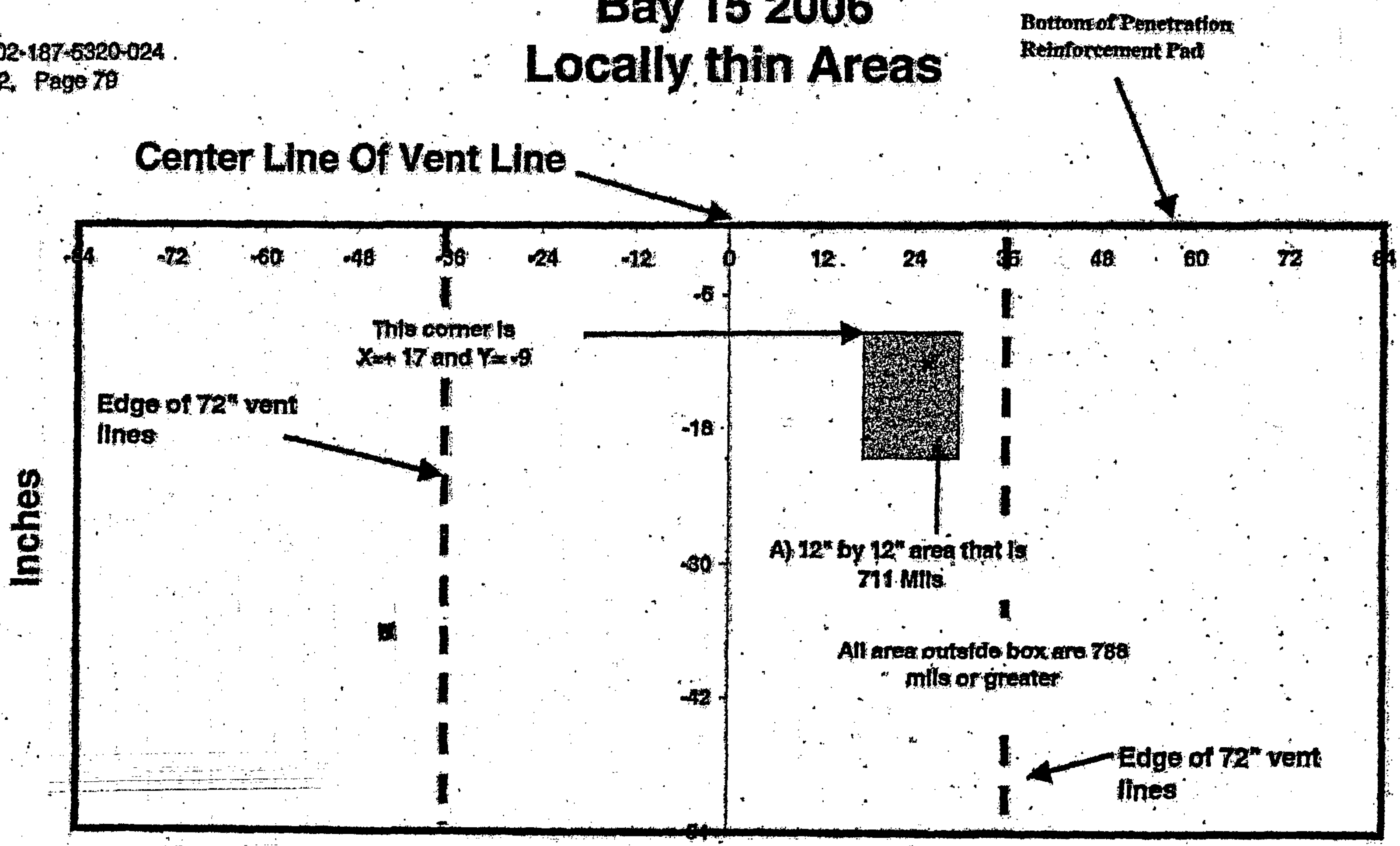
Bay 15 2006
Locally thin Areas



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 92-072-21 page 1 of 1 and 1R21LR-015 page 2 of 2

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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 UT Measurements (inches)	2006 UT Measurements (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	0.720	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

Location [illegible]	1992 UT Measurement [illegible]	2006 UT Measurement [illegible]	1992 Micrometer [illegible]	Mean Depth [illegible]	1992 Evaluation [illegible]	2006 Evaluation [illegible]	Remarks
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 vith thickness equal to thinnest readings (Column 2) hen compared to a uniform thickness of 0.736 inches 0.736 – Column 2)* 3.142*(2.5/2)**2
2	0.633	0.649
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.

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Peter Tamburro	3/21/07	Julien Abramovici		

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".

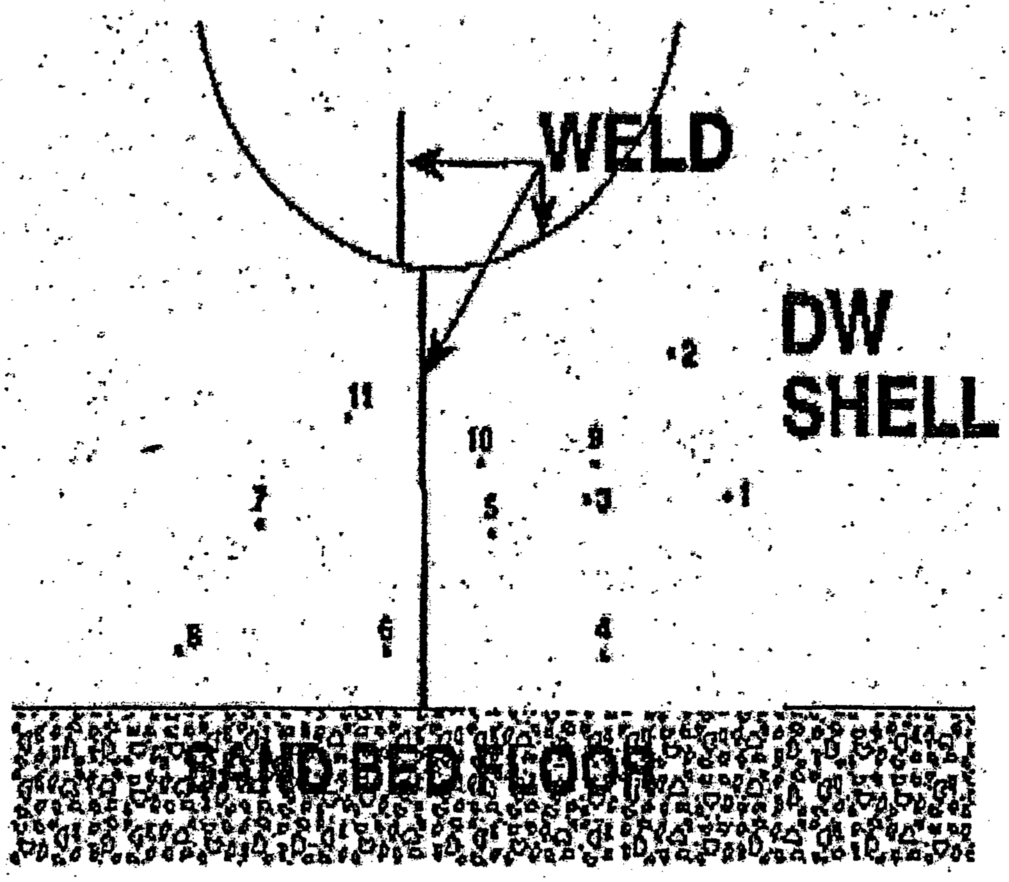
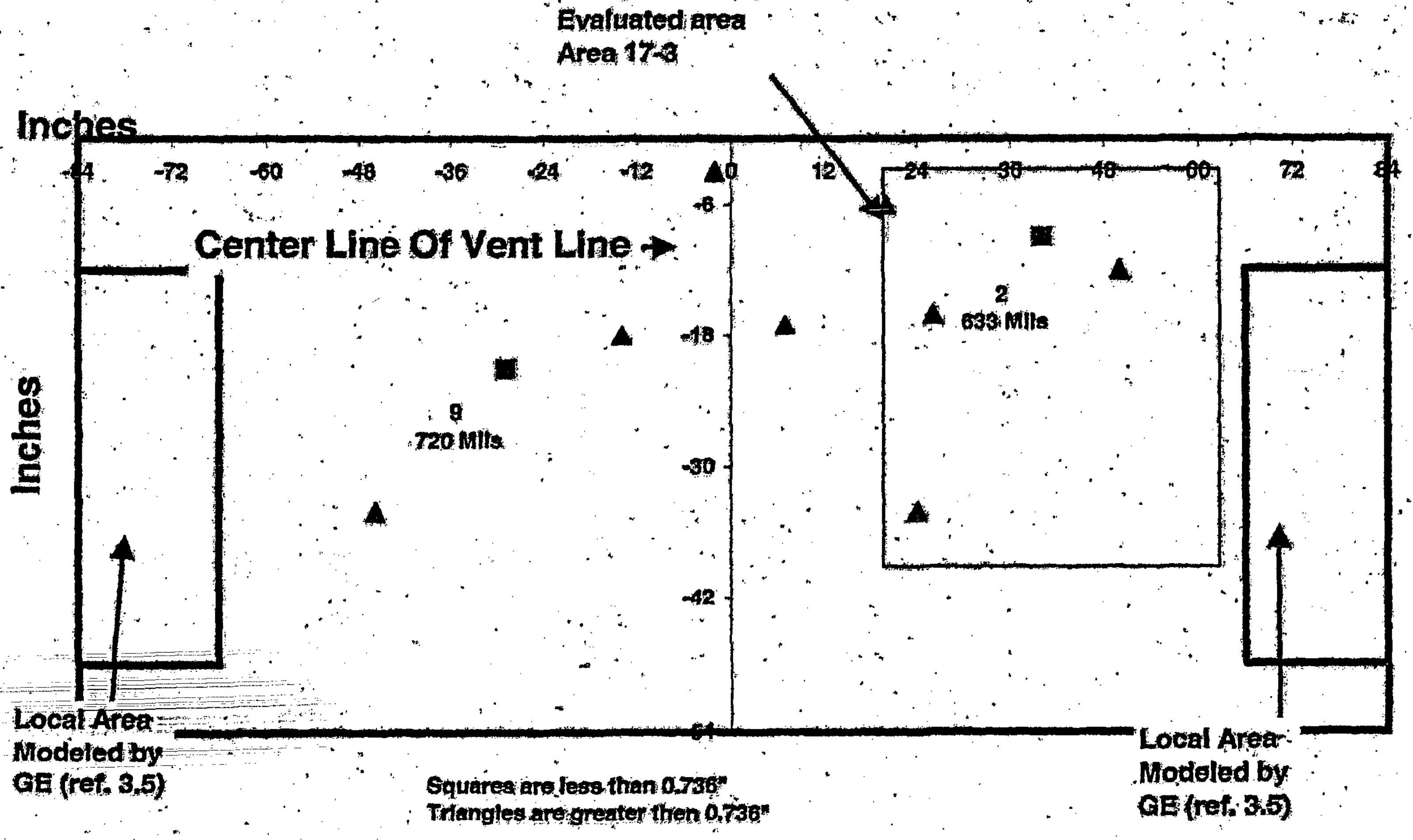


FIGURE (17)

Figure 17-2

Bay 17 2006
Spatial Relationship Of Locally Thin Areas



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

Figure 17-3

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

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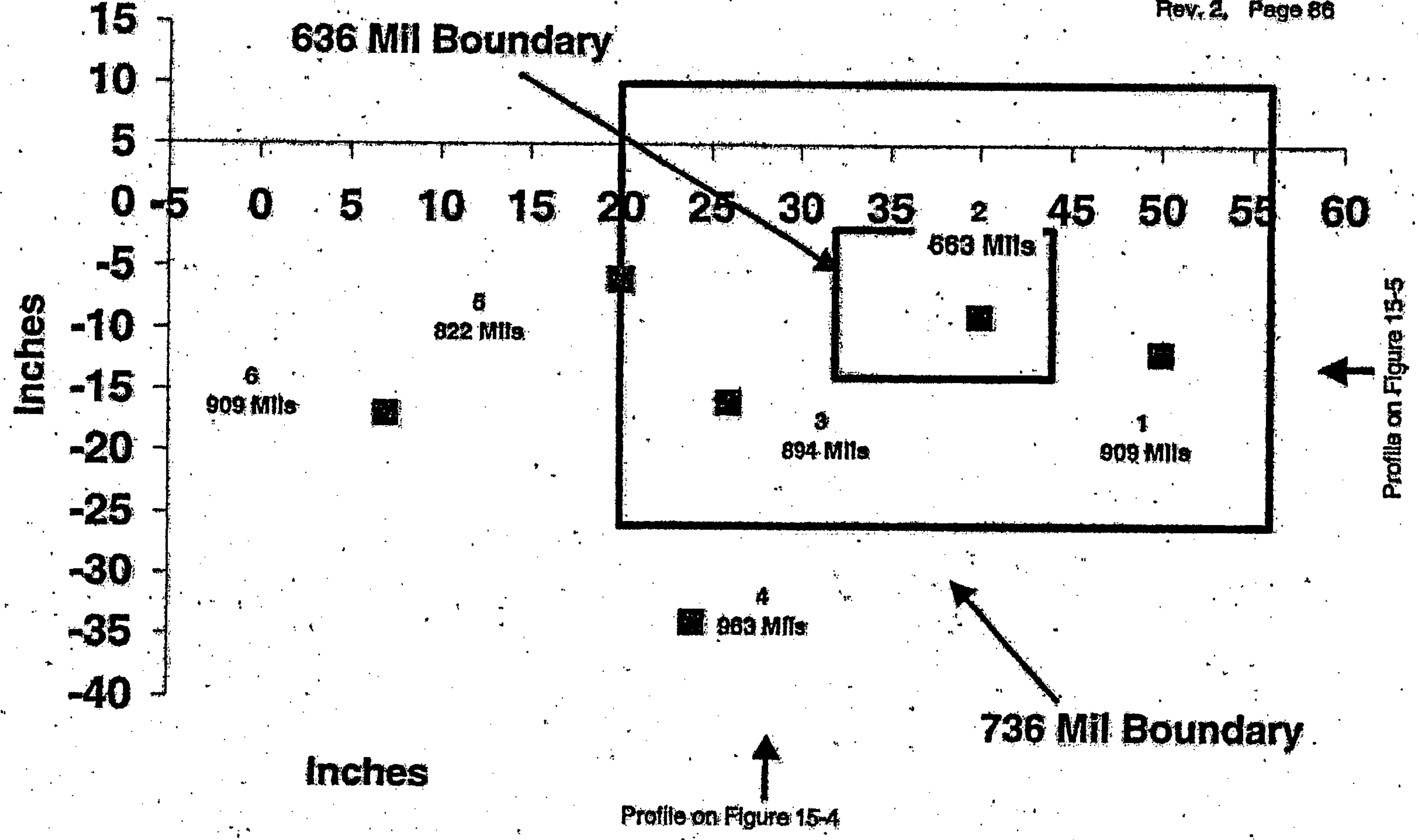


Figure 17-4

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

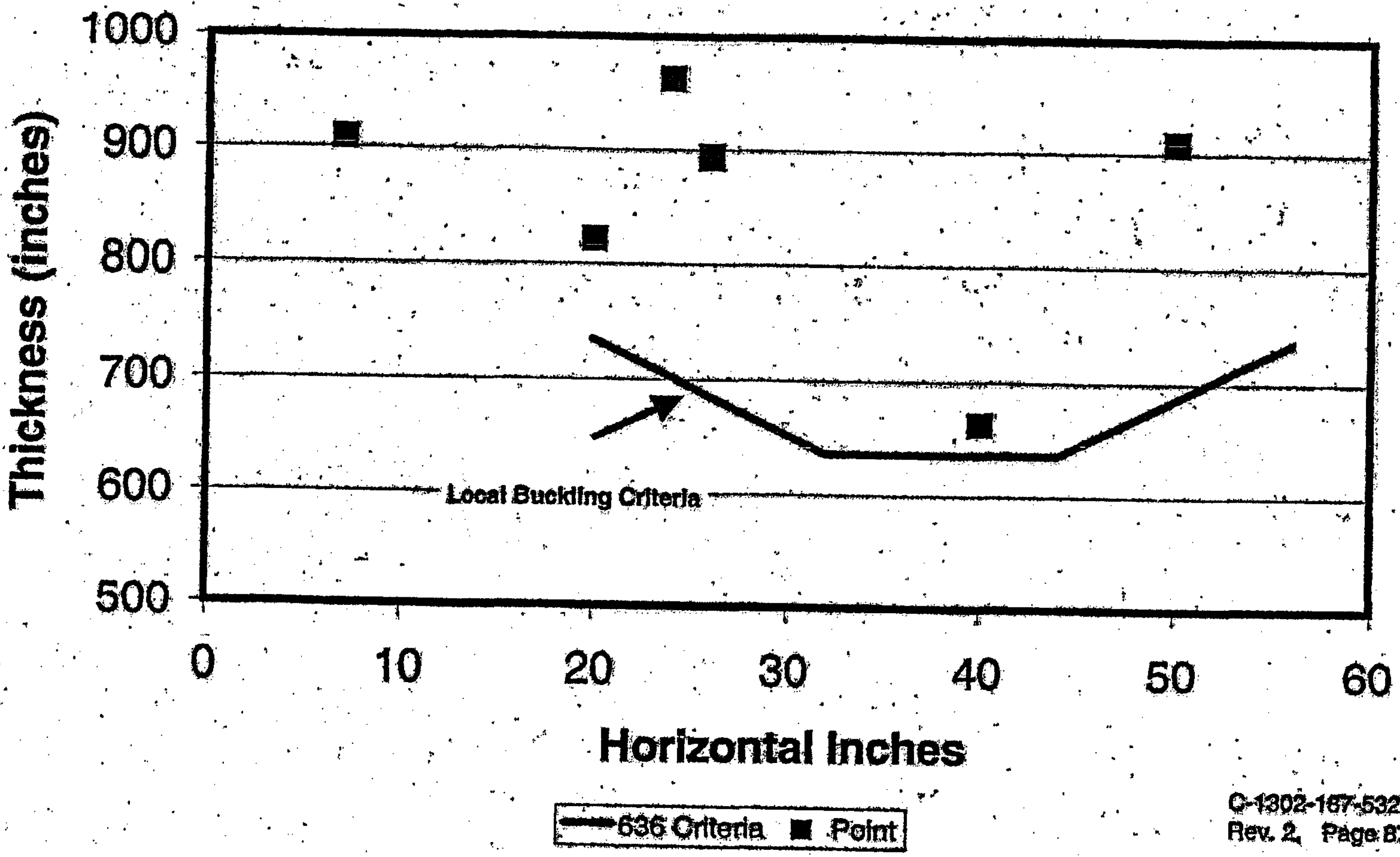


Figure 17-5

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

Figure 17-3

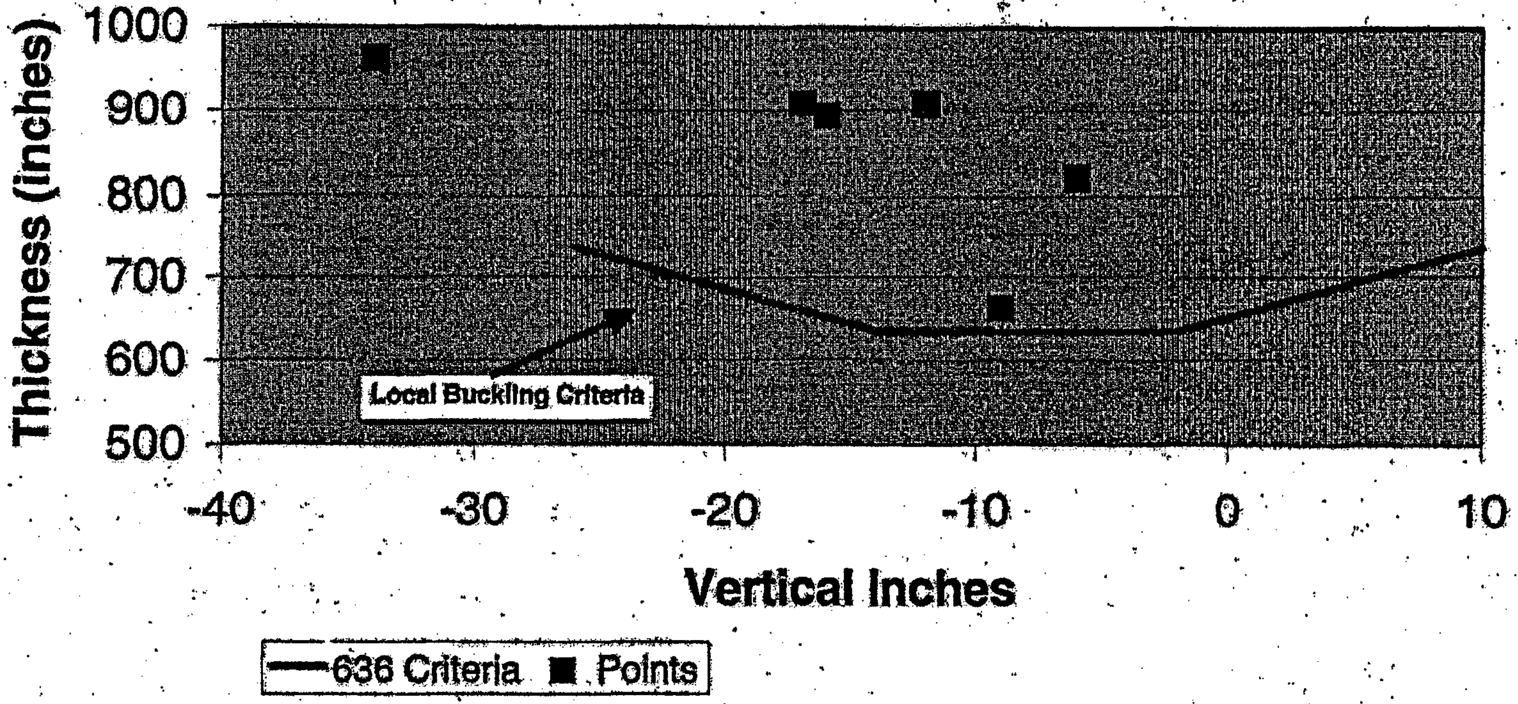
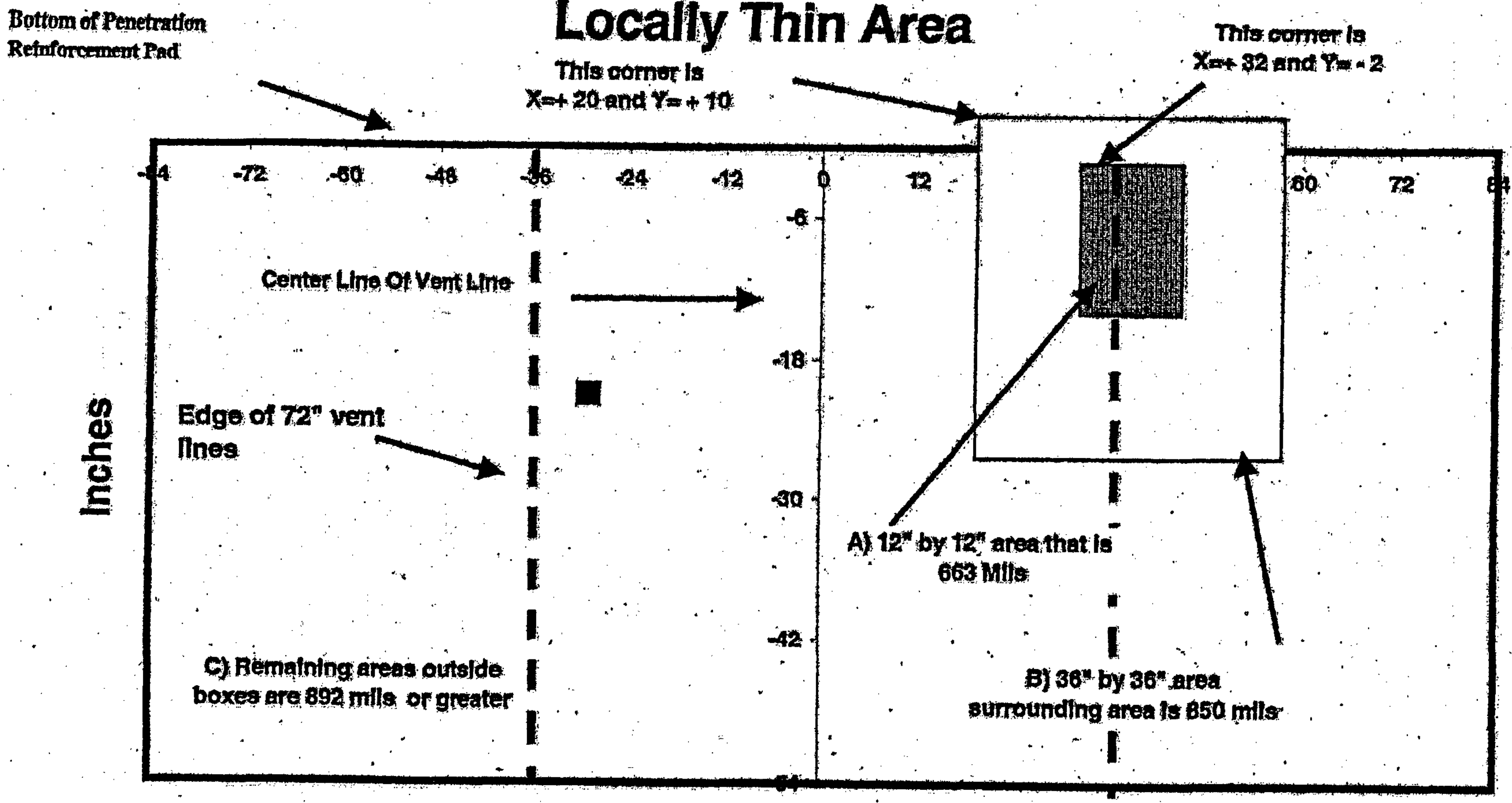


Figure 17-6

Bay 17 2006
Locally Thin Area



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 [illegible]	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	0.721
9	0.776	0.728
10	0.790	0.736
11	NA	0.712
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

Location	1992 UT Measurements (A)	2006 UT Measurement (B)	[illegible] (1)	Max Depth [illegible] (2)	1992 UT Evaluation (A)-(2)-(3)	2006 UT Evaluation (B)-(2)-(3)	Remarks
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.

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Peter Tamburro	3/21/07	Julien Abramovici		

Figure 19-1

BAY #19 DATA

NOTES:

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

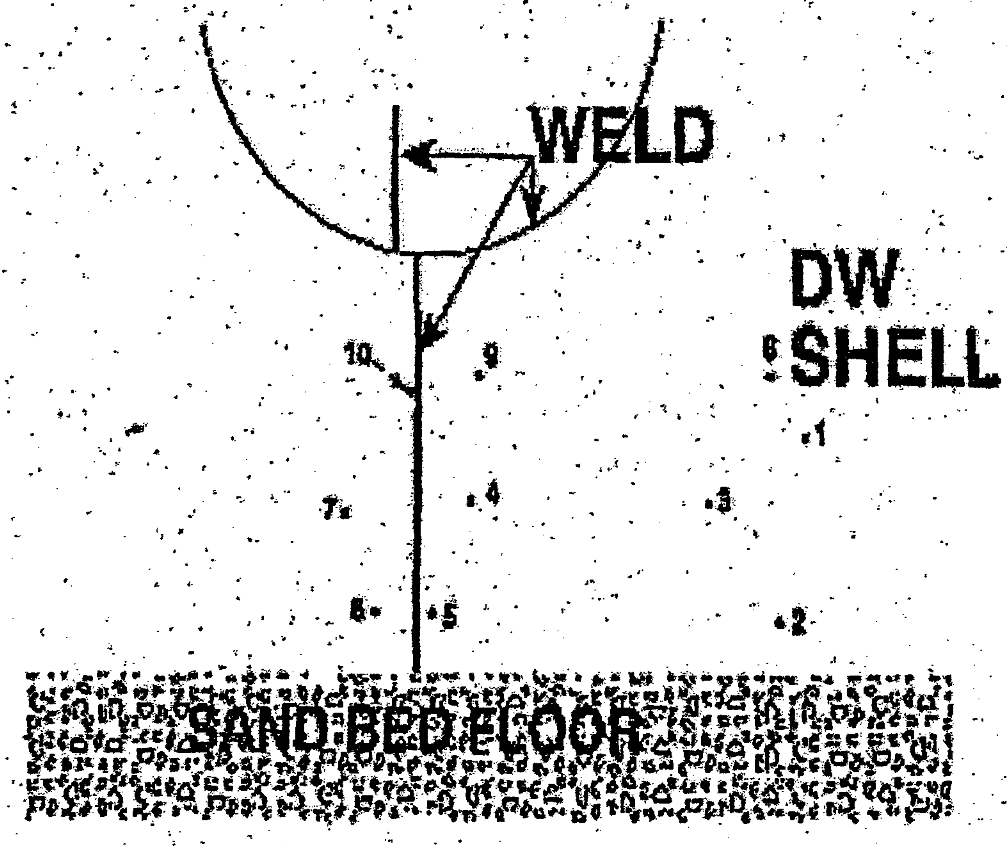


FIGURE (19)

Figure 19-2

Bay 19 2006

Spatial Relationship Of Locally Thin Areas

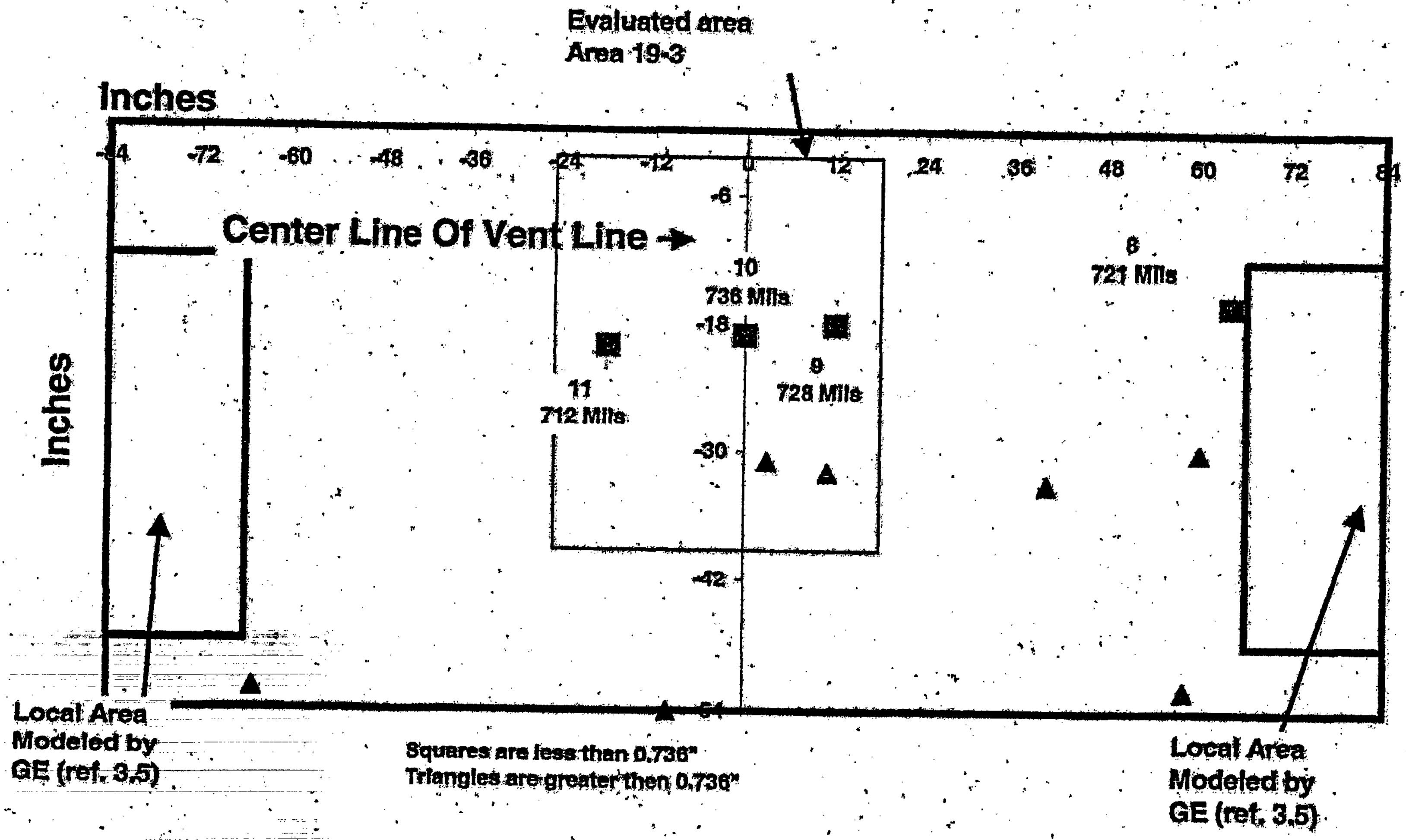
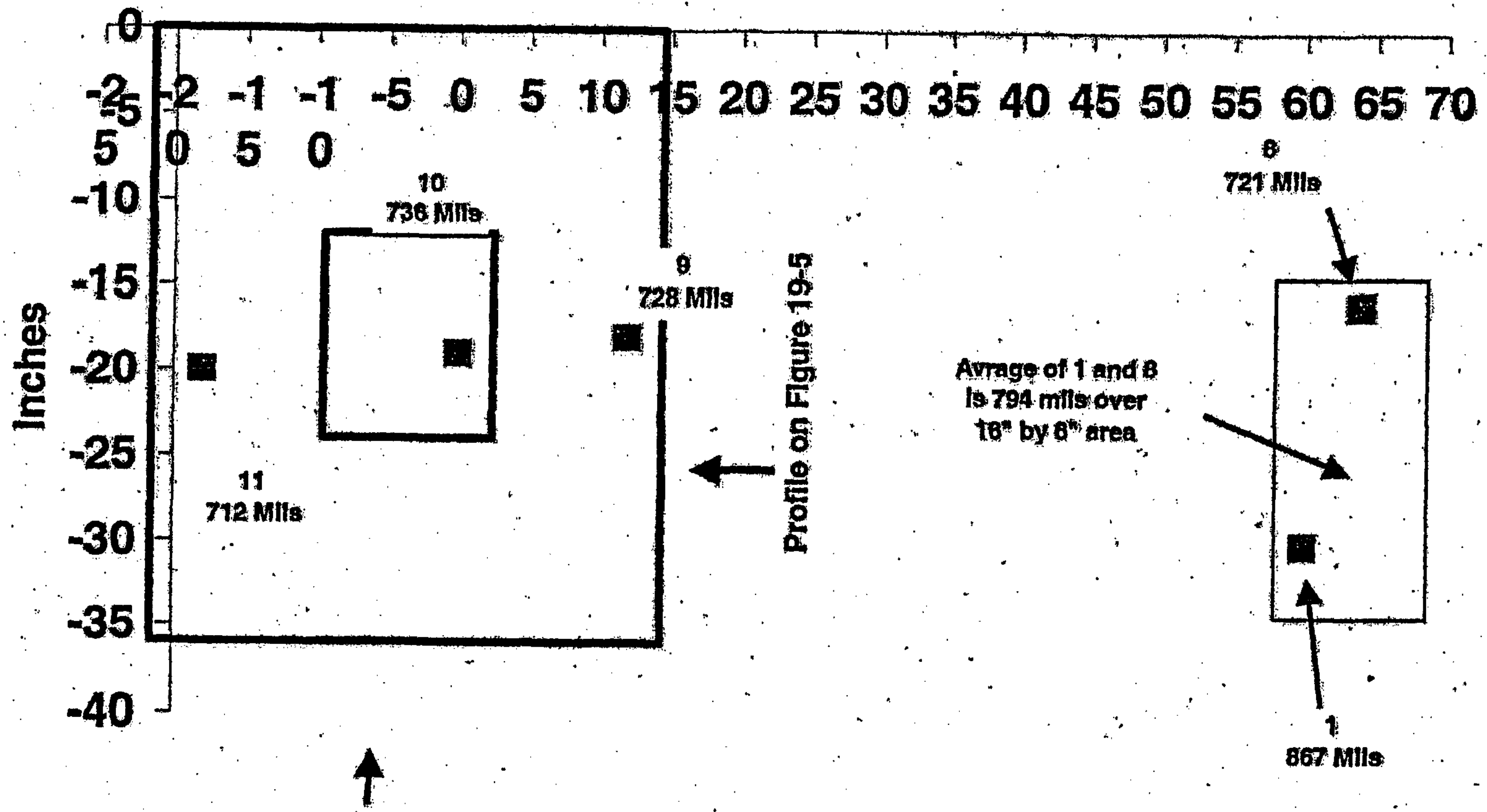


Figure 19-3

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

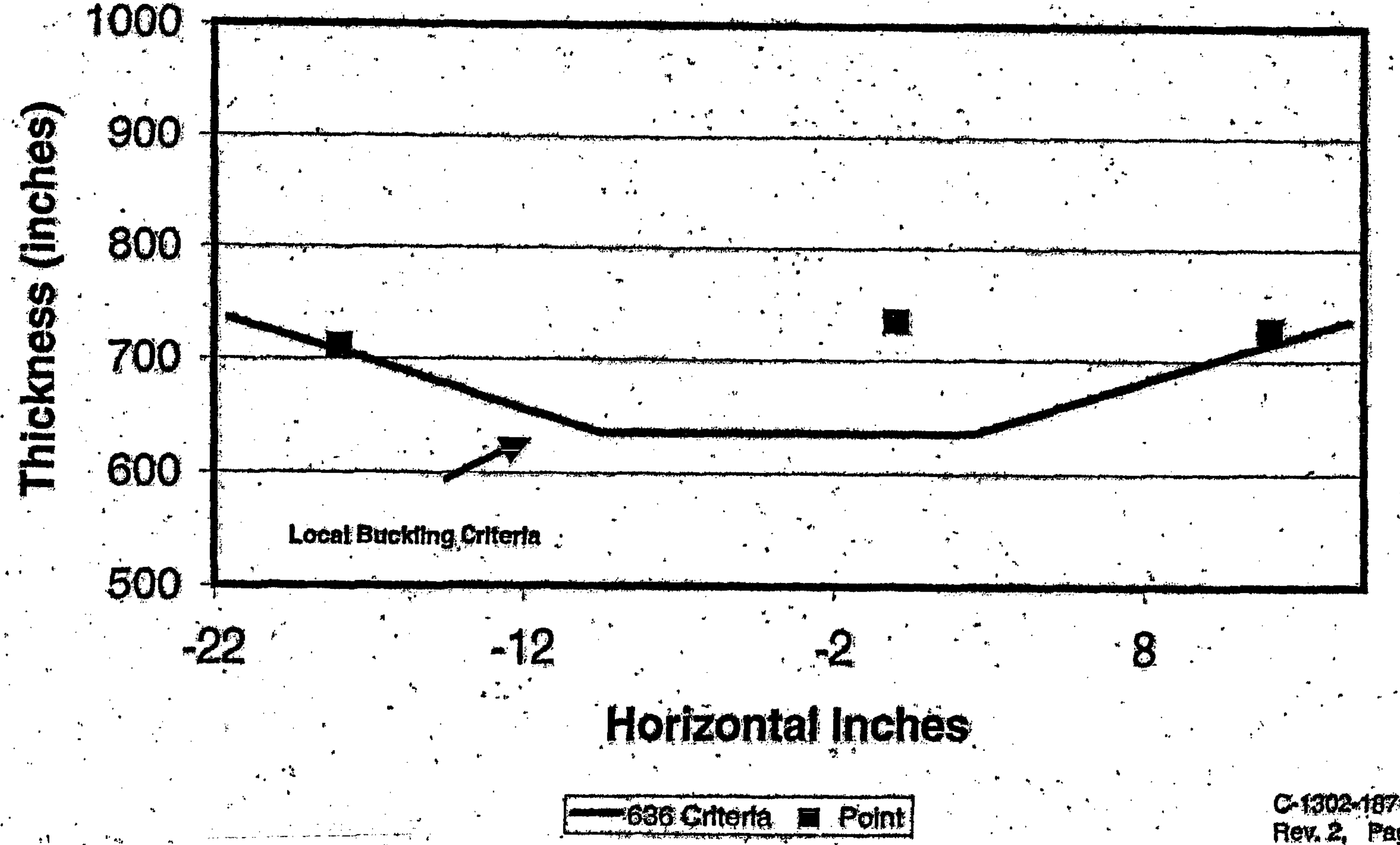


Profile on Figure 19-5

Avrage of 1 and 8 is 794 mils over 16" by 6" area

Profile on Figure 19-4

Figure 19-4



Bay 19 Horizontal Profile
(Evaluation Thickness versus Local Buckling Criteria)

Figure 19-5

Bay 19 Vertical Profile
(Evaluation Thickness versus Local Buckling Criteria)

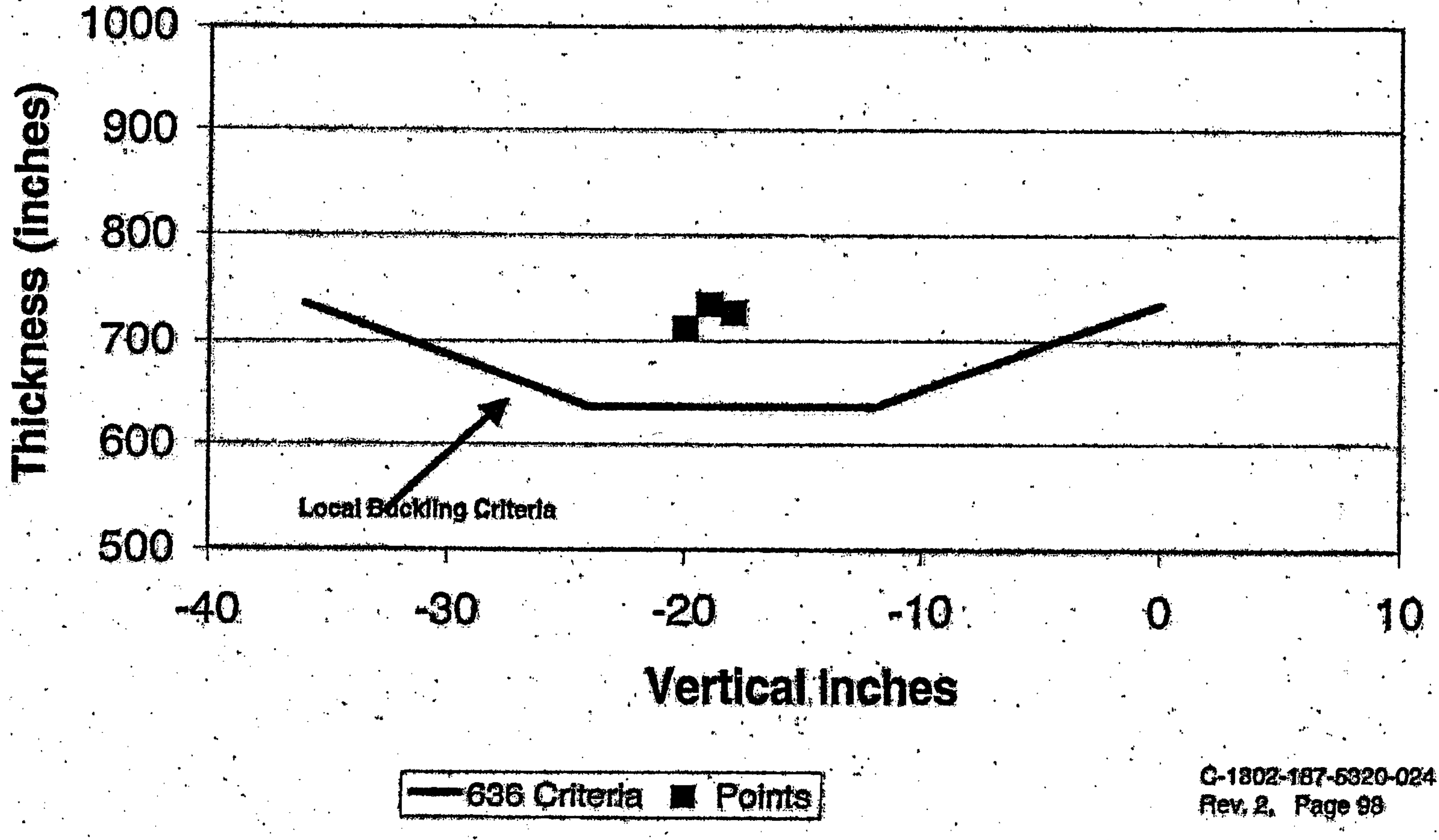


Figure 19-7

Bay 19 2006
Locally Thin Areas

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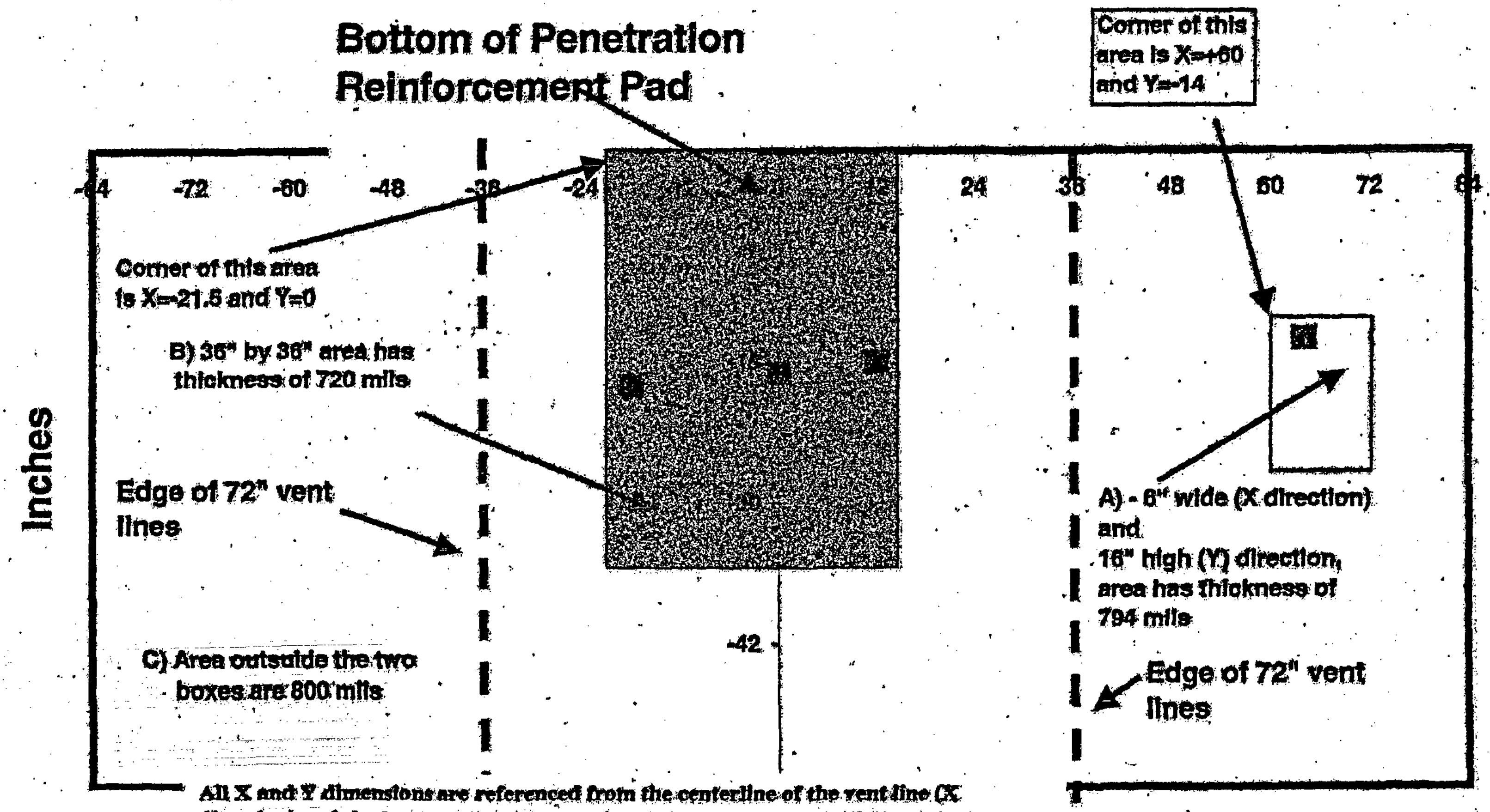
Bottom of Penetration Reinforcement Pad

Corner of this area is X=+60 and Y=-14

Corner of this area is X=-21.5 and Y=0

B) 36" by 36" area has thickness of 720 mils

Edge of 72" vent lines

A) - 6" wide (X direction) and 16" high (Y) direction, area has thickness of 794 mils

C) Area outside the two boxes are 800 mils

Edge of 72" vent lines

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.

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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;

<u>READING</u> (Location)	<u>DEPTH #10</u> (inches)	<u>DEPTH #7</u> 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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CALCULATION OF BUCKLING MARGIN - REFUELING CASE, NO SAND - GE OYCR1S&T - UNIFORM THICKNESS t=0.736 Inch

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

Subject O.C. Drywell Ext. UT Evaluation in Sandbed		**Calc No.** C-1302-187-5320-024	**Rev. No.** 2	**Sheet No.** 105 of 183
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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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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,I, 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	

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 2	**Sheet No.** 107 of 183
Originator Peter Tamburro	**Date** 3/21/07	**Reviewed by** Julien Abramovici	**Date**

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

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

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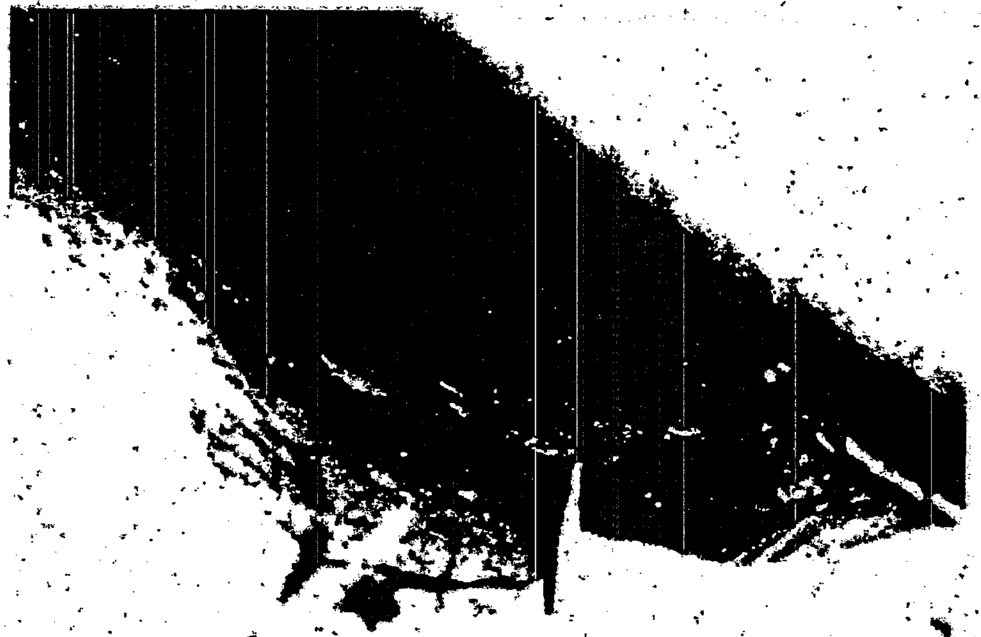
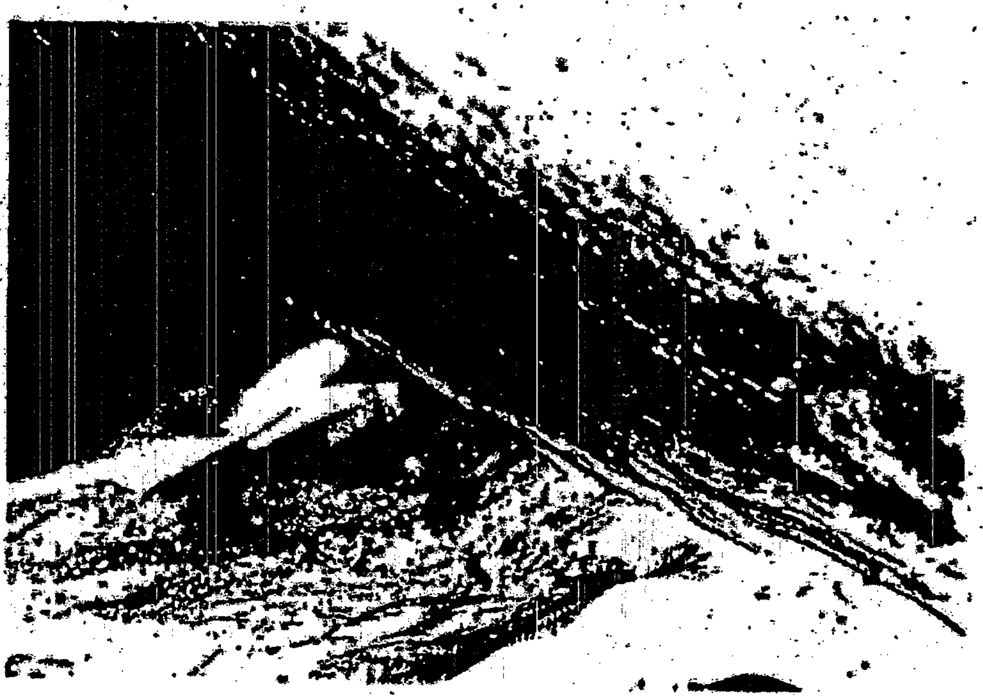
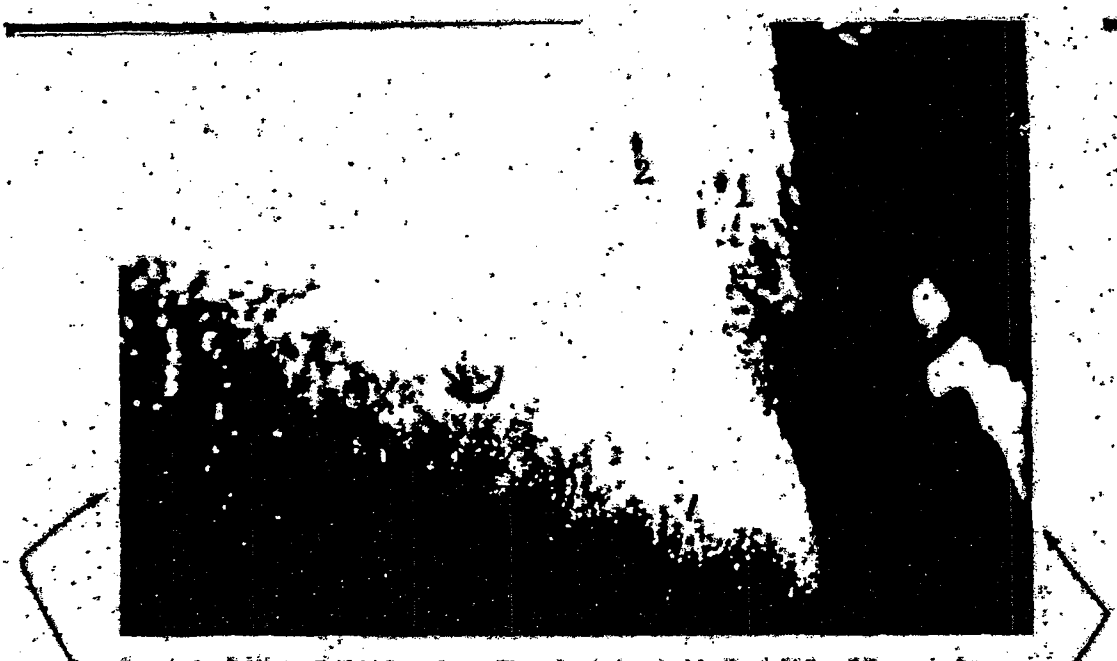
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	109 of 183
Originator	**Date**	**Reviewed by**		**Date**
Pete Tamburro	3/21/07			



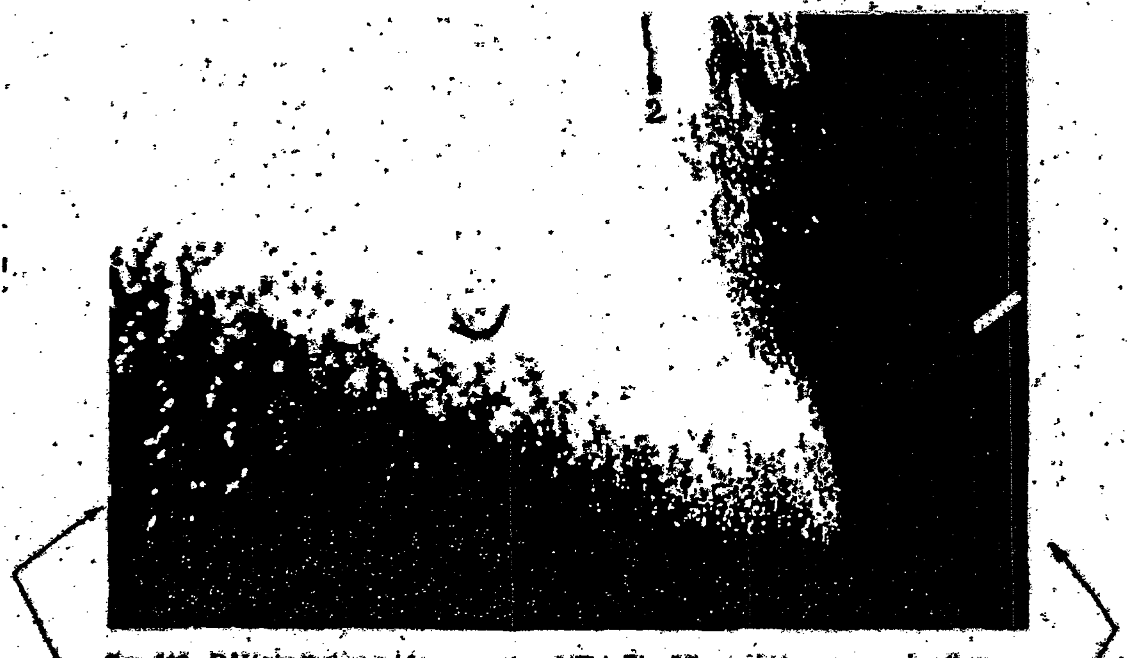
Sand Bed Region - Typical condition found on initial entry.



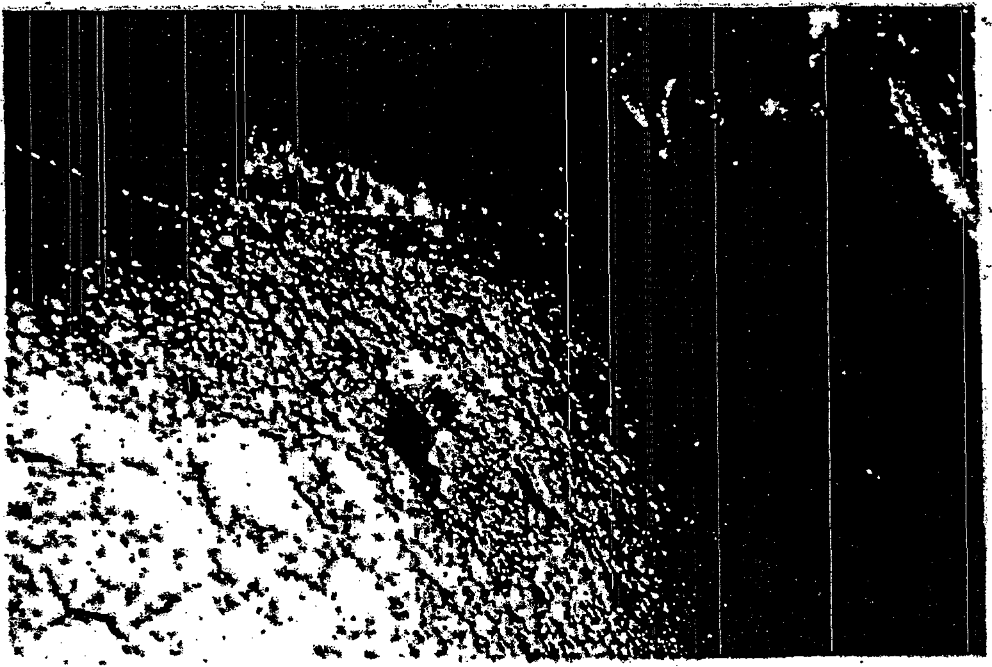
Corrosion product on drywell vessel



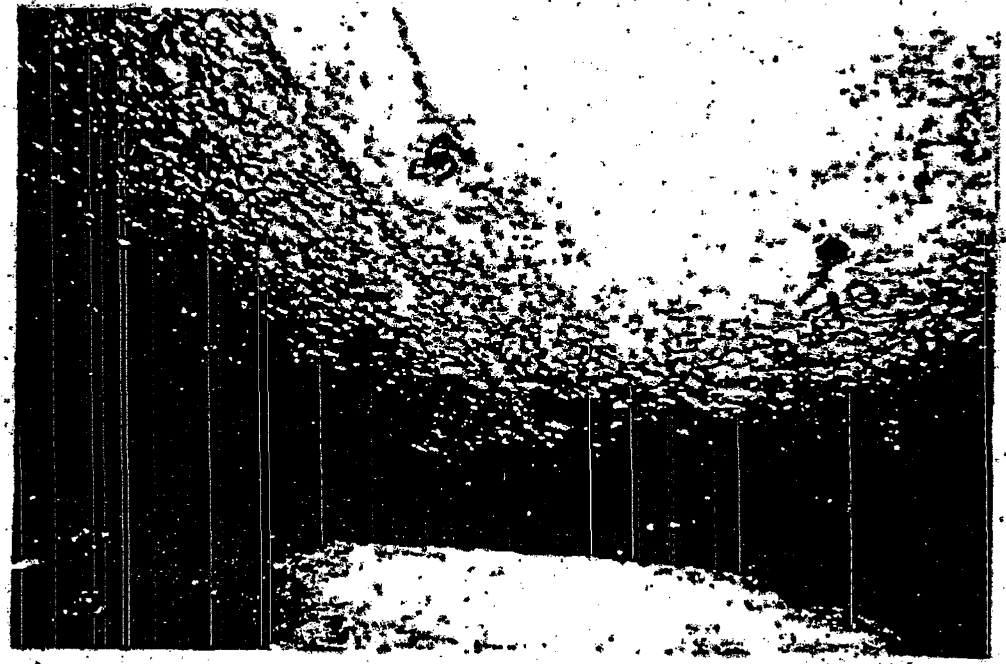
Bay #13 - D/W shell showing plug . The plug is located in the middle of the worst corroded area of the shell The plug showed no sign of corrosion.



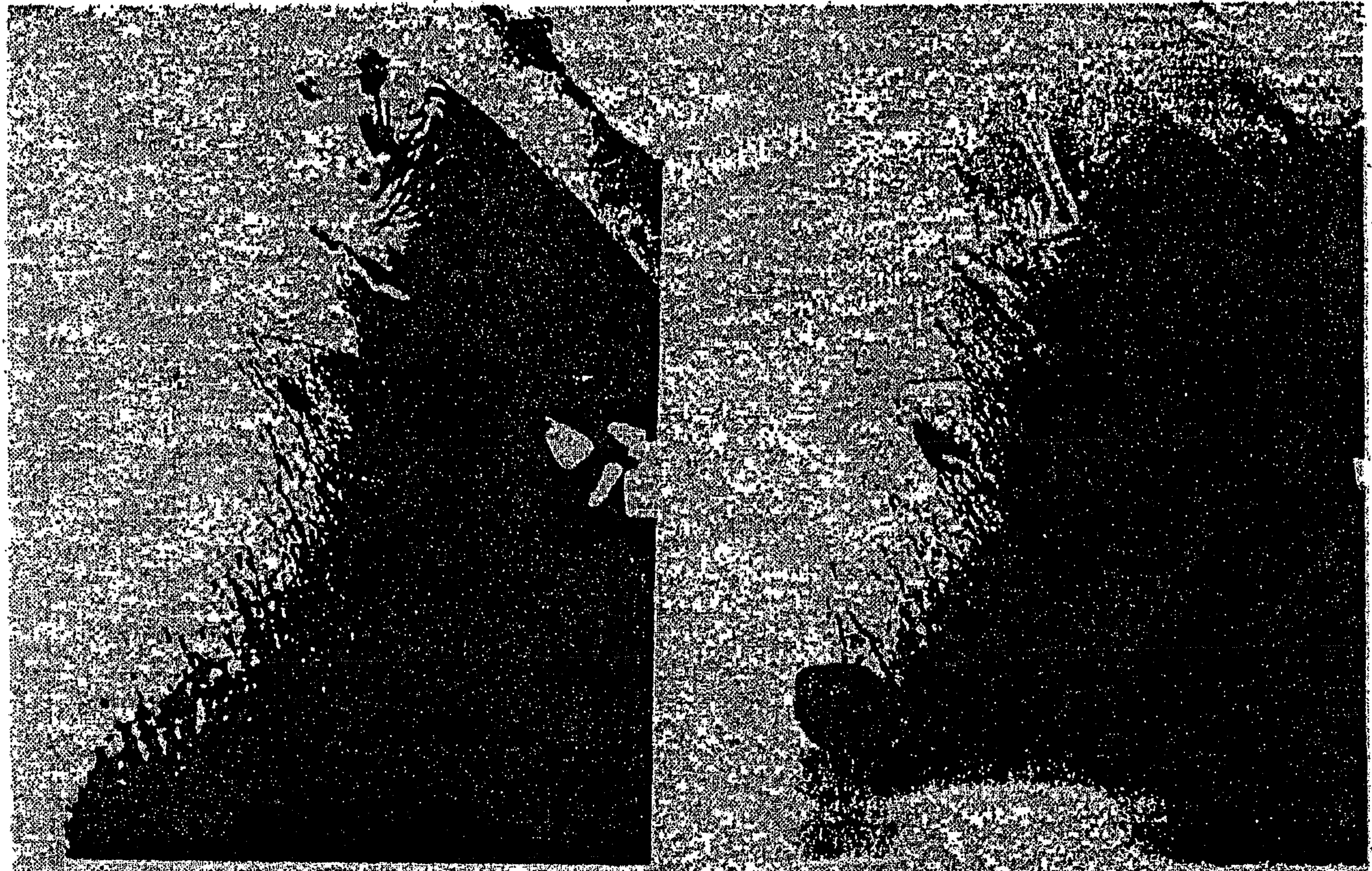
Bay #13 - D/W shell showed less prominent "Tub Ring" than what was seen in other



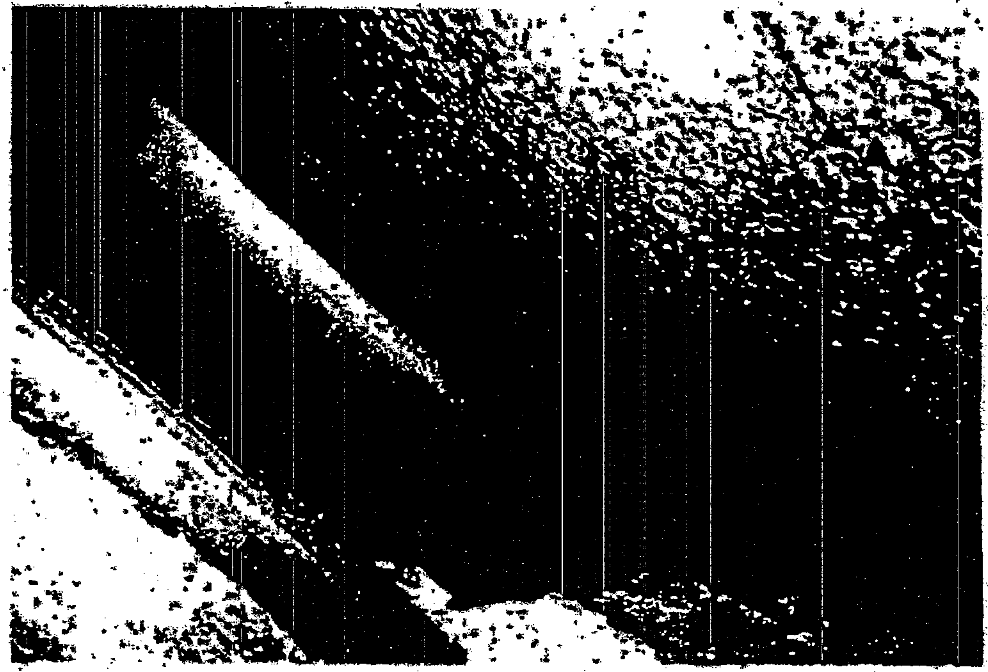
Bay #1 - Looking at the worst corroded area on shell near vent tube collar/ring. The ground spots seen here correspond to UT spot 20.2 - 2.3



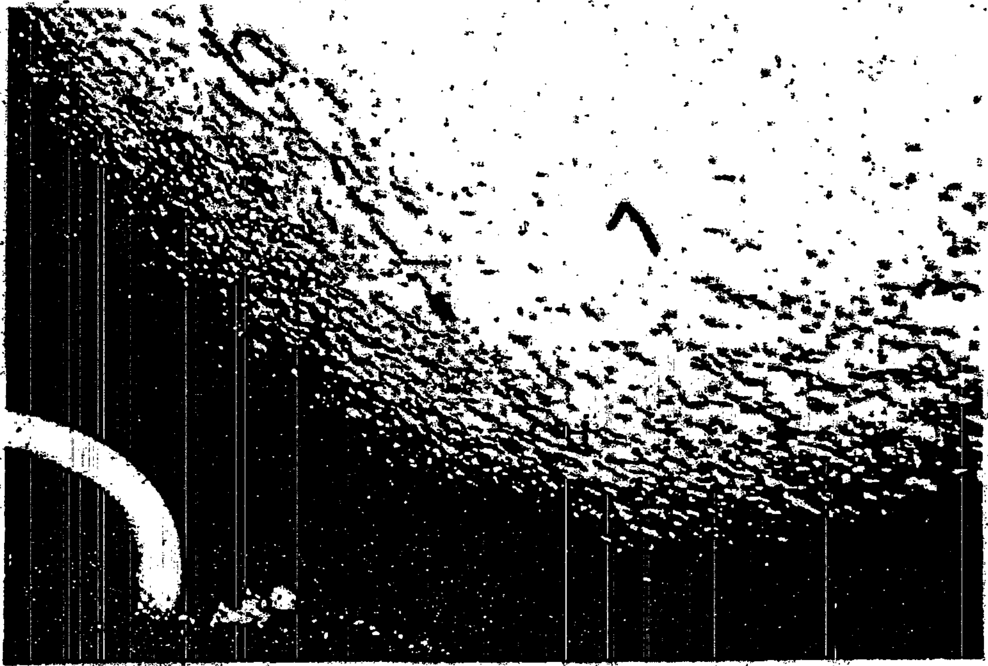
Bay #13 - Lower Mid portion of the D/W shell showing UT spot 5.6 and 10. This close up photo shows the roughness of the corroded surface and how each UT spot has been picked up in the deep valleys thereby biasing the remaining wall readings to the conservative side



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 "Bath Tub Ring" as delineated by marking and ③ locations of UT spots 3, 4, 13 & 17. The photo on right (although blurred by flash reflection) shows 1/8" projection of plug.



Bay #16 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 & 15. 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"

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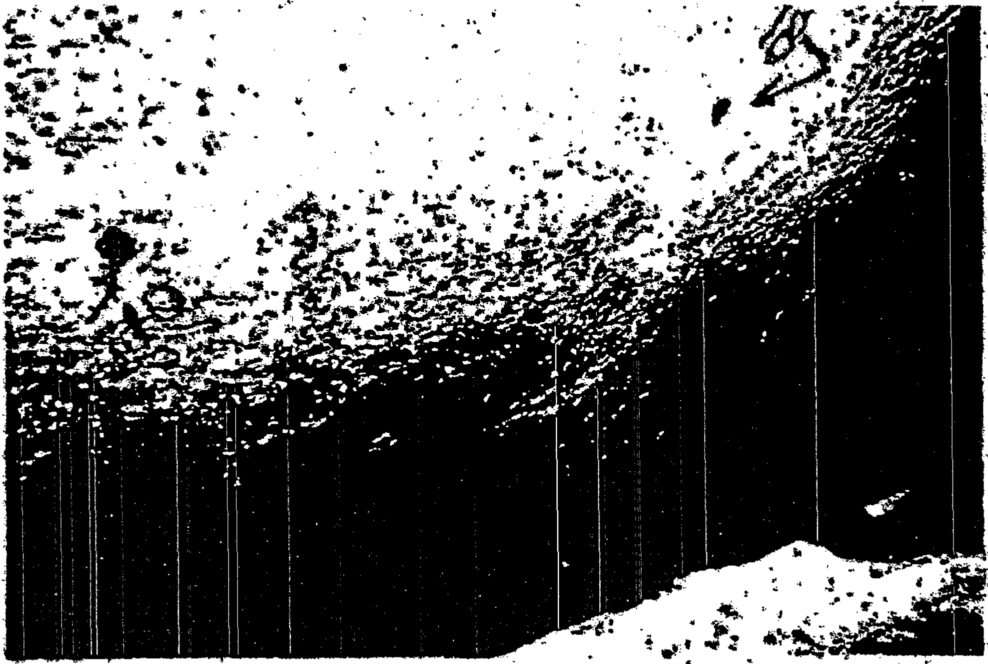
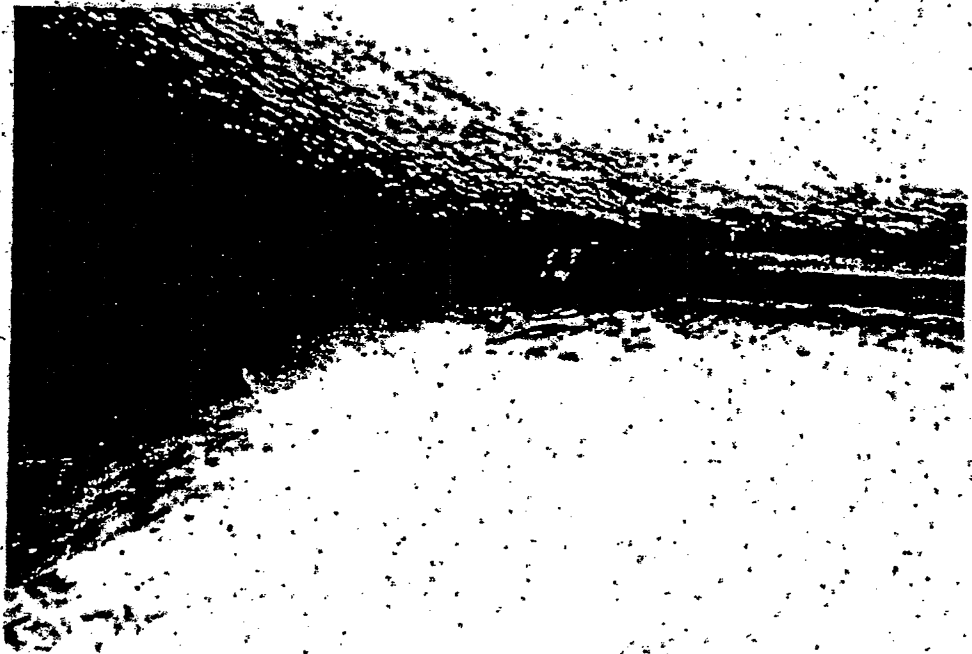
Bay #15 Looking toward Bay #13 showing portions of D/W shell and concrete floor, after removal of loose debris / sand / rust. The concrete floor in this bay is one of the better ones. However - Note (1) no drainage channel and (2) cratered holes near shell contm

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



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

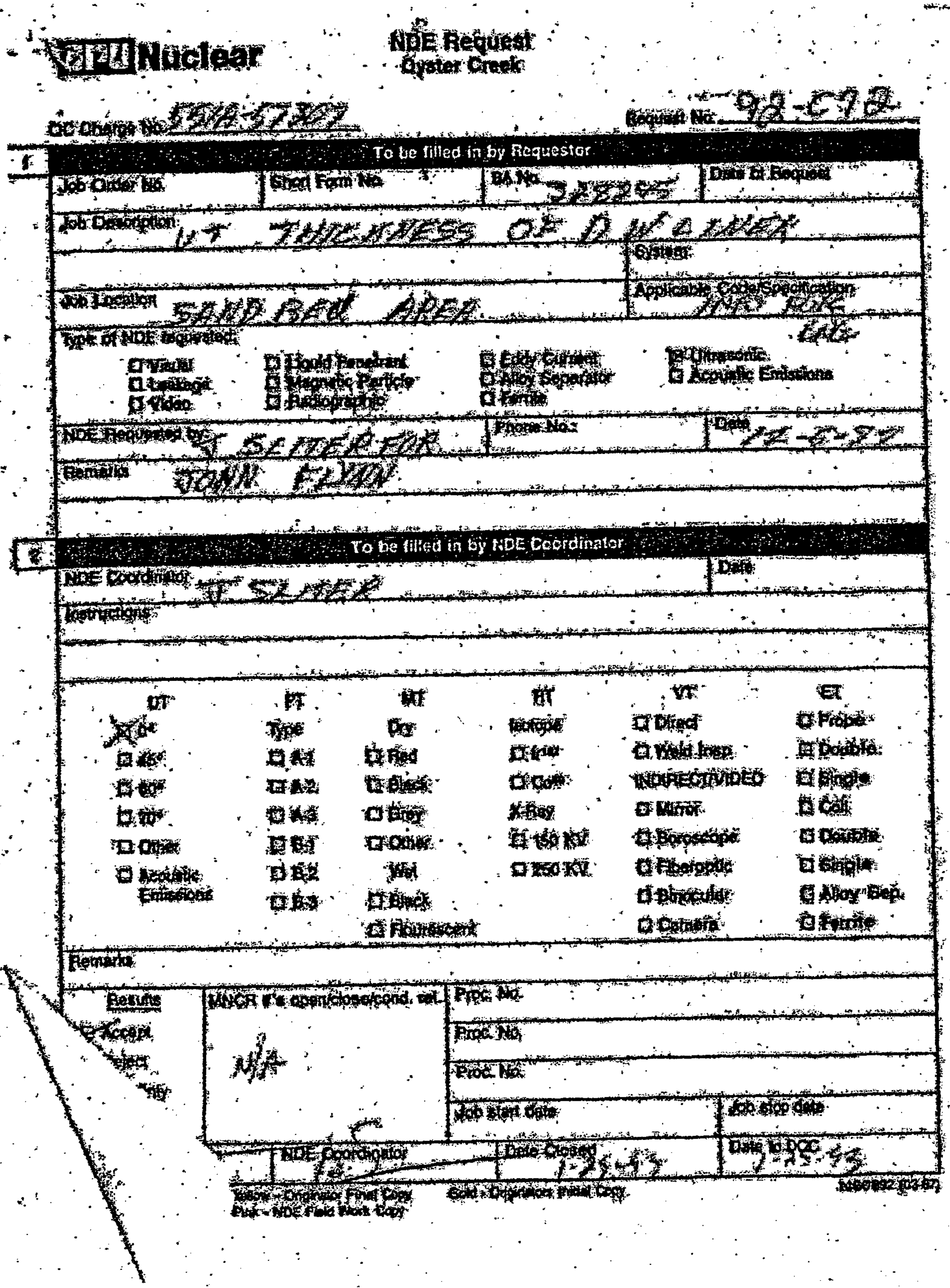
Bay #13 - Looking toward Bay #15 - This photo captures the concrete floor condition and a portion of lower shell corroded surface in very great detail. The floor in this area



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

Drain after floor has been refurbished

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



GPU Nuclear

NDE Request
Oyster Creek

QC Charge No. 5514-57307

Request No. 92-672

1 To be filled in by Requestor

Job Order No.	Short Form No.	BA No. 328265	Date of Request

Job Description: UT THICKNESS OF D W LINER

System:

Job Location: SAND BED AREA

Applicable Code/Specification: [illegible]

Type of NDE requested:

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

NDE Requested by: J SEITER FOR

Phone No.:

Date: 12-6-92

Remarks: JOHN FLYNN

2 To be filled in by NDE Coordinator

NDE Coordinator: J SLAER

Date:

Instructions:

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

Remarks

Results ☐ Accept eject rify	NNCR #'s open/close/cond. rel. N/A	Proc. No. Proc. No. Proc. No.

Job start date

Job stop date

NDE Coordinator

Date Closed 1-25-93

Date to DCC 1-25-93

Yellow - Originator Final Copy
Pink - NDE Field Work Copy
Gold - Originators Initial Copy

ND0892 (03-87)

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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
			[illegible]	[illegible]	[illegible]	
92-072-21	UT	1-8-93				BAY 15
92-072-22	UT	1-7-93				BAY 19
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 5133ADM 7230.01 (2/18/82)

A0001837

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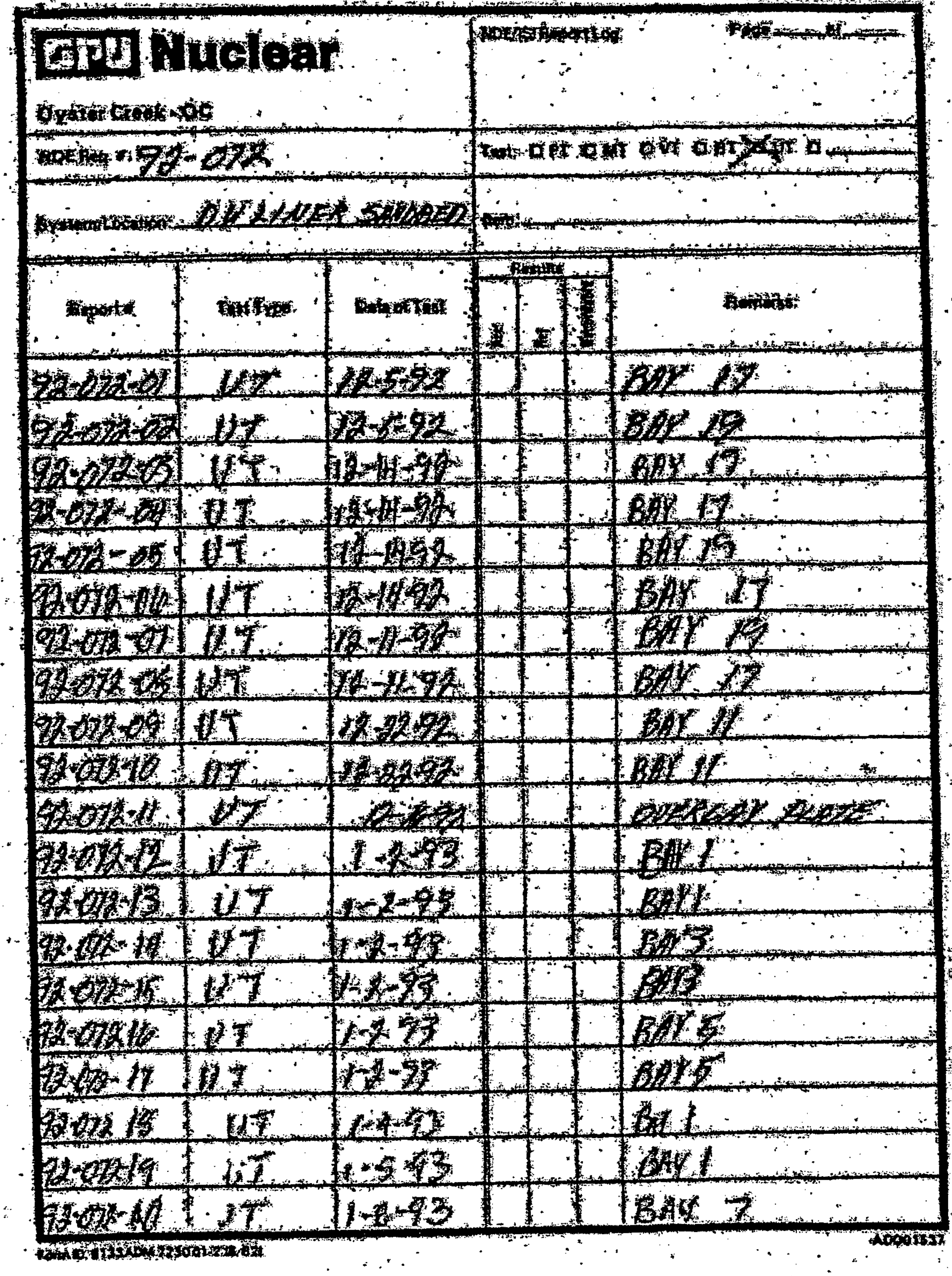
Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 3	**Sheet No.** 120 of 183
Originator Pete Tamburro	**Date** 3/21/07	**Reviewed by**	**Date**



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Oyster Creek - OC

NDE/ISI Report Log

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NDE Req. #: 92-072

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

System/Location: DW LINER SANDBED

Item: ______

Report #	Test Type	Date of Test	Results A	Results R	Results [illegible]	Remarks:
92-072-01	UT	12-5-92				BAY 17
92-072-02	UT	12-6-92				BAY 19
92-072-03	UT	12-11-92				BAY 17
92-072-04	UT	12-11-92				BAY 17
92-072-05	UT	12-10-92				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	UT	12-[illegible]-92				OVERLAY PLATE
92-072-12	UT	1-2-93				BAY 1
92-072-13	UT	1-2-93				BAY 1
92-072-14	UT	1-2-93				BAY 3
92-072-15	UT	1-2-93				BAY 3
92-072-16	UT	1-2-93				BAY 5
92-072-17	UT	1-2-93				BAY 5
92-072-18	UT	1-4-93				BAY 1
92-072-19	UT	1-5-93				BAY 1
92-072-20	UT	1-8-93				BAY 7

Form ID: 6135-ADM-7230.01-228/821

A0001537

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 3	**Sheet No.** 121 of 183
Originator Pete Tamburro	**Date** 3/21/07	**Reviewed by**	**Date**

Program	Xducer	Screen	Digital
1	5 mhz 3/4" Single A321002 [illegible]	2"	2"
2	2.25 mhz 3/4" Single F28932	2"	2"
3	2 mhz MSEB MC8524	2"	2"
4	5 mhz Bubbler water delay	2" delayed	2" delayed
5	5 mhz bubbler water delay	2" sync. sound	none
6	5 mhz bubbler water delay	2" sync. sound	2"
7	5 mhz 3/4" single A321002 [illegible]	1"	1"
8	2 mhz MSEB MC8524	1"	2"
9	5 mhz 1/4" delay GD0504 single	2"	none
10	5 mhz 1/4" dual D7852	1"	1"
11	5 mhz 1/4" dual D7952	2"	2"

Same for pour info.

GPU Nuclear

Ultrasonic Thickness Data Sheet

☑ DC ☐ TMI-1 ☐ TMI-2	Class: N/A	Item: N/A	NDE Request: 92-072
Data Sheet No: 92-072-12			
Task Description: UT Thickness		Task No: 012	Date: 1/2/93
Comp. Desc.: Drywell liner	System: 187	Code/Spec: Proc. [illegible]	
Procedure/Rev: 6100-QAP-7209.03 Rev 0		Drawing No./Rev: 3E-187-21-001 Rev 0	
Test Surface: O.D.		Thickness: 1 1/8"	Material: C/S
Examiner	Sign:	Print: J. [illegible]	ID No: [redacted] Level: II
Examiner	Sign:	Print: Mark E. Bennett	ID No: [redacted] Level: II

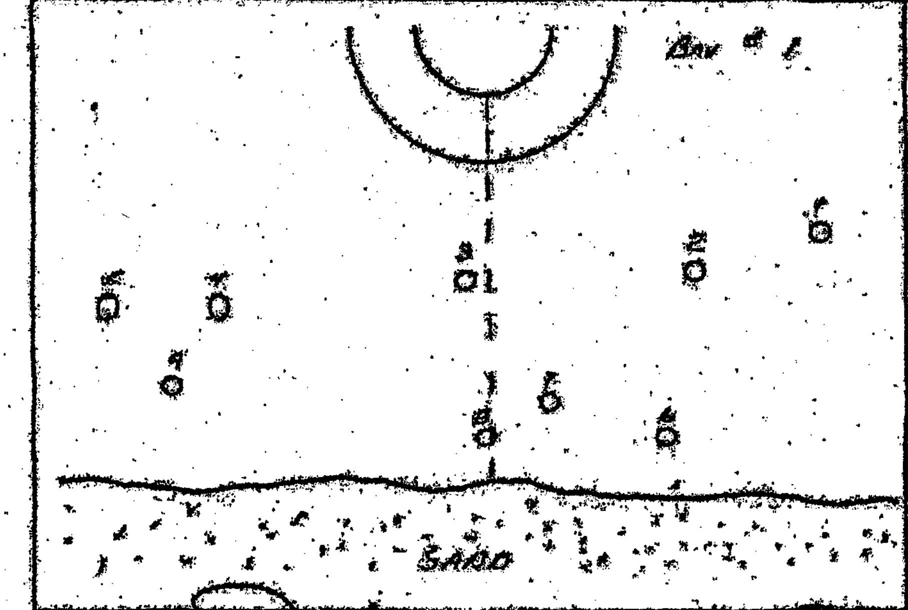
Thermometer S/N 88-001 Part Temperature 22 F D-Meter S/N 92-051
Cal. Blk. S/N 2 W
Cal. Blk. Temp. 22 F
Cal. In: N/A AM 11:51 PM
Cal. Out: N/A AM [illegible] PM

Calibration Readings (Inches)

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

Techniques
☐ CRT ☒ D-Meter
Other N/A

Position #/Reading in Inches



Drawing

	AREA		MEASUREMENT
1	D-10"	R 30"	1.130"
2	D-22"	R 17"	[illegible]
3	D-23"	L 37"	1.105"
4	D-24"	L 33"	[illegible]
5	D-24"	L 42"	1.110"
6	D-28"	R 12"	1.100"
7	D-33"	R 5"	1.100"
8	D-46"	0	1.125"
9	D-34"	L 38"	1.085"

Reviewed by: Level: III Date: 1-3-93 Page 1 of 11

GPU Nuclear

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

GPU Nuclear

Ultrasonic Thickness Data Sheet

☑ OC ☐ TMI-1 ☐ TMI-2

Class: N/A

Item: N/A

NDE Request: 92-072

Data Sheet No.: 92-072-13

Task Description: UT Thickness

Task No.: N/A

Date: 1/8/93

Comp. Desc.: Drywell Liner

System: 187

Code/Spec: Per Dufour

Procedure/Rev.: 6100 + 2HP-7E07.02 Rev 0

Drawing No./Rev.: 3E-187-29-001 Rev 0

Test Surface: O.D.

Thickness: 1 1/8"

Material: C/S

Examiner	Sign:	Print: T. Chuck Link	ID No.: [redacted]	Level: II
Examiner	Sign:	Print: Mark A. Bagnell	ID No.: [redacted]	Level: II

Thermometer S/N 86-007 Part Temperature 22 F D-Meter S/N 137-115

Cal. Blk. S/N 2-9

Cal. Blk. Temp. 77 F

Cal. Init. N/A AM 0151 PM

Cal. Out. N/A AM 0315 PM

Calibration Readings (inches)

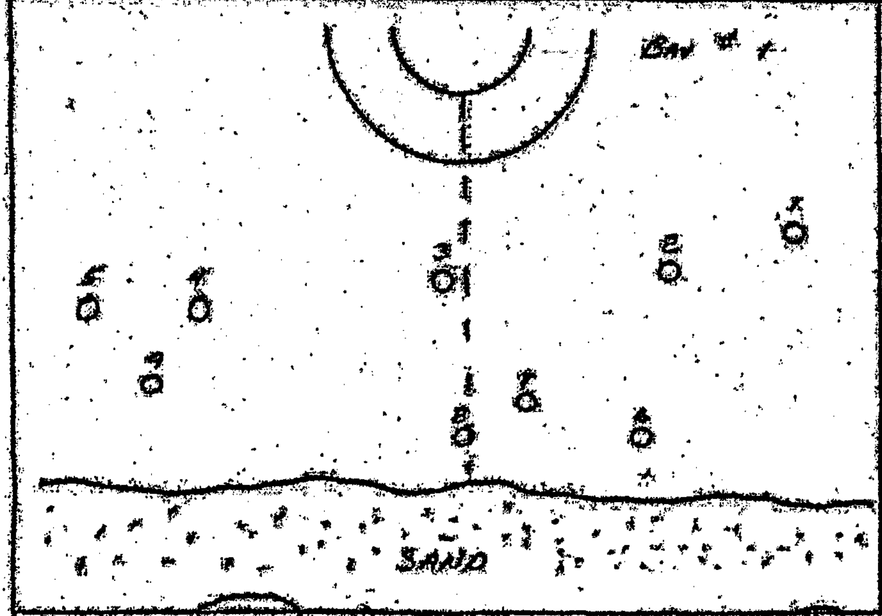
Cal. Blk.	.5"	.25"	1.0	.125"	.75"	N/A
D-Meter	.5"	.25"	1.0	.125	.75"	

Techniques:

☒ CRT ☐ D-Meter

Other N/A

Position #/Reading in Inches



Drawing

NKA measurement

1	D= 16"	R 30"	[illegible]
2	D= 22"	R 7"	.710"
3	D= 25"	L 3"	.600"
4	D= 24"	L 32"	.790"
5	D= 22"	L 45"	.860"
6	D= 46"	R 14"	.760"
7	D= 39"	R 5"	.650"
8	D= 46"	0"	[illegible]
9	D= 38"	L 38"	.820"

Reviewed by: R. C. [illegible] Level: III

Date: 1-8-93

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GPU Nuclear

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

2 Points under

GPU Nuclear

Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A Item: N/A NDE Request: 92-UTZ Data Sheet No.: [illegible]

Task Description: UT THICKNESS Task No.: N/A Date: 1-5-93

Comp. Desc.: DRYWELL LINER Bay 1 System: 187 Code/Specs: Ext. INFO.

Procedure/Rev.: 6100-QAP-7209-07 REV. 0 Drawing No./Rev.: 3E-187-29-001

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

Examiner Sign: Print: Tom [illegible] ID No.: [redacted] Level: II

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

Thermometer S/N 92-065 Part Temperature 76 °F D-Meter S/N 92-036

Cal. Blk. S/N INV. 219 Cal. In: N/A AM 23:31 PM

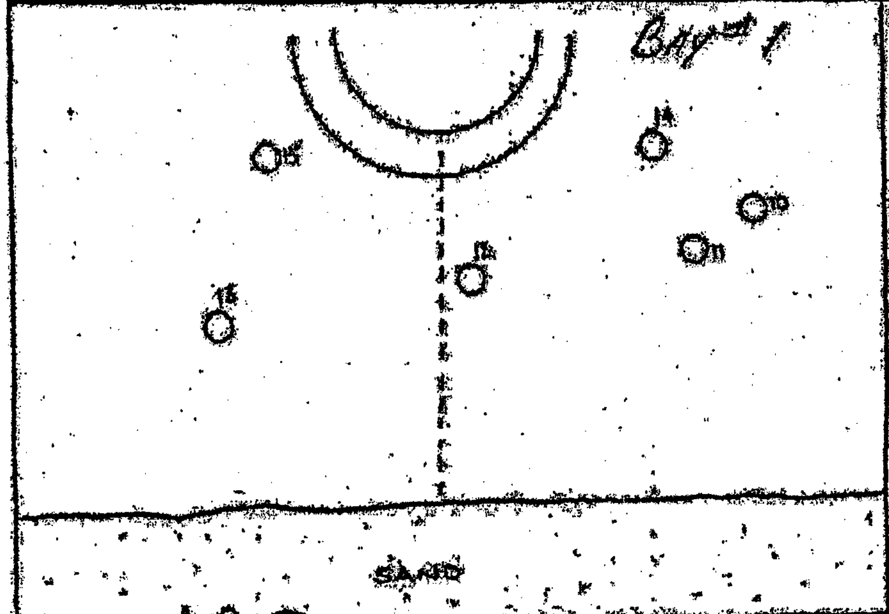
Cal. Blk. Temp. 76 °F Cal. Out: N/A AM 23:24 PM

Calibration Readings (inches)

Cal. Blk.	.5"	.75"	1.0	1.25	1.50	N/A
D-Meter	.5	.75	1.0	1.25	1.5	N/A

Technique: ☐ CRT ☒ D-Meter Other: N/A

Position #/Reading In Inches



Drawing:

AREA		MEASUREMENT
10 D 14"	R 25"	.859
11 D 23"	R 17"	.718
12 O 24"	L 8"	.714
13 D 24"	L 40"	.792
14 D 2"	R 38"	1.147
15 O 8"	L 31"	1.156

NOTE: ADDITIONAL READINGS TAKEN FOR CONFIRMATION OF PREVIOUS INSPECTION.

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

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 125 of 183
Originator Pete Tamburro	**Date** 3/21/07	**Reviewed by**	**Date**

GPU Nuclear

☒ QC ☐ TMI ☐ OTHER

Sketch Form (with grid)

Component: Drywell Apex Sandbed Area

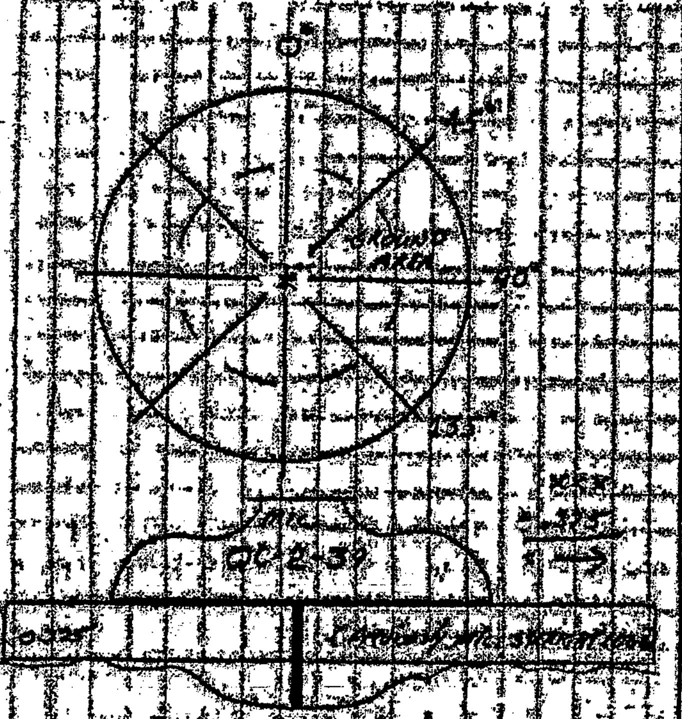
Data Sheet No.: 92-072-29

Location: Bay # 1

Drawing No.: N/A

Rev.: N/A

Drawing:



	AZIMUTH			
AREA	0°	45°	90°	135°
1	272	204	206	185
2	145	177	193	164
3	377	316	*	329
5	530	296	304	330
7	208	251	246	530
11	220	271	225	271
12	277	316	241	328
21	222	202	237	183

Technique utilized for the pit depth measurements

* VALLEY FROM AREA 1/2 INTERFERED WITH TAKING MEANINGFUL MEASUREMENT. TRA 1/12/93

Prepared by:		Title: VT. LC II		Date: 1-12-93
Reviewed by:	Level: II	Date: 1-15-93	Page 1 of 1	NDE Request No.: 92-072

[illegible]

GPU Nuclear

Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2	Class: N/A	Item: N/A	NDE Request: 92-072	Data Sheet No.: 92-072-17
Task Description: UT THICKNESS		Task No.: N/A	Date: 1-6-93
Comp. Desc.: DRYWELL LINER Bay 1	System: 187	Code/Spec.: ENG. INFO.	
Procedure/Rev.: 6100-QAP-7209.07 REV. 0		Drawing No./Rev.: JC-187-28-001 REV. D	
Test Surface: O.D.		Thickness: 1 1/8"	Material: C.S.
Examiner Sign:	Print:	ID No.: [redacted]	Level: II
Examiner Sign: Mark	Print: Mark R. Bagnell	ID No.: [redacted]	Level: II

Thermometer S/N 25-CB1 Part Temperature 72° F D-Meter S/N 30-206

Cal. Blk. S/N RIV 21A Cal. In N/A AM 12:42 PM

Cal. Blk. Temp. 72° F Cal. Out N/A AM 2:55 PM

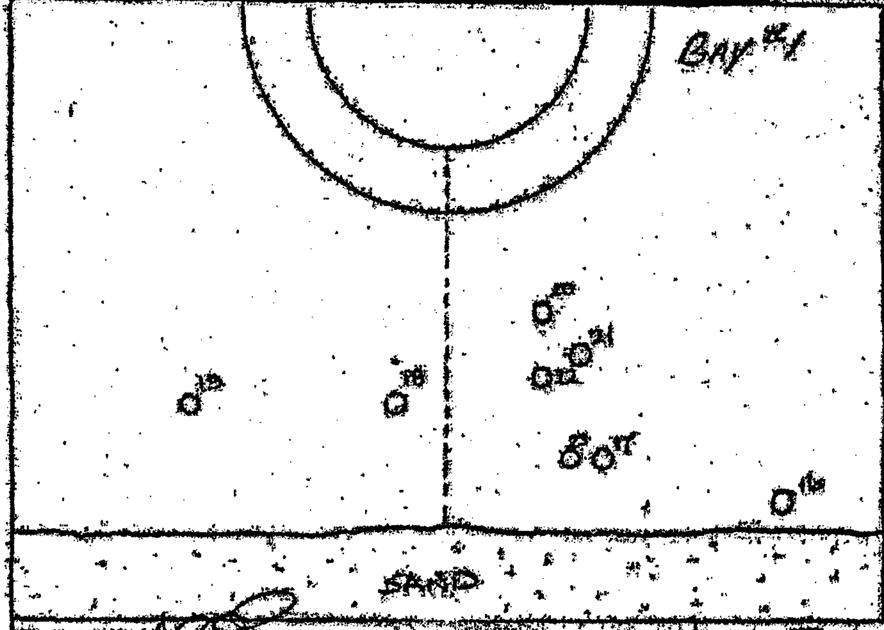
Calibration Readings (Inches)

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

Technique: ☐ CRT ☒ D-Meter

Other N/A

Position #/Reading in Inches



Drawing

	AREA		MEASUREMENT
16	D 50"	R 40"	.796"
17	D 46"	R 16"	.860"
18	D 36"	L 24"	.917"
19	D 38"	L 24"	.890"
20	D 18"	R 15"	.965"
21	D 24"	R 15"	.726"
22	D 32"	R 6"	.852"
23	D 48"	R 15"	.850"

Reviewed by: | Level: II | Date: 1-6-93 | Page 1 of 2

GPU Nuclear

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

NDE Rec. 22078
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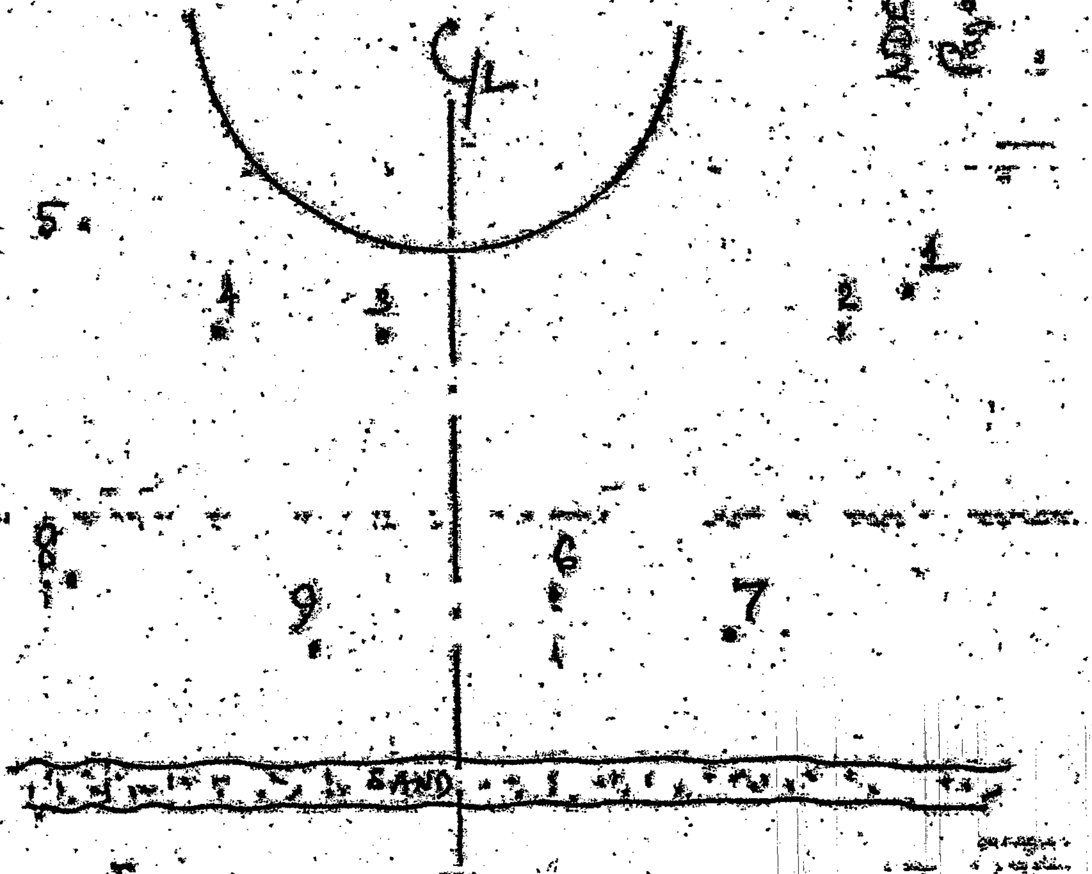


INSPECTION SPOTS FOR UT
BAY #1

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

GPU Nuclear

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

[illegible]

GPU Nuclear Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: 10 | pt Item: N/A NDE Request: 92-072 Data Sheet No.: 92-072-14

Task Description: UT Thickness Task No.: 3/48 Date: 1/13/93

Comp. Desc.: Drywell Liner System: 187 Code/Spec: Eval. Engr.

Procedure/Rev.: 6100-QAP-7209.03 Rev 0 Drawing No./Rev.: 3E-187-23-002 Rev 0

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

Examiner	Sign:	Print: J. Andrew Lusk	ID No.: [redacted]	Level: II
Examiner	Sign: Mark E. Bouquet	Print: Mark E. Bouquet	ID No.: [redacted]	Level: I

Thermometer S/N 85-264 Part Temperature 72 F D-Meter S/N 91-055

Cal. Blk. S/N 2-4 Cal. Im N/A AM 2:15 PM

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

Calibration Readings (Inches)

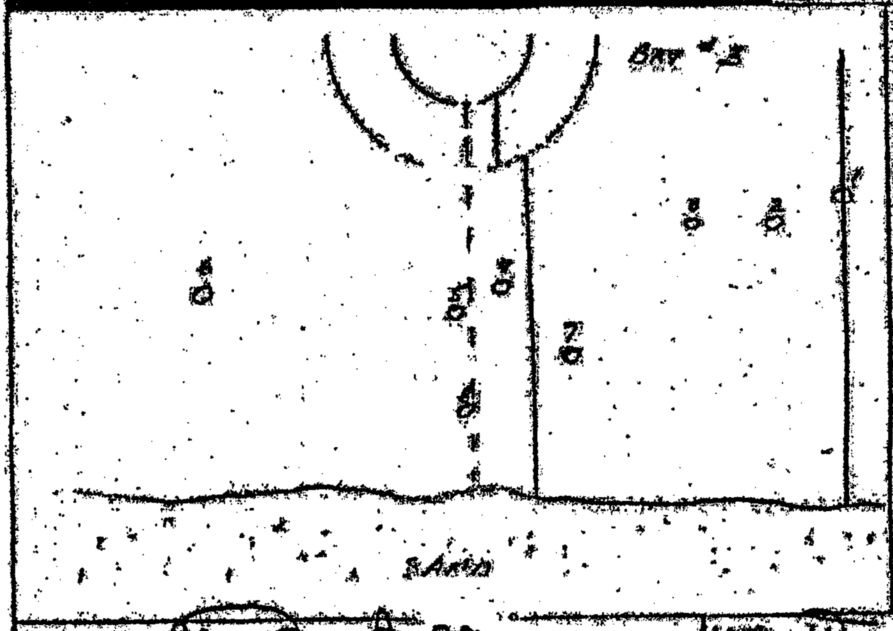
Cal. Blk.	.5"	.75"	1.0"	1.25"	1.5"	N/A
D-Meter	.5"	.75"	1.0"	1.25"	1.5"	

Techniques

☐ CRT ☒ D-Meter

Other: N/A

Position / Reading in Inches



Drawing

	AREA	MEASUREMENT
1	D-5" K-63	.795"
2	D-9" K-35	.76"
3	D-9" K-33	.811"
4	D-13" L-X	.898"
5	D-15" E-B	.825"
6	D-17" E-26	.956"
7	D-19" K	.820"
8	D-21" L	.780"

Reviewed by: Steve [illegible] 00 Level: III Date: 1-5-93 Page: 14 of 21

Ill. good

GPU Nuclear Ultrasonic Thickness Data Sheet

☑ OC ☐ TMI-1 ☐ TMI-2 Class: OTH	Item: 101 A	NDE Request: 92-094	Data Sheet No. 92-072-15
Task Description: UT Thickness		Task No.: 5110	Date: 1/12/93
Comp. Desc.: Drywell Liner	System: 187	Code/Spec.: Exp. Drywell	
Procedure/Rev.: 6100-QAP-7209.03 Rev 0	Drawing No./Rev.: 3E-187-29-001 Rev 0		
Test Surface: O.D.	Thickness: 1.15"	Material: C/S	
Examiner Sign:	Print: J. Christopher Lamb	ID No.: [redacted]	Level: II
Examiner Sign: Mark C. Bunnell	Print: Mark C. Bunnell	ID No.: [redacted]	Level: II

Thermometer S/N 88-001 Part Temperature 72 F D-Meter S/N 157115

Cal. Blk. S/N 244

Cal. Blk. Temp. 72 F

Cal. In: NA AM 12:15 PM

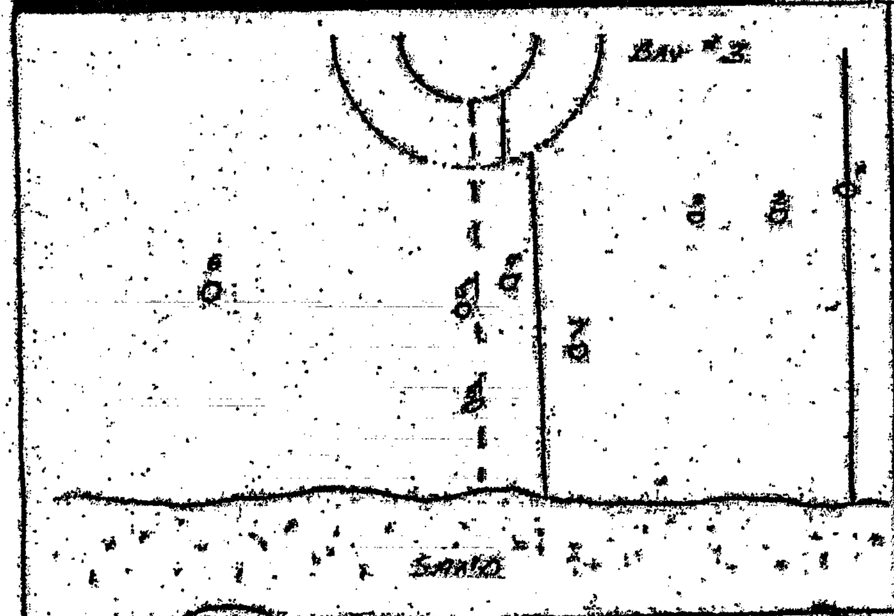
Cal. Out: NA AM 1:45 PM

Calibration Readings (Inches)

Cal. Blk.	.5	.75	1.0	1.25	1.5	NA
D-Meter	.5	.75	1.0	1.25	1.5	

Techniques: ☒ CRT ☐ D Meter Other NA

Position # Reading in Inches



Drawing

Area		Measurement
1	D-3" R-60	.800
2	D-9" R-50	.815
3	D-9" R-33	.800
4	D-13" L-5	.800
5	D-15" U-8	.840
6	D-15" L-5	.806
7	D-17" R-	.840
8	D-21" Z	.790

Reviewed by: Level: III Date: 1-5-93 Page 61 of 81

Good

GPU Nuclear Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: ØFR	Item: N/A	NDE Request: 92-092	Data Sheet No. 92-072-15
Task Description: UT Thickness		Task No.: N/A	Date: 1/12/93
Comp. Desc.: Drywell Liner	System: 187		Code/Spec: Eng. Dir.
Procedure/Rev.: 6100-QAP-7209.01 Rev. 0		Drawing No./Rev.: 3E-187-29-001 Rev. 0	
Test Surface: O.D.		Thickness: 1 1/8"	Material: C/S
Examiner Sign:	Print: J. Chmela Lord	ID No.: [redacted]	Level: II
Examiner Sign: Mark Bagnell	Print: Mark E. Bagnell	ID No.:	Level: II

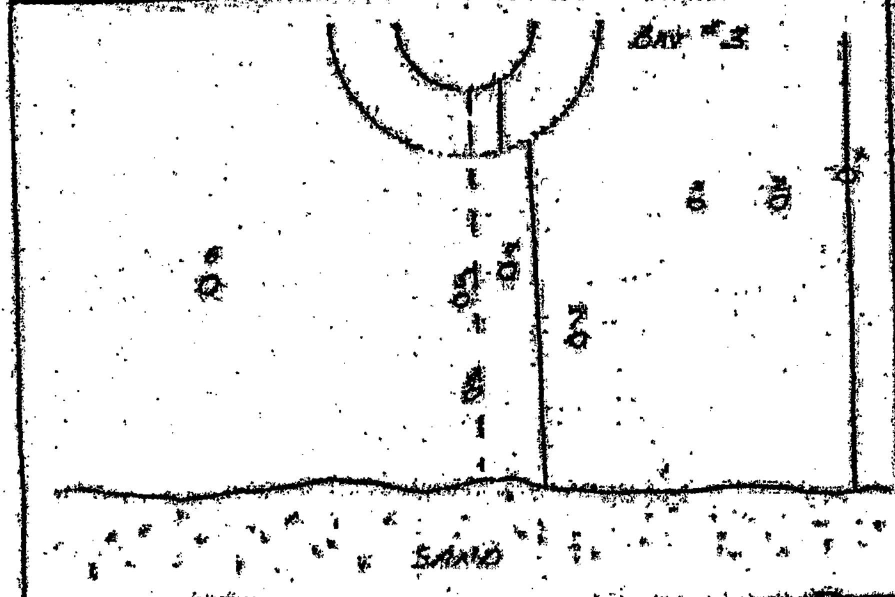
Thermometer S/N 68-088 Part Temperature 72 F D-Meter S/N 57115
Cal. Blk. S/N 217
Cal. Blk. Temp. 72 F
Cal. Int. N/A AM 3:00 PM
Cal. Dbl. N/A AM 3:45 PM

Calibration Readings (inches)

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

Techniques
☒ CRT ☐ D-Meter
Other N/A

Position & Reading in Inches



Drawing

	Area		Measurement
1	0-5"	R 62	[illegible]
2	0-9"	R 47	[illegible]
3	0-9"	R 32	.805
4	0-13"	L 15	[illegible]
5	0-17"	L 8	.840
6	0-17"	L 52	[illegible]
7	0-17"	R	.840
8	0-21"	L	.790

Reviewed By: C. 00

Level: III

Date 1-3-93

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GPU Nuclear

Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2	Class: [illegible]	Item: 4214	NDE Request: 92-072
Task Description: UT Thickness		Task No: [illegible]	Data Sheet No: 92-072-11
Comp. Desc: Drywell Liner	System: 187	Code/Spec: [illegible]	Date: 1/[illegible]/93
Procedure/Rev: [illegible]	Drawing No/Rev: [illegible]		
Test Surface: O.D.	Thickness: [illegible]	Material: C/S	
Examiner Sign:	Print: J. [illegible]	ID No: [redacted]	Level: II
Examiner Sign:	Print: Mark F. Barrett	ID No: [redacted]	Level: II

Thermometer S/N: [illegible] Part Temperature: 72 F D-Meter S/N: [illegible]

Cal. Blk. S/N: [illegible] Cal. In: N/A AM [illegible] PM

Cal. Blk. Temp.: 72 F Cal. Out: N/A AM [illegible] PM

Calibration Readings (Inches)

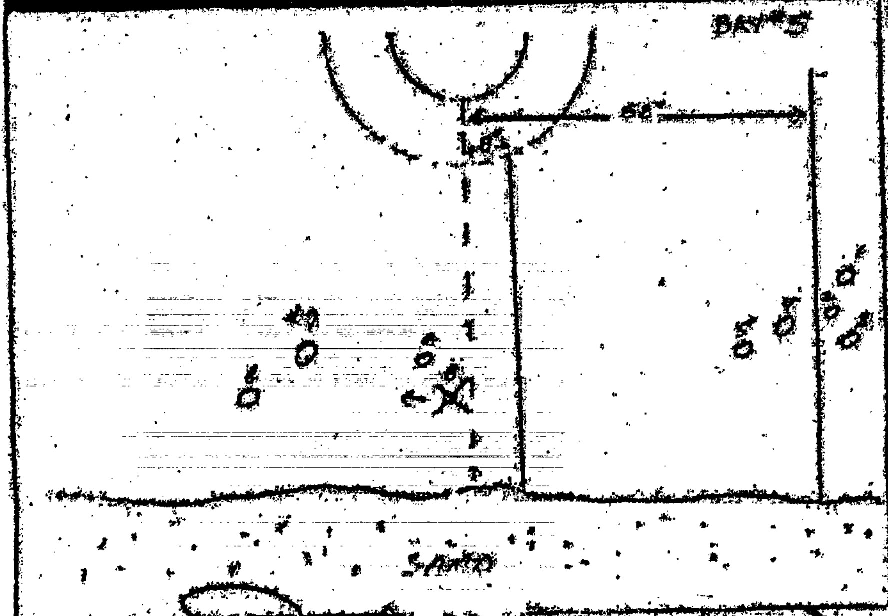
Cal. Blk.	.5"	[illegible]	[illegible]	[illegible]	[illegible]	N/A
D-Meter	.5"	[illegible]	[illegible]	[illegible]	[illegible]	

Techniques

☐ CRT ☒ D-Meter

Other: N/A

Position # Reading in Inches



Drawing

	[illegible]	measurement
1	[illegible]	.970
2	[illegible]	.940
3	[illegible]	.920
4	[illegible]	.970
5	[illegible]	.980
6	[illegible]	.940
7	[illegible]	.950
8	[illegible]	.910

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

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 3	**Sheet No.** 132 of 183
Originator Pete Tamburro	**Date** 3/21/07	**Reviewed by**	**Date**

all good

GPU Nuclear — **Ultrasonic Thickness Data Sheet**

☑ OC ☐ TMI-1 ☐ TMI-2	Class: n/a	Item: 21 %	NDE Request: 93-072
Data Sheet No. 93-072-17			
Task Description: UT Thickness		Task No.: n/a	Date: 1/1/93
Comp. Desc.: Drywell Liner	System: 187	Code/Spec./Rev.: T.W.P.S. R...	
Procedure/Rev.: 6600 - QAP - 7209.07 Rev 0		Drawing No./Rev.: 3E - 187 - 22 - 001 Rev 0	
Test Surface: O.D.		Thickness: 1 1/8"	Material: C/S
Examiner Sign:	Print: J. Cheche Lisle	ID No.: [redacted]	Level: II
Examiner Sign:	Print: Mark F. Bagnell	ID No.: [redacted]	Level: II

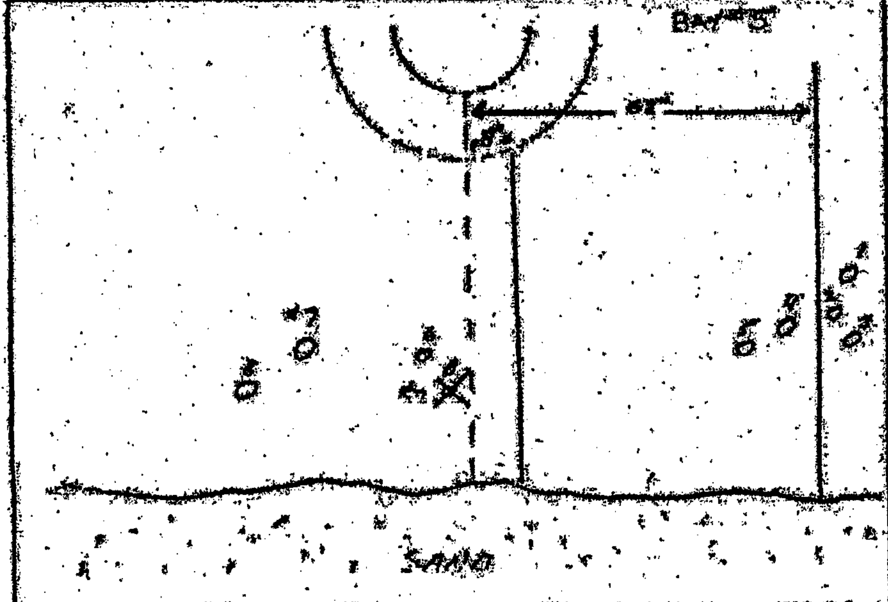
Thermometer S/N 88-001 Part Temperature 72 F D-Meter S/N 137113
Cal. Blk. S/N 2.4 Cal. In n/a AM 12:20 PM
Cal. Blk. Temp. 72 F Cal. Out n/a AM 12:36 PM

Calibration Readings (inches)

Cal. Blk.	.5"	.75"	1.0	1.25	1.5	n/a
D-Meter	.5"	.75"	1.0	1.25	1.5	

Technique
☒ CRT ☐ D-Meter
Other n/a

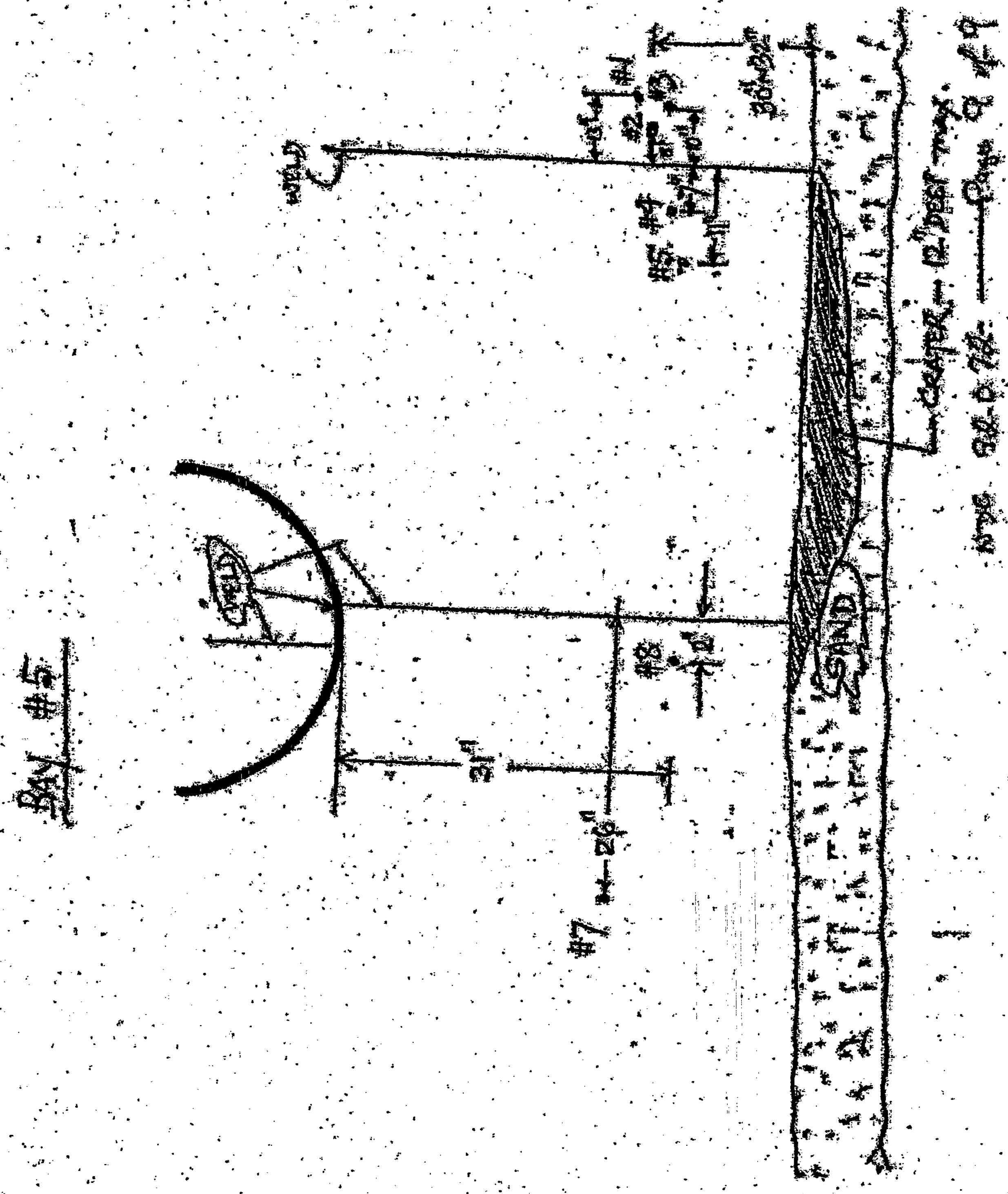
Position # Reading in Inches



Drawing

AREA		Measurement
1	[illegible]	1.016
2	[illegible]	1.150
3	[illegible]	1.141
4	[illegible]	.960
5	[illegible]	.600
6	[illegible]	1.[illegible]
7	[illegible]	1.[illegible]
8	[illegible]	1.[illegible]

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



NDE 92-072 —— Page 9 of 9

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 Tamburro Date 3/21/07	Reviewed by		Date

GPU Nuclear

MGO: 1 (TM)

Calibration Sheet

Cal Sheet 1/2-93

System [illegible]	Component Drywell Shell	Procedure 6100-QAP-7209.07		Rev 0	
Examiner	Signature:	Print: [illegible]	Initials:	ID# [redacted]	Level II
Examiner	Signature: Mark F. B.	Print: Mark F. Bagnell	Initials: MFB	ID# [redacted]	Level I

Instrument Settings
ID# [illegible]
Model/Manuf. Sonic 137 Staveley

Gain
Coarse 65
Fine n/a
Uncal n/a

Sweep Circuit
Coarse 2" (Range)
Fine [illegible]
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 [illegible]

Cal Standard
ID# 244
Size n/a Sch. n/a
Thickness .5" & 1.0"
S/S (CS)
Temp 72 °F

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

Date 1-2-93 Time 1900

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

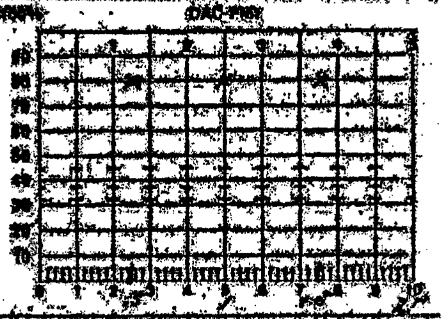
Search Unit
ID# [illegible]
Type MSEB
Freq 5 MHZ
Size 1/2"
Angle 0 Mode Long

Cal Direction
☐Axial ☐Both
☐Circ. ☒Normal

Search Unit Cable
Type [illegible] Length 6'

Couplant
Name Soundsafe Batch# [illegible]

Thermometer
S/N [illegible] Cal Due [illegible]



Time/Date	2118 1-2-93		2137 1-2-93		2225 1-2-93	
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5	80	.5	80	.5	80	.5
1.0	80	1.0	80	1.0	80	1.0
Initials						

Remarks:
Drywell liner thickness
measurements
Digital utilized

Components Examined:
Bays # 1, 3, 5

ANI Review

Technical Review
Reviewed By [illegible]
Level III Date 1-5-93

NDE Request# 92-072

[illegible]

*[illegible]

Ultrasonic Thickness Data Sheet

GPU Nuclear

☒ OC ☐ TMI-1 ☐ TMI-2	Class: N/A	Item: N/A	NDE Request: 92-072
			Data Sheet No.: 92-072-[illegible]
Task Description: UT Thickness		Task No.: N/A	Date: 1-8-93
Comp. Desc.: Drywell Ext.	System: 187		Code/Spec.: Gen Eng.
Procedure/Rev.: 6100-QAP-7209.27 Rev. 0		Drawing No./Rev.: 3E-187-23-001	
Test Surface: O.D.		Thickness: 1 1/8"	Material: c/s
Examiner	Sign:	Print: [illegible]	ID No.: [redacted]	Level: II
Examiner	Sign:	Print: [illegible]	ID No.: [redacted]	Level: II

Thermometer S/N 92-035 Part Temperature 70°F D-Meter S/N 92-015

Cal. Blk. S/N: C-2

Cal. In: 0220 AM ____ PM

Cal. Blk. Temp.: 72 F

Cal. Out: 0230 AM ____ PM

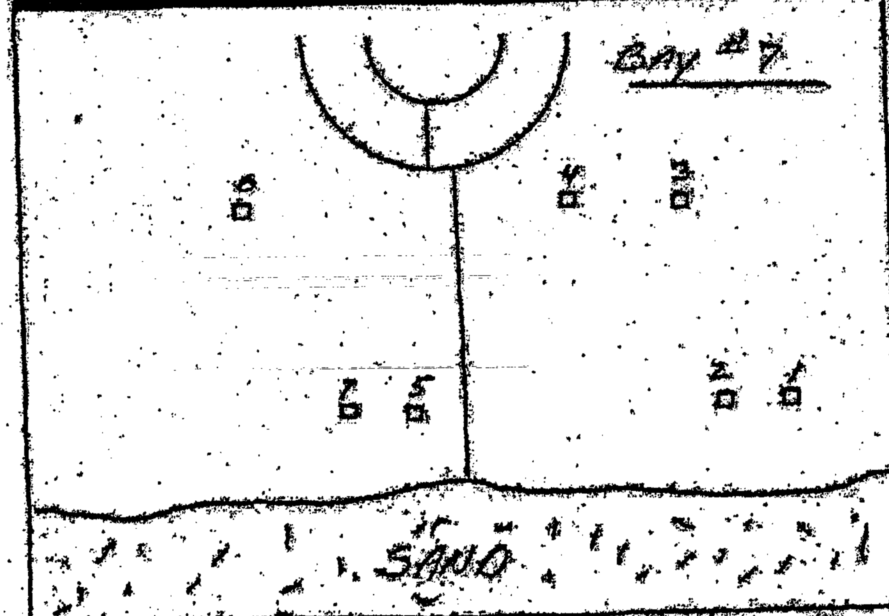
Calibration Readings (Inches)

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

Technique: ☐ CRT ☒ D-Meter

Other ______

Position #/Reading In Inches



Drawing

	AREA	MEASUREMENT
1	0.2" X .29"	.915"
2	0.2" X .32"	1.04"
3	0.10" X .20"	.965"
4	0.10" X .10"	1.04"
5	0.2" X .6"	1.03"
6	0.10" X .27"	1.09"
7	0.2" X .12"	1.0"

Reviewed by: [illegible]

Level: II

Date: 1-8-93

Page 1 of 1

all good

GPU Nuclear **Ultrasonic Thickness Data Sheet**

☒ OC ☐ TMI-1 ☐ TMI-2	Class: N/A	Item: N/A	NDE Request: 92-072
Data Sheet No: 92-072-02			
Task Description: UT Thickness			TWO No: N/A
Date: 2-7-93			
Comp. Desc: Drywell Liner	System: 187	Code/Spec: Eng. info.	
Procedure/Rev: 6100-QAP-7209.07	Rev 2	Drawing No/Rev: 3E-187-20-002	Rev 0
Test Surface: O.C.	Bay #9	Thickness: 1.15"	Material: A-212
Examiner Sign:	Print: T. Hanchek	ID No: [redacted]	Level: II
Examiner Sign:	Print: Larry Nickerson	ID No: [redacted]	Level: II

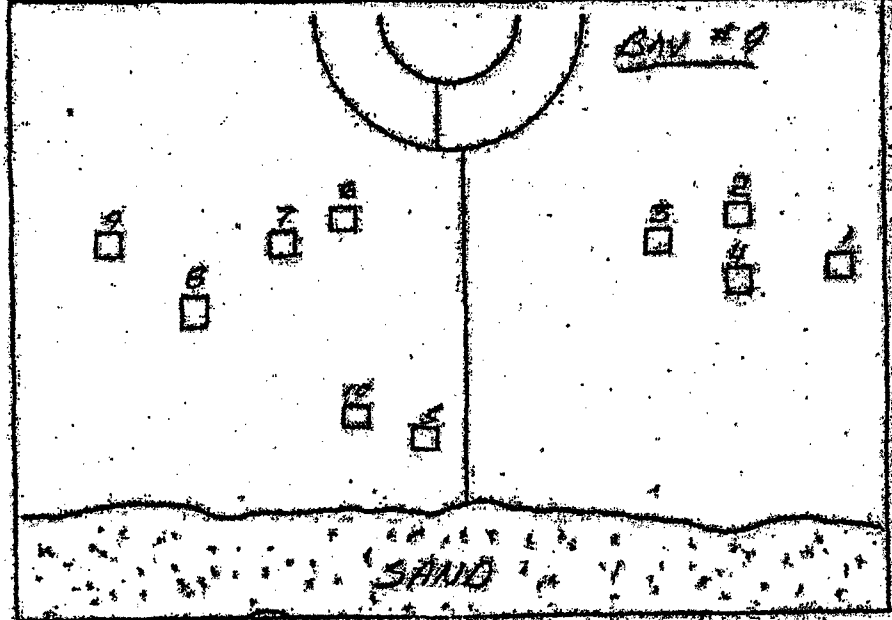
Thermometer S/N 92-002 Part Temperature 72 F D-Meter S/N 92-009
Cal. Blk. S/N 2-9
Cal. Blk. Temp. 72 F
Cal. In: 0900 AM 1200 PM
Cal. Out: 0915 AM 1215 PM

Calibration Readings (Inches)

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

Techniques
☐ CRT ☒ D-Meter
Other ______

Position #/Reading in Inches



Drawing

AREA	MEASUREMENT
1. 0-21 R-32	.960
2. 0-15 R-17	.97
3. 0-18 R-8	.920
4. 0-21 R-12	1.020
5. 0-36 L-4	.850
6. 0-34 1/2 L-30	.82
7. 0-16 L-?	.825
8. 0-27 L-?	.770
9. 0-54 L-53	.832
10. 0-32 L-6	.950

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

GPU Nuclear

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

one Point

GPU Nuclear Ultrasonic Thickness Data Sheet

☑ OC ☐ TMI-1 ☐ TMI-2	Class: N/A	Item: N/A	NDE Request: 92-072
Data Sheet No.: 92-07-09			
Task Description: ext. thickness		Task No.: N/A	Date: [illegible]
Comp. Desc.: Drywell liner Bay 8	System: 187		Code/Spec.: ASME [illegible]
Procedure/Rev.: 6100-QAP-7209.[illegible] Rev. [illegible]		Drawing No./Rev.: 3E-187-[illegible]	
Test Surface: [illegible]		Thickness: 1.15"	Material: [illegible]
Examiner Sign: [illegible]	Print: T. [illegible]	ID No.: [redacted]	Level: II
Examiner Sign: [illegible]	Print: Mark F. Brunell	ID No.: [redacted]	Level: I

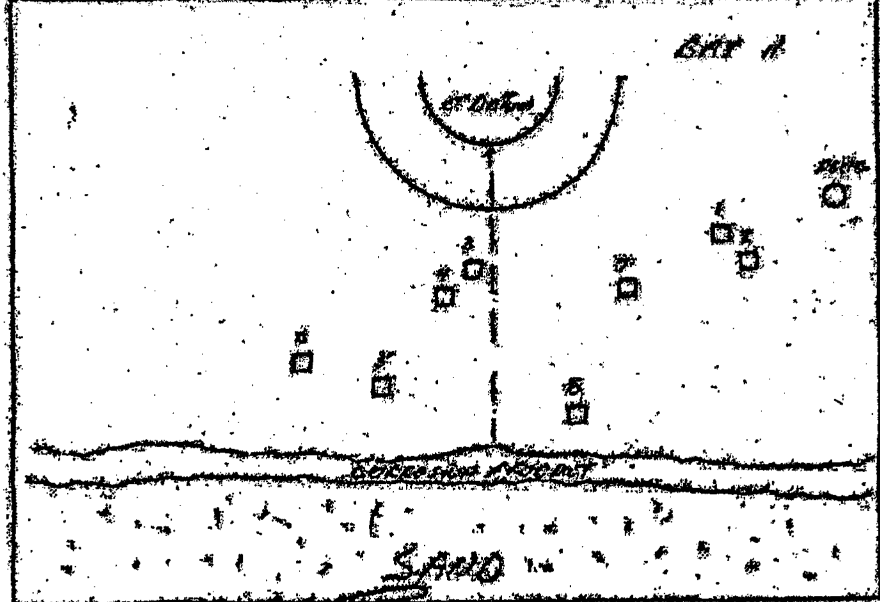
Thermometer S/N: 92-[illegible] Part Temperature: 65 °F D-Meter S/N: 92-[illegible]
Cal. Blk. S/N: 92-[illegible]
Cal. Blk. Temp.: 65 °F
Cal. In: [illegible] AM [illegible] PM
Cal. Out: [illegible] AM [illegible] PM

Calibration Readings (inches)

Cal. Blk.	.1"	.75"	1.0"			
D-Meter	.1"	.75"	1.0"			

Techniques
☑ DRT ☐ D-Meter
Other: ______

Position #, Reading in Inches



Drawing

[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]
5	[illegible]	[illegible]
6	[illegible]	[illegible]
7	[illegible]	[illegible]
8	[illegible]	[illegible]
9	[illegible]	[illegible]

Reviewed by: [illegible] Level: III Date: 12-22-92 Page 1 of 2

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

GPU Nuclear Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A	Item: N/A	NDE Request: 92-022	Data Sheet No.: [illegible]
Task Description: UT thickness		Task No.: N/A	Date: [illegible]
Comp. Desc.: Drywell Liner Bay 11	System: 187	Code/Spec.: [illegible]	
Procedure/Rev.: [illegible]		Drawing No./Rev.: 3E-187-23-001 [illegible]	
Test Surface: [illegible]		Thickness: [illegible]	Material: CS
Examiner Sign: [illegible]	Print: [illegible]	ID No.: [redacted]	Level: II
Examiner Sign: [illegible]	Print: Mark F. Bagnell	ID No.: [redacted]	Level: II

Thermometer S/N [illegible] Part Temperature [illegible] °F D-Meter S/N [illegible]

Cal. Blk. S/N [illegible] Cal. In: N/A AM [illegible] PM

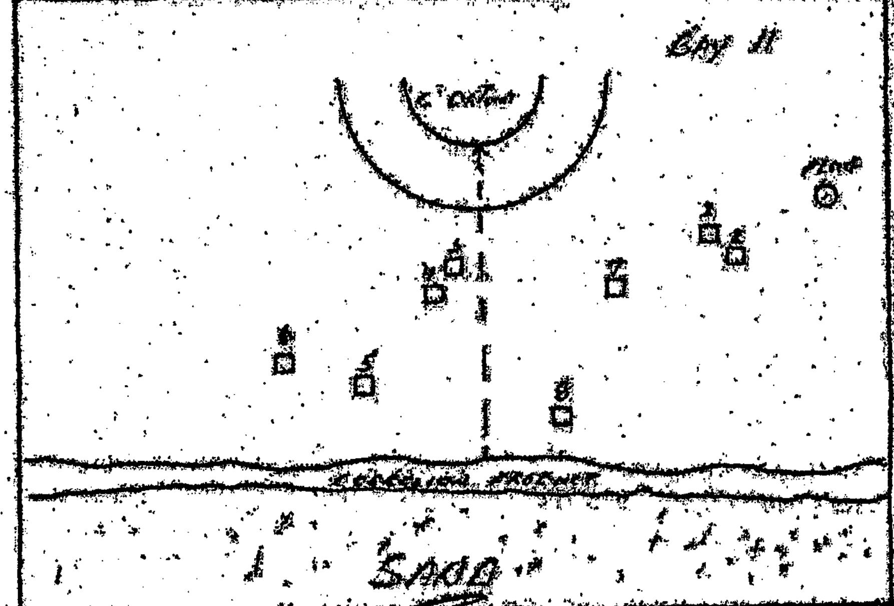
Cal. Blk. Temp. [illegible] °F Cal. Out: N/A AM [illegible] PM

Calibration Readings (inches)

Cal. Blk.	[illegible]	[illegible]	[illegible]			
D-Meter	[illegible]	[illegible]	[illegible]			

Techniques ☐ CRT ☒ D-Meter Other

Position #/Reading in Inches



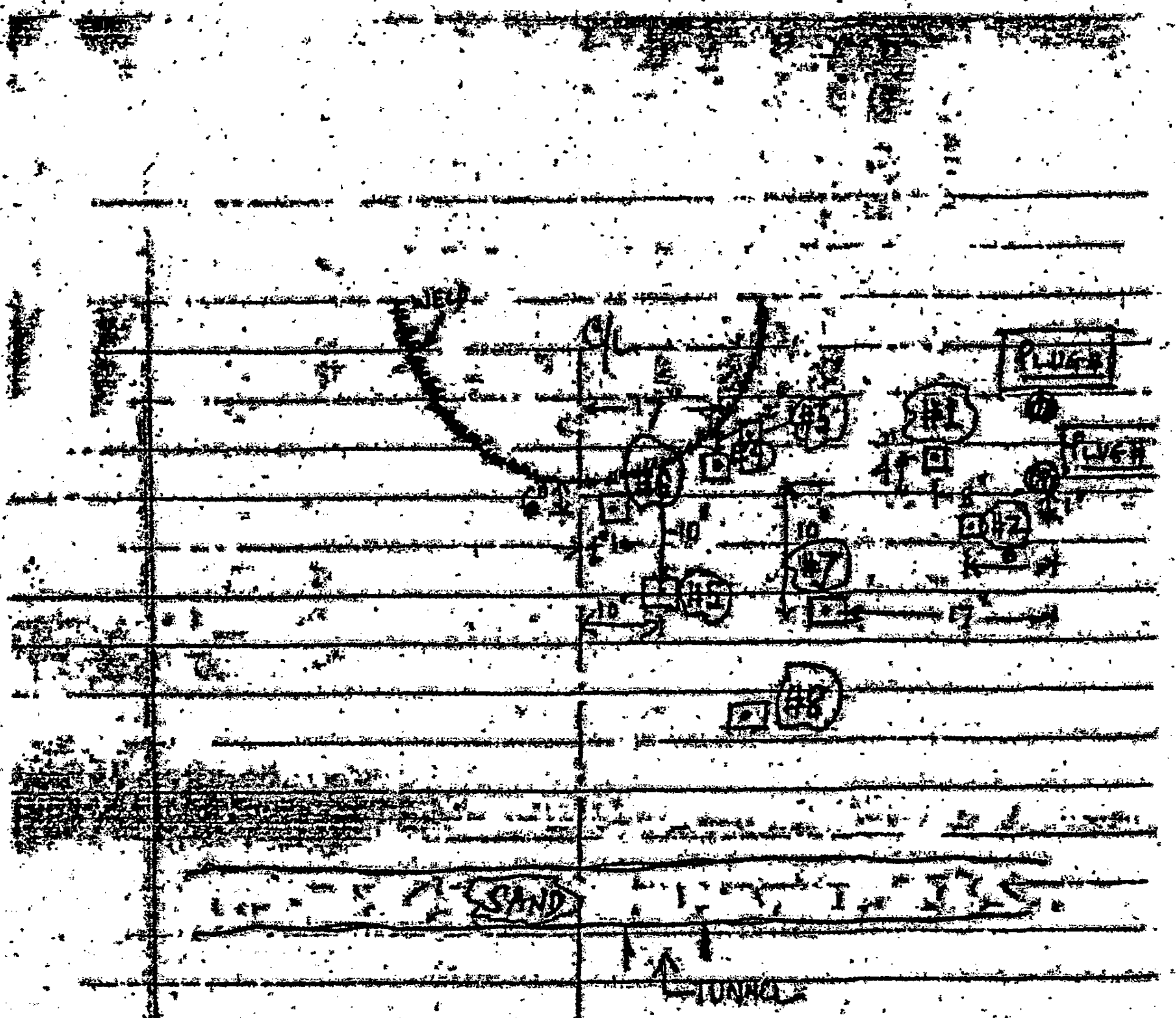
Drawing

[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]
5	[illegible]	[illegible]
6	[illegible]	[illegible]
7	[illegible]	[illegible]
8	[illegible]	[illegible]

Reviewed by: [illegible] Level: [illegible] Date: [illegible] Page 1 of 1

GPU Nuclear

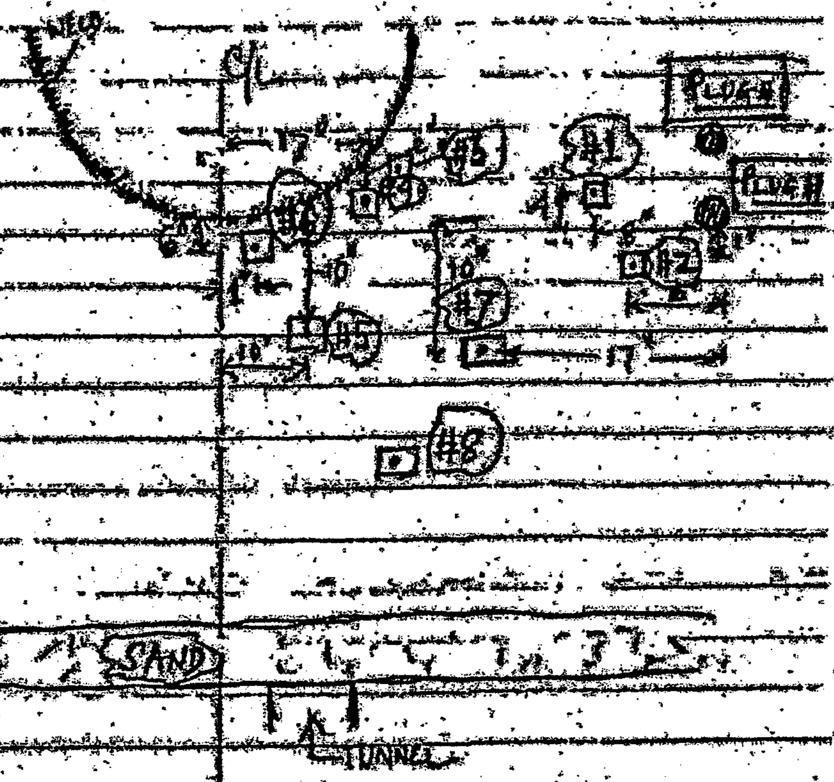
Subject O.C. Drywell Ext. UT Evaluation in Sandbed		Calc No. C-1302-187-5320-024	Rev. No. 3	Sheet No. 139 of 183
Originator Pete Tamburro	Date 3/21/07	Reviewed by		Date



BAY-11 — U.T. SPOTS FOR GRINDING

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

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 3	**Sheet No.** 140 of 183
Originator Pete Tamburro	**Date** 3/21/07	**Reviewed by**	**Date**



BAY-11 — U.T. SPOTS FOR GRINDING

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

GPU Nuclear

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

GPU Nuclear

Calibration Sheet

Cal Sheet# [illegible]

System: 187	Component: Drywell [illegible]	Procedure: [illegible]		Rev: [illegible]
Examiner:	Signature:	Print: J. [illegible]	Initial: [illegible]	ID# [redacted] Level: [illegible]
Examiner:	Signature:	Print: Mark F. Bagnell	Initial: [illegible]	ID# [redacted] Level: [illegible]

Instrument Settings
ID# [illegible]
Model/Manuf [illegible]

Gain
Coarse [illegible]
Fine [illegible]
Uncal [illegible]

Sweep Circuit
Coarse 2" (Range)
Fine [illegible]
Delay [illegible]
Screen Depth [illegible]

Operation
[✓ T&R] Normal
Frequency: [illegible] MHZ
Reject: ☒Off ☐On ______ %
Filter: ☐Off ☒On [illegible] %
Damping: ☐Off ☒On [illegible] %

Rep Rate: [illegible]

Cal Standard
ID# [illegible]
Size [illegible] Sch. [illegible]
Thickness [illegible]
SS [✓ CS]
Temp. [illegible] °F

System Check
☐Exit Point [illegible]
☐Angle +/- 2

Search Unit
ID# [illegible]
Type [illegible]
Freq. 2 MHZ
Size [illegible]
Angle [illegible] Mode [illegible]

Cal Direction
☒Axial ☐Both
☐Circ. ☒Normal

Search Unit Cable
Type [illegible] Length [illegible]

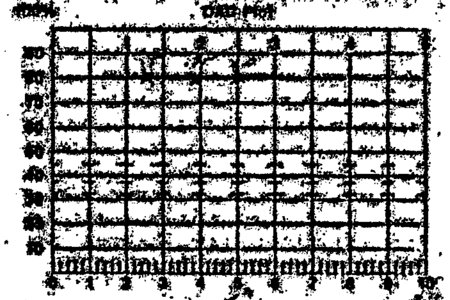
Couplant
Make [illegible] Batch# [illegible]

Thermometer
S/N [illegible] Cal Due [illegible]

Date [illegible] Time [illegible]

Reflector	Amplitude % of FSH	Screen Reading In Inches
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

DAC Plot



Time/Date	[illegible]		/		/	
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
[illegible]	[illegible]	[illegible]				
[illegible]	[illegible]	[illegible]				
[illegible]	[illegible]	[illegible]				
Initials	[illegible]					

Remarks:

Components Examined:
[illegible]

ANI Review

Technical Review
Reviewed By [illegible]
Level III Date 12-27-92

NDE Request# [illegible]

GPU Nuclear

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

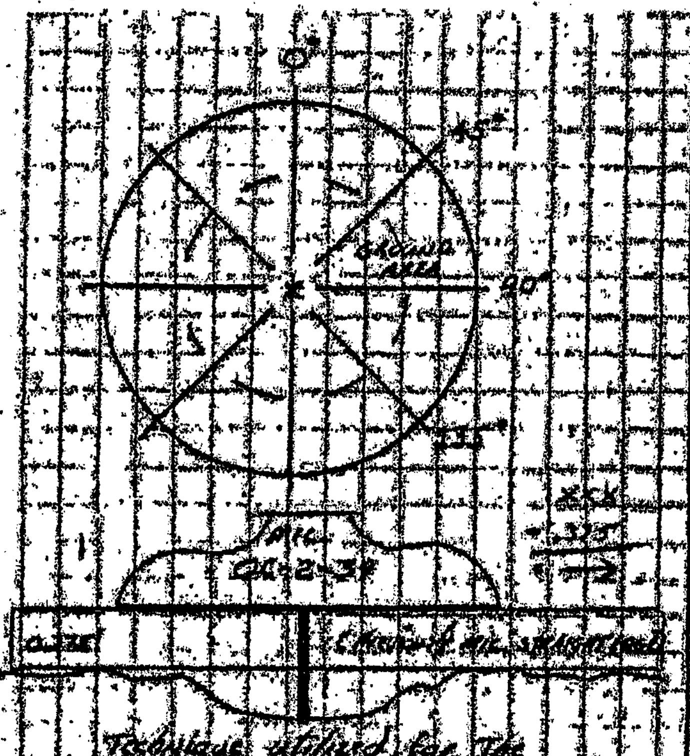
GPU Nuclear

☒ QC ☐ IML ☐ OTHER ____________

Sketch Form (with grid)

Component: Drywell Liner Sandbed Area	Data Sheet No.: 92-072-31
Location: Bay # 11	Drawing No.: N/A Rev.: N/A

Drawing:



Technique utilized for the pit depth measurements

AREA	0°	45°	90°	135°
1	.267	.338	.167	.200

Azimuth

Prepared by:		Title: UT LV II	Date: 1/11/93
Reviewed by:	Level: III	Date: 1-13-93	Page 1 of 1
			NDE Request No.: 92-072

GPU Nuclear

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

Bay [illegible] wider

Ultrasonic Thickness Data Sheet

GPU Nuclear

☒ OC ☐ TMI-1 ☐ TMI-2	Class: N/A	Item: N/A	NDE Request: 92-092
Data Sheet No.: 92-072-23	Date: 1/7/93		

Task Description: Drywell [illegible] [illegible] (Shell thickness)

Task No.: N/A

Comp. Desc.: Drywell [illegible] Bay 13

System: Drywell

Code/Spec.: [illegible]

Procedure/Rev.: 6100-QAP-7209.01 Rev 0

Drawing No./Rev.: 3E-153-[illegible]-001

Test Surface: O.D.

Thickness: 1 1/8"

Material: C.S.

Examiner	Sign: [illegible]	Print: [illegible]	ID No.: [redacted]	Level: II
Examiner	Sign: N/A	Print: N/A	ID No.: N/A	Level: N/A

Thermometer S/N: [illegible] Part Temperature: 74° F D-Meter S/N: [illegible]

Cal Blk. S/N: 2.1.4 Cal In: N/A AM 1:20 PM

Cal Blk. Temp.: 69° F Cal Out: N/A AM 3:30 PM

Calibration Readings (inches)

Cal. Blk.	.502"	1.489"			N/A	
D-Meter	.502"	1.500"				

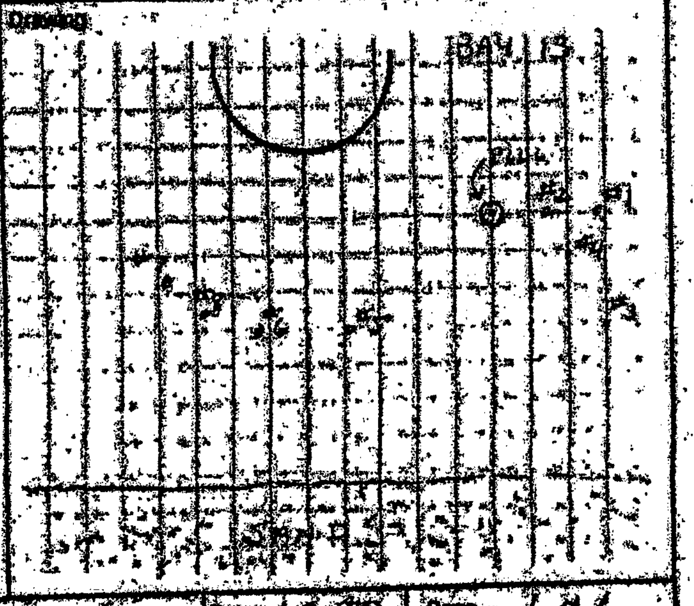
Techniques: ☐ CRT ☒ D-Meter

Other: N/A

Position #/Reading in Inches

AREA	LOCATION	THK
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]
5	[illegible]	[illegible]
6	[illegible]	[illegible]
7	[illegible]	[illegible]
8	[illegible]	[illegible]

Drawing



Reviewed by: [illegible] Level: II/III Date: 1-8-93 Page 1 of 1

GPU Nuclear

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

7 Points under

GPU Nuclear

Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A Item: N/A NDE Request: 93-[illegible] Data Sheet No.: 93-[illegible]

Task Description: Drywell [illegible] [illegible] [illegible] Task No.: N/A Date: 1-11-93

Comp. Desc.: Drywell [illegible] [illegible] System: 187 Code/Spec: N/A [illegible]

Procedure/Rev.: [illegible] Drawing No./Rev.: [illegible] 29 [illegible]

Test Surface: O.D. Thickness: 1.15" Material: C.S.

Examiner Sign: Print: [illegible] ID No.: [redacted] Level: II

Examiner Sign: Print: [illegible] ID No.: Level: III

Thermometer S/N 92-[illegible] Part Temperature 68 F D-Meter S/N 92-[illegible]

Cal. Blk. S/N 339 Cal. In: N/A AM 2:25 PM

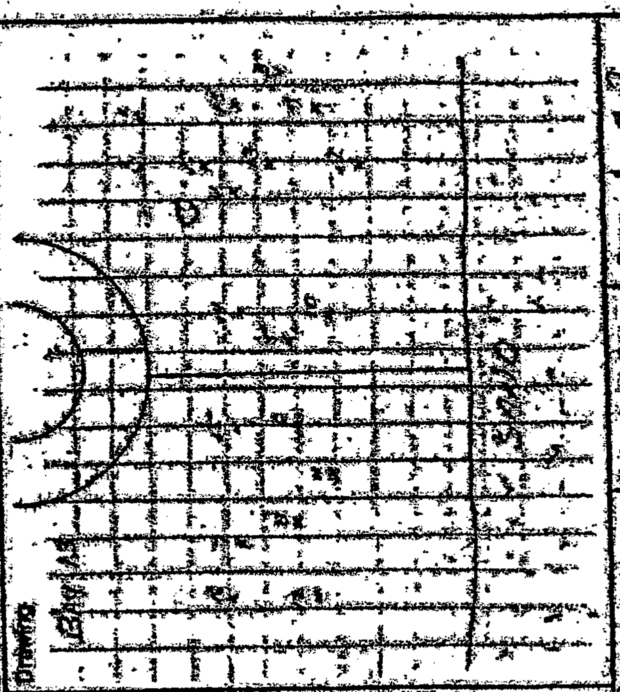
Cal. Blk. Temp. [illegible] F Cal. Out: N/A AM 2:50 PM

Calibration Readings (inches)

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

Techniques: ☐ CRT ☒ D-Meter Other ______

Drawing



Position #/Reading in Inches

Area	Location	THK
1	UP 4" R-45"	0.682"
2	UP 1" R-38"	0.7[illegible]
3	D-21" R-48"	0.801"
4	D-12" R-35"	0.915"
5	D-24" R-8	0.7[illegible]
6	D-24" L-18"	0.655"
7	D-27" L-22"	0.686"
8	D-27" L-28"	0.716"
9	D-28" R-41"	0.744"
10	D-26" R-12"	0.725"
11	D-28" L-15"	0.667"
12	D-26" L-23"	0.682"
13	D-16" R-30"	0.751"
14	D-18" R-8"	0.816"
15	D-20" L-4"	0.803"
16	D-20" L-28"	0.828"
17	D-8" R-32"	0.801"
18	D-23" R-32"	0.811"
19	D-23" R-32"	0.715"

[illegible]

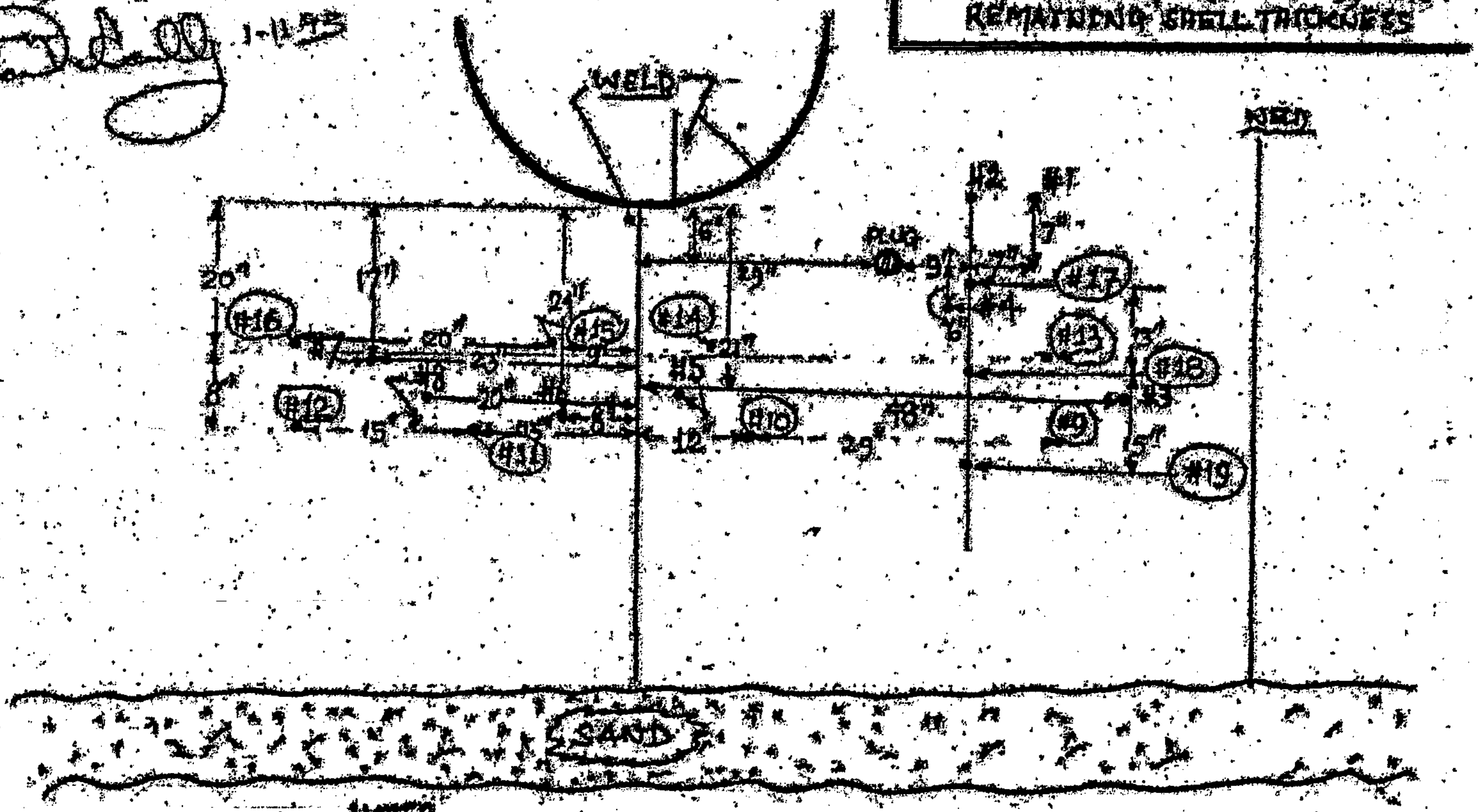
Reviewed by: [illegible] Level: III Date: 1-11-93 Page: 1 of 2

[illegible]

BAY # 13

#92.072.24
Pg 2 of 2
1-11-93

NOTES:
- SPOT (#9) THRU (19) MARKED ON 1/10/93.
SKD 1/10/93
- GRIND ABOVE SPOTS CAREFULLY AS NOT TO REDUCE SHELL THICKNESS EXCESSIVE
- UT ALL SPOTS (1 THRU 19) FOR REMAINING SHELL THICKNESS



NOTES
- PLUG UNCORRODED – LOCATED IN A DEEP VALLEY.
- "TUB RING" LESS PROMINENT.
- SHELL & FLOOR NEEDS MORE CLEANING.

none under

GPU Nuclear — Ultrasonic Thickness Data Sheet

☑ OC ☐ TMI-1 ☐ TMI-2 Class: n/a	Item: n/a	NDE Request: 92-072	Data Sheet No.: 92-072-25
Task Description: Drywell [illegible] [illegible]		Task No.: n/a	Date: 4/[illegible]/92
Comp. Desc.: Drywell [illegible] Bay 13	System: [illegible]		Code/Spec: [illegible]
Procedure/Rev.: 6100-QAP-7209.07 Rev 0		Drawing No./Rev.: 3E-187-29-001	
Test Surface: O.D.		Thickness: ~1 1/8"	Material: CS
Examiner Sign: [illegible]	Print: T. [illegible]	ID No.: [redacted]	Level: II
Examiner Sign: n/a	Print: n/a	ID No.: n/a	Level: n/a

Thermometer S/N 92-066 Part Temperature 70 F D-Meter S/N 92-[illegible]

Cal. Blk. S/N 212 Cal. In: n/a AM 1230 PM

Cal. Blk. Temp. 70 F Cal. Out: n/a AM 1245 PM

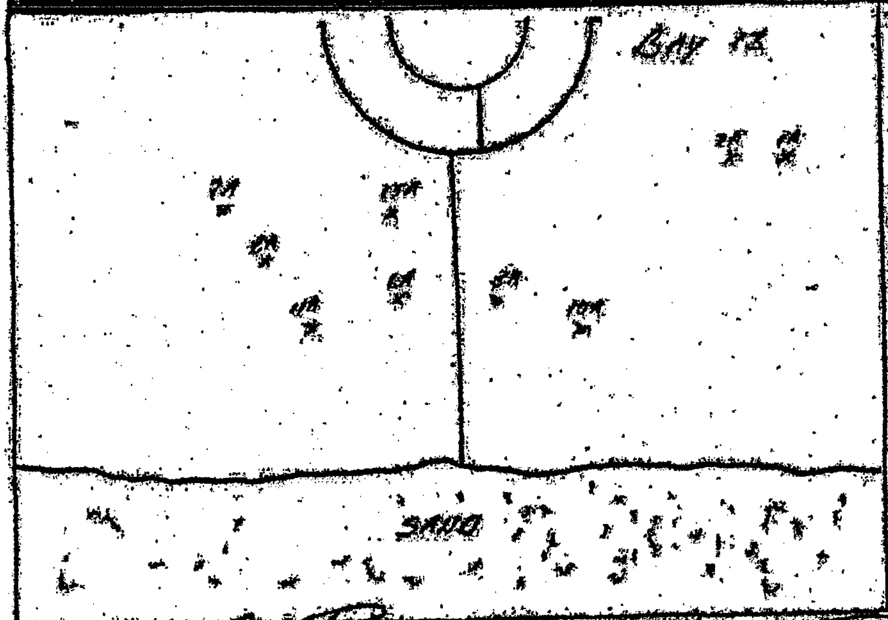
Calibration Readings (Inches)

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

Technique: ☐ CRT ☑ D-Meter

Other ______

Position #, Reading in Inches



Drawing

Area	Thickness
1A	0.80
2A	0.892*
3A	0.84[illegible]
12A	0.87[illegible]
14A	0.857
8A	0.9[illegible]
7A	0.772
5A	~~[illegible]~~ .776
13A	~~[illegible]~~ [illegible]

* [illegible] adjacent to [illegible] locations

Reviewed by: [illegible] Level: III Date: [illegible] Page 1 of 1

GPU Nuclear

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

from under

GPU Nuclear — Ultrasonic Thickness Data Sheet

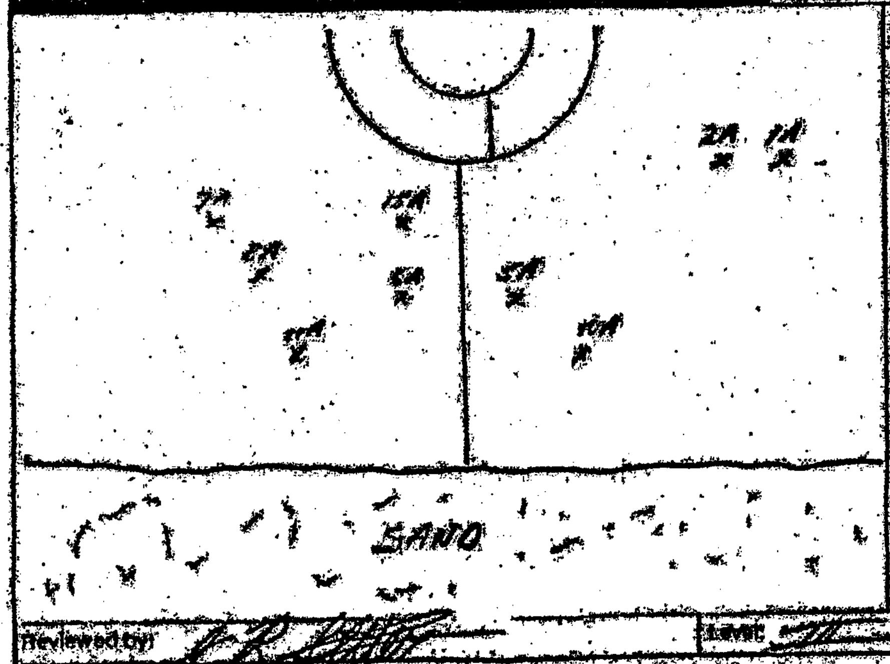
☒ OC ☐ TMI-1 ☐ TMI-2
Class: NA
Item: NA
NDE Request: 92-078
Data Sheet No.: 92-022-16
Task Description: Drywell Liner Thickness
Task No.: N/A
Date: 7/11/97
Comp/Desc: Drywell Ext. Bay 13
System: 187
Code/Spec: Eng. Info.
Procedure/Rev: 6100-QAP-7209.07 Rev 0
Drawing No/Rev: 3E-187-29-001
Test Surface: O.D.
Thickness: 1.15"
Material: C/S
Examiner Sign:
Print: T. [illegible]
ID No.: [redacted]
Level: II
Examiner Sign: NA
Print: NA
ID No.: NA
Level: NA
Thermometer S/N 21-012 Part Temperature 72 F D-Meter S/N 27-112
Cal. Blk. S/N 2-8
Cal. Blk. Temp. 72 F
Cal. In: NA AM 10:15 PM
Cal. Out: NA AM 11:25 PM

Calibration Readings (Inches)

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

Techniques: ☒ CRT ☐ D-Meter
Other: ____

Position & Reading In Inches



Drawing

AREA	Thickness
1A	0.88
2A	0.75
3A	0.83
10A	0.86
11A	0.85
6A	0.87
7A	0.76
8A	0.82
15A	0.854

7A" [illegible] grind area adjacent to Previous grinded locations

Reviewed by: Level: III Date: 7-11-97 Page 1 of 1

GPU Nuclear

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

GPU Nuclear

Calibration Sheet

Cal Sheet # 92-03

System: 187	Component: Bay 13 [illegible]	Procedure: [illegible]			Rev: 0
Examiner:	Signature:	Print: J. [illegible]	Initial: [illegible]	ID# [redacted]	Level: II
Examiner:	Signature: n/a	Print: n/a	Initial: n/a	ID# n/a	Level: n/a

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

Gain
Coarse 42.5
Fine n/a
Uncal n/a

Sweep Circuit
Coarse 2" (Range)
Fine [illegible]
Delay 0.750"
Screen Depth 2"

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

Rep Rate: 200 Hz

Cal Standard
ID# 219
Size 24 Sch [illegible]
Thickness [illegible]
S/S (CS)
Temp 72 °F

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

Date 11/1/92

Search Unit
ID# [illegible]
Type [illegible]
Freq 5 MHZ
Size .25"
Angle 0 Mode [illegible]

Cal Direction
☐ Axial ☐ Both
☐ Circ. ☒ Normal

Time 1032 hrs

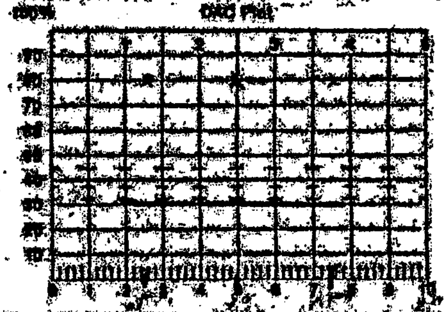
Reflector	Amplitude % of FSH	Screen Reading In Inches
.5	80	.5
1.0	80	1.0
1.5	80	1.5

Search Unit Cable
Type [illegible] Length [illegible]

Couplant
Make [illegible] Batch# [illegible]

Thermometer
S/N [illegible] Cal Due [illegible]

DAC Plot



Time/Date	[illegible]					
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5	80	.5				
1.0	80	1.0				
1.5	80	1.5				
Initials	[illegible]					

Remarks:
Crystal centered
data at 80% FSH
refer to UT thickness
data sheet 92-072

Components Examined:
Drywell liner Bay 13

ANI Review

Technical Review
Reviewed By: [illegible]
Level: [illegible] Date 11/1/92
NDE Request#: 92-072

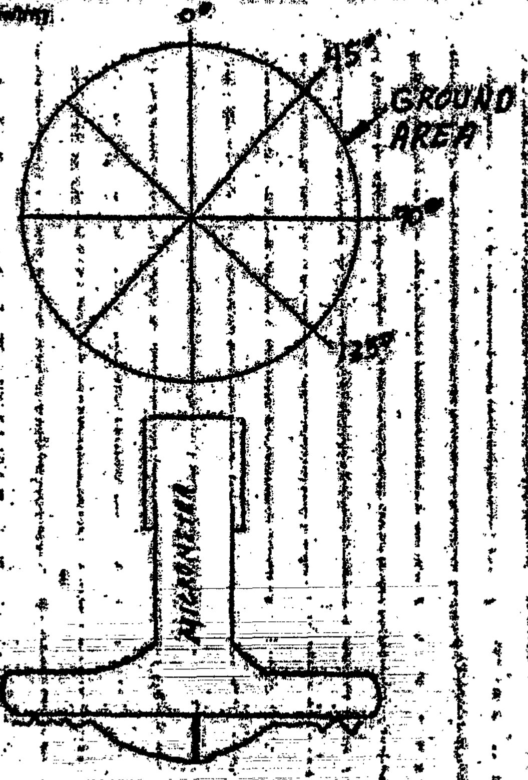
GPU Nuclear

☒ OC ☐ TMI ☐ OTHER: ______

Sketch Form (with grid)

Component: DRY WELL LINEAR	Data Sheet No.: 92-072
Location: BAY 13	Drawing No.: N/A Rev.: N/A

Drawing:



TECHNIQUE USED TO
DETERMINE DETH OF GROUND AREAS

UT READING LOCATIONS	0°	45°	90°	135°
1	.330	.392	.340	.340
2	.312	.377	.360	.393
5	.150	.193	.230	.298
6	.347	.339	.270	.247
7	.241	.279	.260	.239
8	.319	.245	.262	.279
10	.184	.173	.255	.219
11	.240	.231	.271	.183
15	.169	.217	.237	.256

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

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

GPU Nuclear

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

[illegible]

Ultrasonic Thickness Data Sheet

GPU Nuclear

☒ OC ☐ TMI-1 ☐ TMI-2	Class: n/a	Item: n/a	NDE Request: 92-076
Data Sheet No.: 93-076-7			
Task Description: UT Thickness			Task No.: n/a
Date: 1-8-93			
Comp. Desc.: Drywell Liner	System: 187		Code/Specs: [illegible]
Procedure/Rev.: 6100-QAP-7209.03 [illegible]	Drawing No./Rev.: 3E-187-23-004		
Surface: O.D.	Thickness: 1 1/8"	Material: c/s	
Examiner: Sign: [illegible]	Print: Tom Murdock [illegible]	ID No.: [redacted]	Level: II
Examiner: Sign: [illegible]	Print: Luis Valenzuela	ID No.:	Level: II

Thermometer S/N 92-005 Part Temperature 72°F D-Meter S/N 92-035

Cal. Blk. S/N 220 Cal. In: [illegible] AM ____ PM

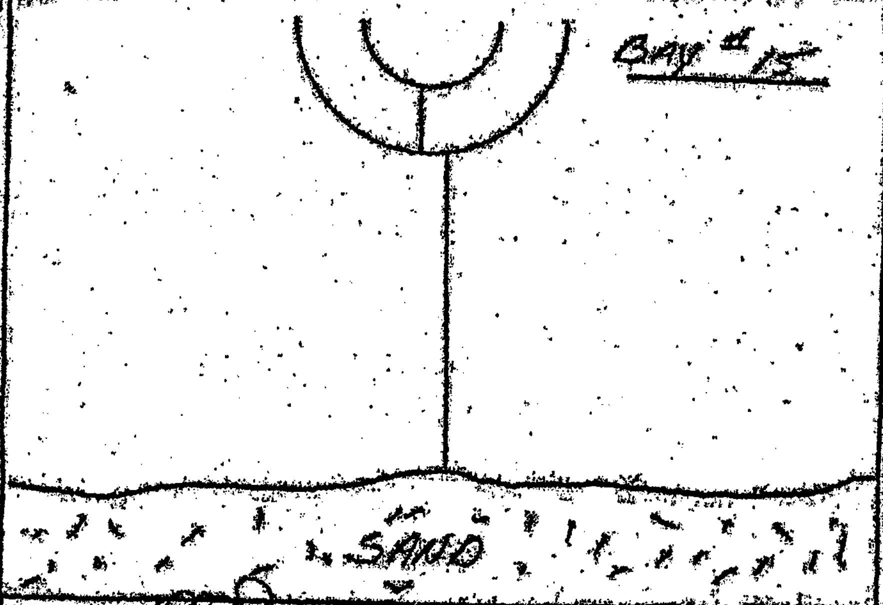
Cal. Blk. Temp. 72 F Cal. Out: [illegible] AM ____ PM

Calibration Readings (inches)

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

Technique: ☐ CRT ☒ D-Meter

Other: ________



Drawing

Area				Thickness
1	D=12"	A=36"		0.786
2	A=22"	A=24"		0.829
3	D=33"	A=17"		0.735
4	D=33"	A=2"		0.798
5	D=26"	L=5"		0.757
6	D=6	L=8"		0.786
7	D=27"	L=12"		0.803
8	D=27"	L=36"		0.77
9	D=32"	L=30"		0.735
10	D=22"	L=40"		0.756
11	D=27"	L=65"		0.808

Reviewed by: [illegible]

Level: II

Date: 1-8-93

Page 1 of 1

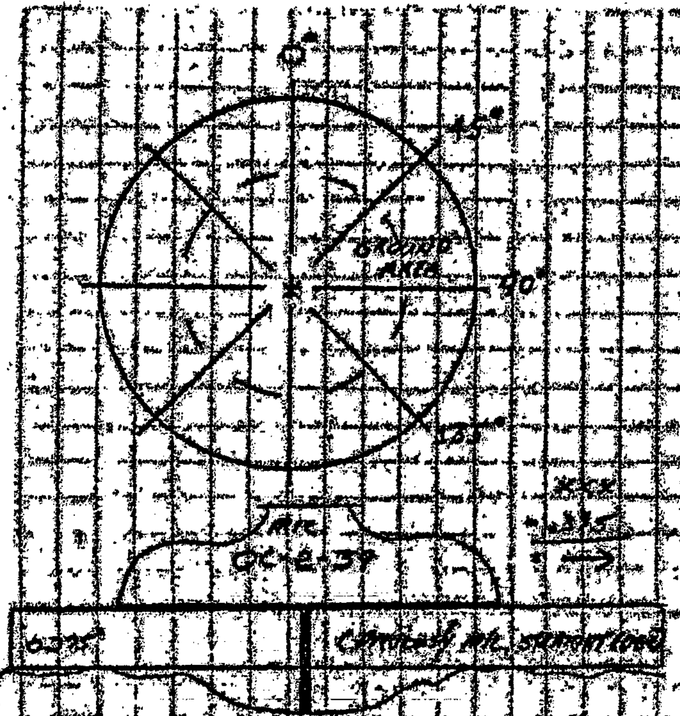
GPU Nuclear

☒ OC ☐ TMI ☐ OTHER________

Sketch Form (with grid)

Component: Drywell Neck Sandbed Area	Data Sheet No.: 92-072-20
Location: Bay # 15	Drawing No.: N/A Rev.: N/A

Drawing



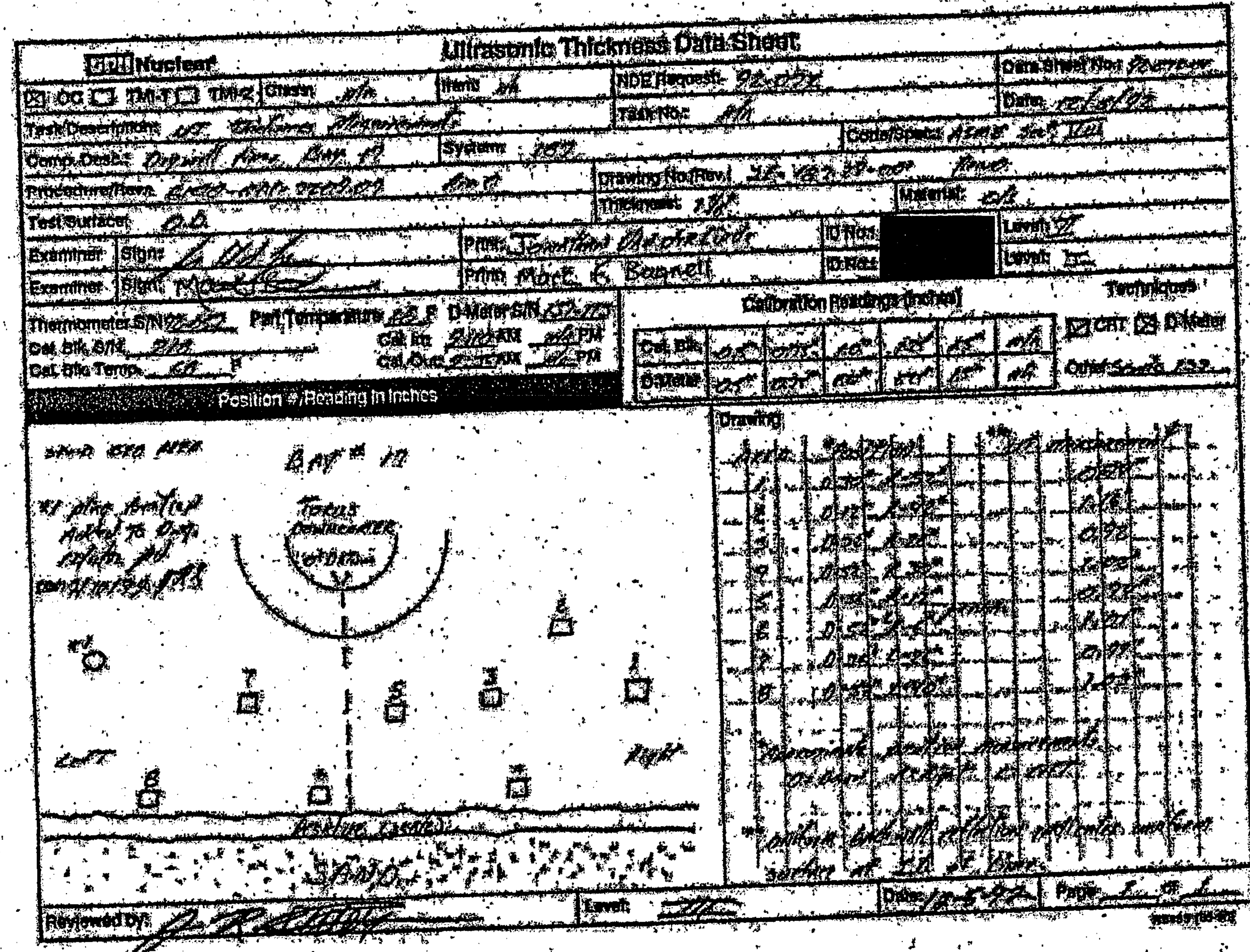
Technique utilized for the pit depth measurements

AZIMUTH

AREA	0°	45°	90°	135°
7	.350	.350	.359	.282

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

6110-QAP-7200.56 (1/93)



[illegible]

Ultrasonic Thickness Data Sheet

GPU Nuclear

☒ OC ☐ TMI-1 ☐ TMI-2 | Class: n/a | Item: n/a | NDE Request: 92-0[illegible] | Data Sheet No: [illegible]

Task Description: UT Thickness Measurements | Task No: n/a | Date: 12/[illegible]/92

Comp. Desc: Drywell liner Bay 13 | System: 187 | Code/Spec: ASME Sec. XI

Procedure/Rev: 6100-QAP-7209.03 Rev 7 | Drawing No./Rev: 3E-153-29-00[illegible] [illegible]

Test Surface: O.D. | Thickness: 1 1/8" | Material: c/s

Examiner Sign: | Print: [illegible] | ID No: [redacted] | Level: II

Examiner Sign: | Print: Mark G. Bagnell | ID No: | Level: III

Thermometer S/N: [illegible] | Part Temperature: 68 F | D-Meter S/N: [illegible]

Cal. Blk. S/N: [illegible] | Cal In: [illegible] AM n/a PM

Cal. Blk. Temp.: 68 F | Cal. Out: [illegible] AM n/a PM

Calibration Readings (Inches)

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

Technique: ☒ CRT ☒ D-Meter

Other: Sonic 132

Position #/Reading in Inches

Drawing

Area	Position	UT measurement
1	0.30" [illegible]	0.84"
2	0.12" [illegible]	1.16"
3	[illegible]	0.92"
4	[illegible]	1.02"
5	[illegible]	0.7[illegible]"
6	[illegible]	1.2[illegible]"
7	[illegible]	0.9[illegible]"
8	[illegible]	1.0[illegible]"

Measurement position measurements [illegible]

*uniform [illegible] corrosion pattern [illegible] surface at [illegible] of liner.

Reviewed By: | Level: III | Date: 12-5-92 | Page 1 of 1

[illegible]

GPU Nuclear

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

Ultrasonic Thickness Data Sheet

GPU Nuclear

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

Task Description: UT Thickness Task No.: n/a Date: [illegible]

Comp. Desc.: Drywell Exterior Bay 17 System: 187 Code/Spec.: ASME Sec. VIII

Procedure/Rev.: 6100-QAP-7209.03 Rev. 0 Drawing No./Rev.: [illegible]

Test Surface: OD Thickness: [illegible] Material: c/s

Examiner: Sign: [illegible] Print: [illegible] ID No.: [redacted] Level: II

Examiner: Sign: n/a Print: n/a ID No.: n/a Level: n/a

Thermometer S/N: [illegible] Part Temperature: [illegible] D-Meter S/N: [illegible]

Cal. Blk. S/N: [illegible]

Cal. Blk. Temp.: [illegible] F

Cal. In: n/a AM [illegible] PM

Cal. Out: n/a AM [illegible] PM

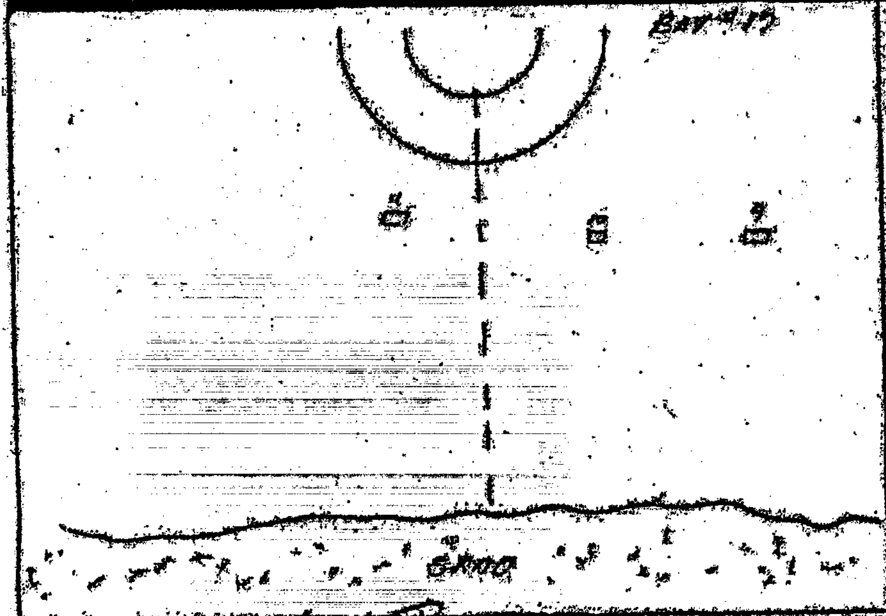
Calibration Readings (Inches)

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

Technique: ☒ CRT ☒ D-Meter

Other: ______

Position #/Reading in Inches



Drawing:

Area [illegible] Thickness

[illegible]

[illegible]

[illegible]

[illegible]

Reviewed by: Level: III Date: [illegible] Page 1 of 1

GPU Nuclear **Ultrasonic Thickness Data Sheet**

☒ OC ☐ TMI-1 ☐ TMI-2 · Class: n/a · Item: n/a	NDE Request: 92-232		Data Sheet No.: 92-[illegible]
Task Description: UT Thickness	Task No.: n/a		Date: [illegible]
Comp. Desc.: Drywell [illegible] Bay 17	System: 187	Code/Spec.: [illegible]	
Procedure/Rev.: [illegible]	Drawing No./Rev.: 3E-187-29-[illegible] Rev 0		
Test Surface: O.S.	Thickness: [illegible]	Material: n/a	
Examiner · Sign:	Print: [illegible]	ID No.: [redacted]	Level: II
Examiner · Sign: n/a	Print: n/a	ID No.: n/a	Level: n/a

Thermometer S/N: 92-[illegible] Part Temperature 68 F · D-Meter S/N 92-[illegible]

Cal. Blk. S/N: 68 · Cal. In: n/a AM [illegible] PM

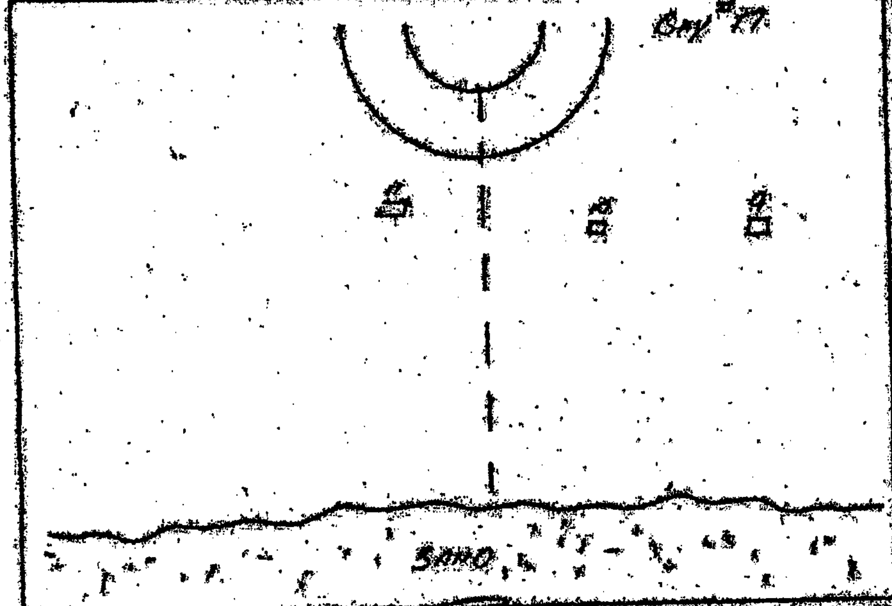
Cal. Blk. Temp: 68 F · Cal. Out: n/a AM [illegible] PM

Calibration Readings (Inches)

Cal. Blk.	.50"	.75"	1.0			
D-Meter	.5	.75"	1.0			

Techniques: ☒ CRT ☒ D-Meter · Other ______

Position #/Reading in Inches



Drawing:

Index		Thickness
9	[illegible]	[illegible]
10	[illegible]	[illegible]
11	[illegible]	[illegible]

Performed after [illegible]

[illegible]

Reviewed by: · Level: III · Date: [illegible] · Page 1 of 1

GPU Nuclear **Ultrasonic Thickness Data Sheet**

☒ OC ☐ TMI-1 ☐ TMI-2	Class: N/A	Item: N/A	NDE Request: 92-072
Data Sheet No.: 92-072-05			
Task Description: UT Thickness Measurements		Task No.: N/A	Date: 12/11/92
Comp. Desc.: Drywell [illegible]	Systems: 187	Code/Spec.: ASME Sect. [illegible]	
Procedure/Rev.: 6100-QAP-7209.03 Rev. 0		Drawing No./Rev.: 3E-187-23-001 Rev. 0	
Test Surface: O.D.		Thickness: 1.15"	Material: C/S
Examiner	Sign:	Print: [illegible]	ID No.: [redacted] Level: II
Examiner	Sign:	Print: Mark F. [illegible]	ID No.: [redacted] Level: II

Thermometer S/N 92-232 Part Temperature 72 F D-Meter S/N 92-072

Cal. Blk. S/N 85 Cal. In: [illegible] AM [illegible] PM

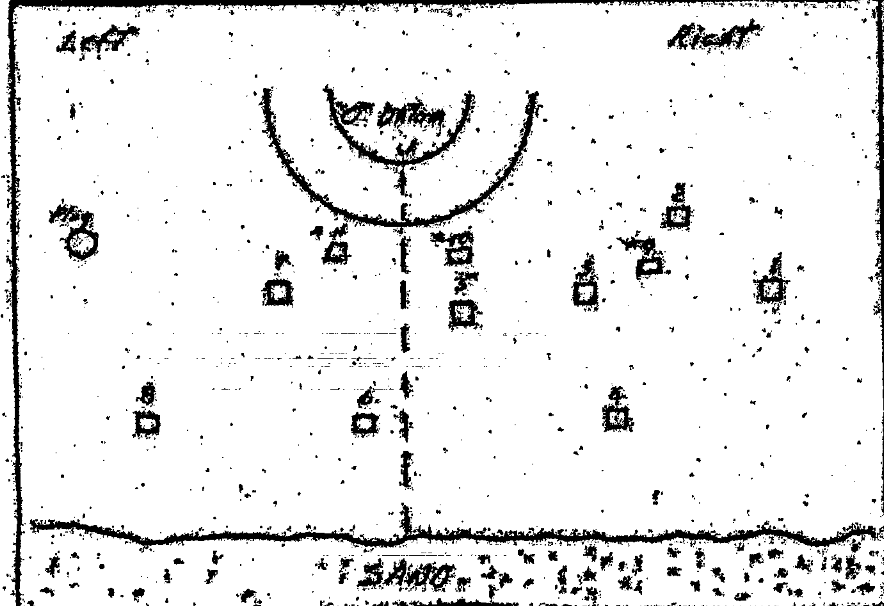
Cal. Blk. Temp. 72 F Cal. Out: [illegible] AM [illegible] PM

Calibration Readings (Inches)

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

Techniques: ☐ CRT ☒ D-Meter Other

Position #/Reading in Inches



Drawing

Area	Position	Thickness
1	0.30" R [illegible]	0.916"
2	0.12" R [illegible]	1.152"
3	0.32" R [illegible]	0.898"
4	0.52" R [illegible]	0.937"
5	0.36" R [illegible]	[illegible]
6	0.52" L [illegible]	[illegible]
7	0.36" L [illegible]	0.97"
8	0.32" R [illegible]	0.92"
Plug	0.20" L [illegible]	
9	[illegible]	[illegible]
10	[illegible]	[illegible]
11	[illegible]	[illegible]

[illegible]

Reviewed by: Level: Date: 12-12-92 Page 1 of 1

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

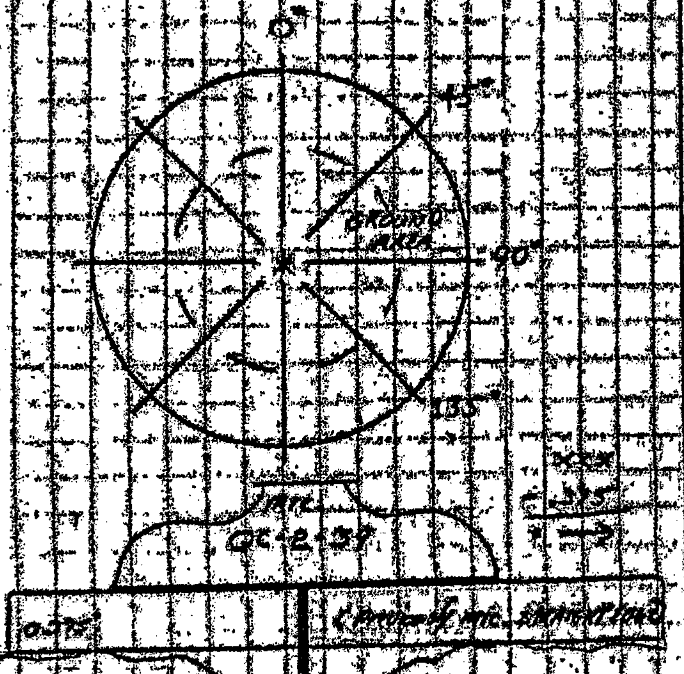
GPU Nuclear

☒ OC ☐ TMI ☐ OTHER

Sketch Form (with grid)

Component: DRYWELL LINER SANDBED AREA	Data Sheet No: 92-072-27
Location: BAY # 17	Drawing No: N/A Rev: N/A

Drawing



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

Technique utilized for the pit depth measurements

Prepared by:		Title: VT LV II	Date: 1/13/93
Reviewed by:	Level: II Date: 1-13-93	Page 1 of 1	NDE Request No: 92-072

NO. Above 0.736

Ultrasonic Thickness Data Sheet

GPU Nuclear

☒ OC ☐ TMI-1 ☐ TMI-2	Class: NA	Item: 2	NDE Request: 92-1??2
Data Sheet No.: 92-[illegible]			
Task Description: UT Thickness		Task No.: NA	Date: 12/?/92
Comp. Desc.: Drywell Liner Bay 19	System: 187		Code/Spec.: ASME Sect. VIII
Procedure/Rev.: 6100-QAP-7209.07 Rev 0		Drawing No./Rev.: 3E-187-29-001 Rev 0	
Test Surface: O.D.		Thickness: 1 1/8"	Material: C/S
Examiner	Sign:	Print: Jonathan [illegible]	ID No.: [redacted]	Level: II
Examiner	Sign: M [illegible]	Print: Mark F. Bagnell	ID No.: [redacted]	Level: II

Thermometer S/N 92-257 Part Temperature 65 F D-Meter S/N [illegible]

Cal. Blk. S/N 1?2

Cal. Blk. Temp. 62 F

Cal. In: 1030 AM NA PM

Cal. Out: 1225 AM NA PM

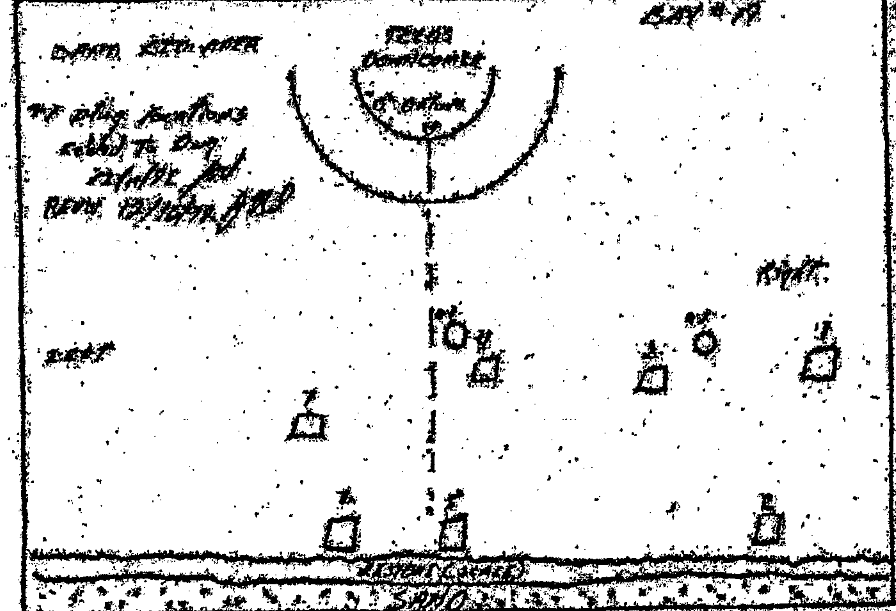
Calibration Readings (inches)

Cal. Blk.	.25	.505"	.70	.[illegible]	.?5	
D-Meter	.25	.505"	.70	.[illegible]	.?5	

Techniques: ☒ CRT ☒ D-Meter

Other: Scan 1??

Position #/Reading in Inches



DATUM: 12th AREA

UT reading locations added to Dwg. 12/11/92 [illegible]

REV'D 12/11/92 JRB

Drawing

Area	Position	UT Measurement
1	D-30" L-70"	0.97"
2	D-32" C-26"	0.96"
3	D-37" C-49"	0.98"
4	D-32" L-11"	0.97"
5	D-50" L-12"	0.95"
6	D-32" L-36"	0.96"
7	D-39" L-12"	0.98"

* Position measurements are approximate

** [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] of the UT [illegible]

Reviewed by: J R [illegible]

Level: III

Date: 12-?-92

Page 1 of 1

[illegible]

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 3	**Sheet No.** 158 of 183
Originator Pete Tamburro	**Date** 3/21/07	**Reviewed by**	**Date**

elev

GPU Nuclear Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: n/a Item: n/a

NDE Request: 92-277

Data Sheet No: 92-077-05

Task No.: n/a

Date: 12/11/92

Task Description: UT Thickness

Comp. Descr.: Drywell Liner Bay #19

System: 187

Code/Spec: ASME Sect XI

Procedure/Rev.: [illegible]

Drawing No./Rev.: JC-19479 004 [illegible]

Test Surface: O.D.

Thickness: 1.15"

Material: c/s

Examiner Sign: [illegible] Print: T. [illegible] ID No.: [redacted] Level: II

Examiner Sign: n/a Print: n/a ID No.: n/a Level: n/a

Thermometer S/N 92-022 Part Temperature 65 F D-Meter S/N 1-2-15

Cal. Blk. S/N 8?? Cal. In: n/a AM 2:20 PM

Cal. Blk. Temp. 68 F Cal. Out: n/a AM 2:22 PM

Calibration Readings (inches)

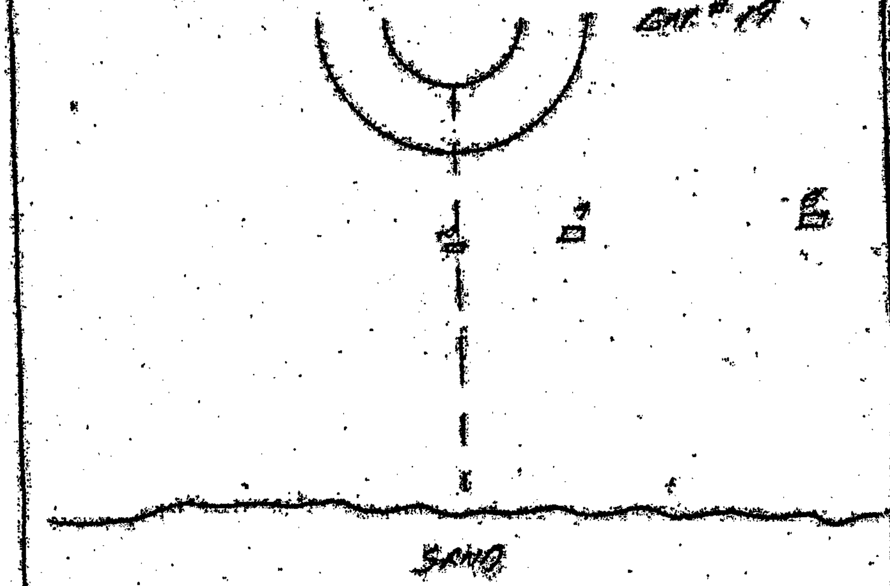
Cal. Blk.	.5"	.75"	1.0"	n/a		
D-Meter	.5"	.75"	1.0"			

Techniques

☒ CRT ☒ D-Meter

Other ______

Position #/Reading in Inches



Drawing

Pos.	[illegible]	Thickness
8	[illegible]	0.857
9	[illegible]	0.855
10	[illegible]	0.836

[illegible]

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

GPU Nuclear

Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2	Class: N/A	Item: N/A	NDE Request: 92-072
Data Sheet No.: 92-072-05			
Task Description: UT Thickness		Task No.: N/A	Date: 12/16/92
Comp./Dist.: Drywell Liner Bay 19	System: 187	Code/Spec: ASME Sect VIII	
Procedure/Rev.: 6100-QAP-7209.03 Rev 0		Drawing No./Rev.: 3E-187-23-004 Rev 0	
Test Surface: O.D.		Thickness: 1.15"	Material: C/S
Examiner	Sign:	Print: T. [illegible]	ID No: [redacted]	Level: II
Examiner	Sign: N/A	Print: N/A	ID No.: N/A	Level: N/A

Thermometer S/N 92-0[illegible] Part Temperature 65°F D-Meter S/N 92-0[illegible]

Cal. Blk. S/N N/A

Cal. Blk. Temp. 65 F

Cal. In: N/A AM 1:32 PM

Cal. Out: N/A AM 2:0[illegible] PM

Calibration Readings (Inches)

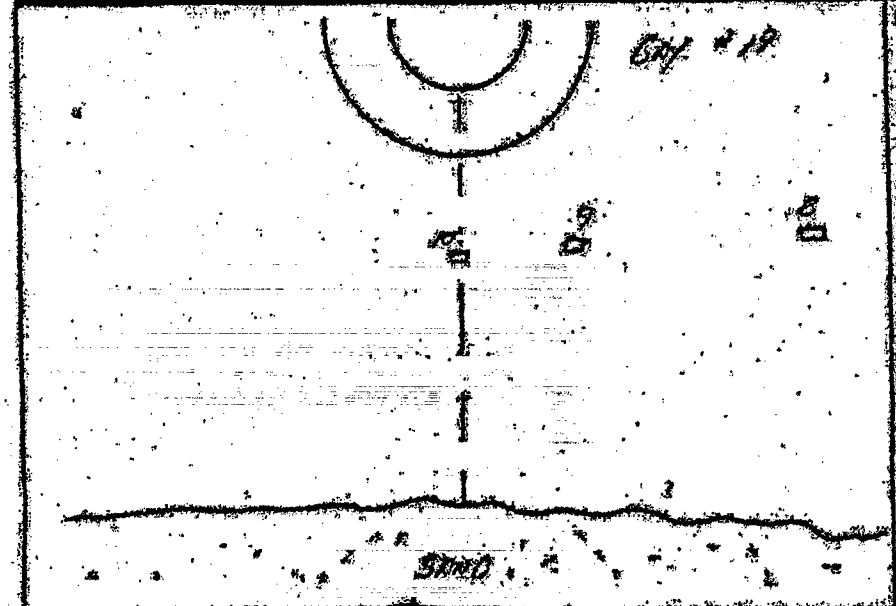
Cal. Blk.	.5"	.77"	1.0"	N/A		
D-Meter	.5"	.77"	1.0"			

Technique

☒ CRT ☒ D-Meter

Other: ______

Position #/Reading in Inches



Drawing

[illegible] [illegible]

8 Dn [illegible] Rt [illegible] 0.[illegible]

9 Dn [illegible] Rt [illegible] 0.[illegible]

10 Dn [illegible] Rt [illegible] 0.[illegible]

[illegible] after additional [illegible]

[illegible] [illegible] [illegible]

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

Ultrasonic Thickness Data Sheet

GPU Nuclear

☒ OC ☐ TMI-1 ☐ TMI-2	Class: N/A	Item: N/A	NDE Request: 92-072
Data Sheet No.: 92-022-07			
Task Description: UT THICKNESS		Task No.: N/A	Date: 12-11-92
Comp. Desc.: DRYWELL LINER BAY 17	System: 181	Code/Spec.: ASME SEC. VIII	
Procedure/Rev.: 6100-QAP 7209.07 REV 0	Drawing No./Rev.: GE 181-21-1104 REV 6		
Test Surface: O.D.	Thickness: 1 1/8"	Material: C/S	
Examiner Sign:	Print: Jonathan [illegible]	ID No.: [redacted]	Level: II
Examiner Sign:	Print: MARK F. BALNELL	ID No.:	Level: I

Thermometer S/N 81-053 Part Temperature 72°F D-Meter S/N 92-010

Cal. Blk. S/N 58 Cal. Ins. N/A AM 12:45 PM

Cal. Blk. Temp. 72° F Cal. Out N/A AM 1:55 PM

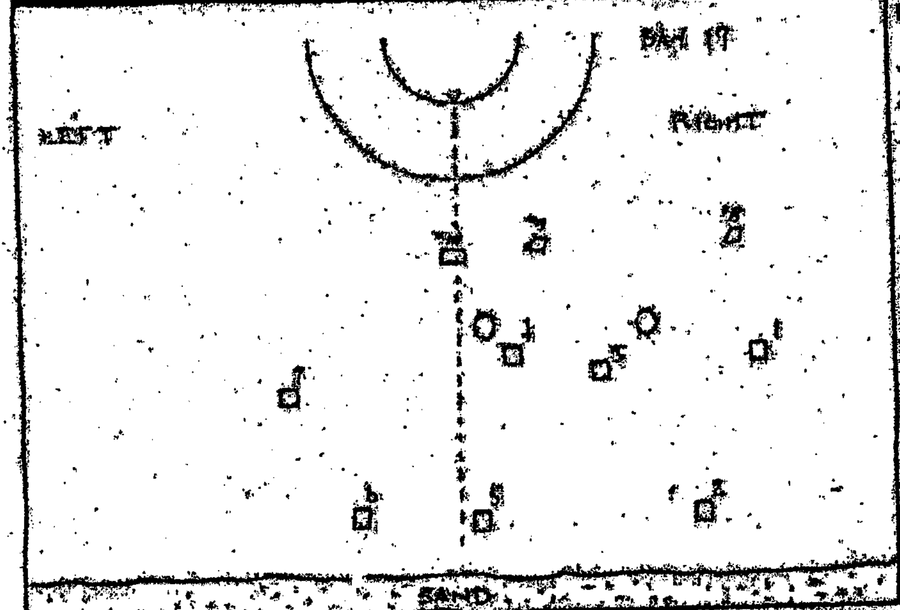
Calibration Readings (inches)

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

Technique: ☐ CRT ☒ D-Meter

Other: N/A

Position #/Reading In Inches



Drawing

AREA	POSITION	MEASUREMENT
1	D 74" R 70"	0.735"
2	D 57" R 66"	0.721"
3	D 65" R 47"	0.797"
4	D 44" R 41"	0.776"
5	D 77" R 8"	0.756"
6	D 85" L 6"	[illegible]
7	D 97" L 12"	0.905"
8	D 110" R 65"	[illegible]
9	D 9" R 17"	[illegible]
10	D 21"	[illegible]
Plug #1	D 41" R 6"	
Plug #2	D 21" R 55"	

Surface pitted would not allow accurate measurement

Reviewed by: Level: II Date: 12-11-92 Page 1 of 1

GPU Nuclear

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

GPU Nuclear

Calibration Sheet

Cal Sheet # 92-034

System: 187	Component: Drywell Shell	Procedure: 6100-QAP-7209.07	Rev: 0
Examiner: Signature:	Print: J. [illegible]	Initial: [illegible]	ID#: [redacted] Level: II
Examiner: Signature:	Print: Mark F. Bagnell	Initial: MFB	ID#: [redacted] Level: II

Instrument Settings:
ID#: [illegible]
Model/Manuf: [illegible]

Gain
Coarse: [illegible]
Fine: n/a
Uncal: n/a

Sweep Circuit
Coarse: 2.0 Cal. [illegible] (Range)
Fine: n/a
Delay: n/a
Screen Depth: 2" [illegible]

Operation
Frequency: 2.25 MHZ
Reject: ☐ Off ☐ On ____ %
Filter: ☐ Off ☐ On ____ %
Damping: ☐ Off ☐ On 200 %

Rep Rate: 1000 Hz

Cal Standard
ID#: 218
Size: n/a Sch: n/a
Thickness: [illegible]
S/S: CS
Temp: 65 °F

System Check
☐ Exit Point
☐ Angle 1-2
n/a

Date: 12-5-92

Search Unit
ID#: [illegible]
Type: [illegible]
Freq: 2.25 MHZ
Size: [illegible]
Angle: 0 Mode: Long

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

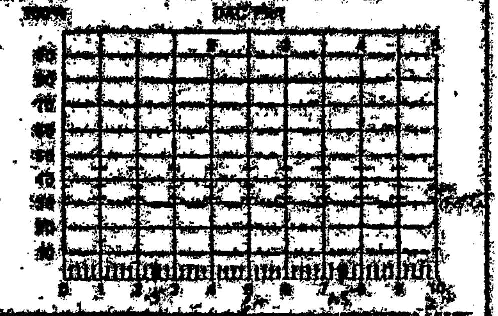
Time: 0910

Search Unit Cable
Type: [illegible] Length: 6 ft

Couplant
Make: Soundsafe Batch#: [illegible]

Thermometer
S/N: [illegible] Cal Due: [illegible]

Reflector	Amplitude % of FSH	Screen Reading in Inches
.5	80	.5
.75	80	.75
1.0	80	1.0
1.25	80	1.25
1.5	80	1.5



Time/Date	0936 12-5-92		1004 12-5-92		1056 12-5-92	
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5	80	.5	80	.5	80	.5
.75	80		80		80	
1.0	80		80		80	
1.25	80		80		80	
1.5	80	1.5	80	1.5	80	1.5
Initials						

Remarks:
* reflector adjusted to 80% FSH as required
** Digital calibration - independent of [illegible]

Components Examined:
Bay 13 → Bay 11

ANI Review:

Technical Review
Reviewed By: [illegible]
Level: III Date: 12-5-92

NDE Request#: 92-72

NDO LTM

GPU Nuclear

Calibration Sheet

Cal Sheet# [illegible]

System 187		Component Drywell Liner	Procedure [illegible]		Rev 0
Examiner:	Signature:	Print: [illegible]	Initial: [illegible]	ID# [redacted]	Level II
Examiner:	Signature: Mark [illegible]	Print: Mark E. Bazzell	Initial: [illegible]	ID# [redacted]	Level I

Instrument Settings
ID# [illegible]
Model/Manuf [illegible] Panametrics

Gain
Coarse N/A
Fine N/A
Uncal N/A

Sweep Circuit
Coarse N/A (Range)
Fine N/A
Delay N/A
Screen Depth N/A

Operation [✓ T&R] Normal
Frequency N/A MHZ
Reject: ☐Off ☐On N/A %
Filter: ☐Off ☐On N/A %
Damping: ☐Off ☐On N/A %

Rep Rate N/A

Cal Standard
ID# BC
Size [illegible] Ser. [illegible]
Thickness [illegible]
S/S [✓ CS]
Temp 72 °F

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

Date [illegible]

Search Unit
ID# [illegible]
Type [illegible]
Freq 5 MHZ
Size [illegible]
Angle 0 Mode [illegible]

Cal Direction
☐Axial ☐Both
☐Circ. ☐Normal

Time [illegible]

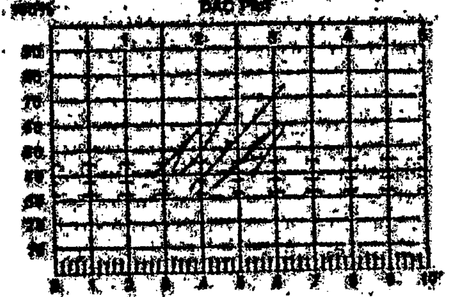
Search Unit Cable
Type [illegible] Length [illegible]

Couplant
Make [illegible] Batch# [illegible]

Thermometer
S/N [illegible] Cal Due [illegible]

Reflector	Amplitude % of FSH	Screen Reading in Inches
.5	N/A	N/A
.75	N/A	N/A
1.0	N/A	N/A

DAC Plot



Time/Date	[illegible]		[illegible]		[illegible]	
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5	N/A	.5	N/A	.5	N/A	.5
.75	N/A	.75	N/A	.75	N/A	.75
1.0	N/A	1.0	N/A	1.0	N/A	1.0
Initials	[illegible]		[illegible]		[illegible]	

Remarks:

Components Examined:
Bay 17-19

ANI Review

Technical Review
Reviewed By [illegible]
Level II Date 12-14-92

NDE Request# 92-072

N0027 (05/90)

[illegible] 1T00

GPU Nuclear

Calibration Sheet

Cal Sheet# [illegible]

System 187	Component Drywell Liner	Procedure 6000-QAP-7209.07		Rev 0
Examiner: Signature: [illegible]	Print: J. [illegible]	Initial: [illegible]	ID# [redacted]	Level II
Examiner: Signature: n/a	Print: n/a	Initial: n/a	ID# n/a	Level n/a

Instrument Settings
ID# 924-010
Model/Manuf DL-25 Panametrics

Gain
Coarse n/a
Fine n/a
Uncal n/a

Sweep Circuit
Coarse n/a (Range)
Fine n/a
Delay n/a
Screen Depth n/a

Operation (T&R) (Normal)
Frequency n/a MHZ
Reject ☐Off ☐On n/a %
Filter ☐Off ☐On n/a %
Damping ☐Off ☐On n/a %

Rep Rate n/a

Cal Standard
ID# 03
Size 4" Sch 80
Thickness .5-.75
S/S CS
Temp 68 °F

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

Search Unit
ID# [illegible]
Type [illegible]
Freq 5 MHZ
Size [illegible]
Angle 0 Mode [illegible]

Cal Direction
☐Axial ☐Both
☐Circ. ☑Normal

Date 12/10/92

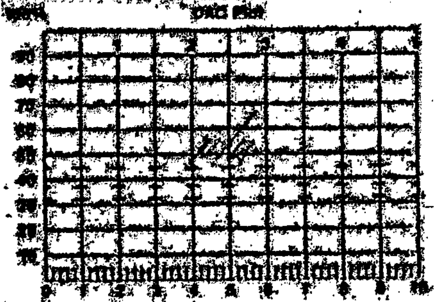
Time [illegible]

Reflector	Amplitude % of FSH	Screen Reading in Inches
.5	n/a	n/a
.75	n/a	n/a
1.0	n/a	n/a

Search Unit Cable
Type [illegible] Length 6'

Couplant
Make [illegible] Batch# [illegible]

Thermometer [illegible]
S/N [illegible] Cal Due [illegible]



Time/Date	[illegible]		[illegible]		[illegible]	
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5	n/a	.5	n/a	.5	n/a	.5
.75	n/a	.75	n/a	.75	n/a	.75
1.0	n/a	1.0	n/a	1.0	n/a	1.0
Initials	[illegible]		[illegible]		[illegible]	

Remarks:

ANI Review

Components Examined:
[illegible]

Technical Review
Reviewed By [illegible]
Level III Date 12-10-92

NDE Request#: 92-072

[illegible]

GPU Nuclear

NQC I (TSI)

Calibration Sheet

Cal Sheet# [illegible]

System 187	Component Drywell [illegible]	Procedure [illegible]		Rev. 0
Examiner: Signature: [illegible]	Print: [illegible]	Initial: [illegible]	ID# [redacted]	Level II
Examiner: Signature: NA	Print: NA	Initial: NA	ID# NA	Level NA

Instrument Settings
ID# [illegible]
Model/Manuf [illegible]

Gain
Coarse 80.2
Fine NA
Unical NA

Sweep Circuit
Coarse [illegible] (Range)
Fine NA
Delay 1.0
Screen Depth 2"

Operation
T&B Normal
Frequency: 2.25 MHZ
Reject: ☒Off ☐On %
Filters: ☐Off ☒On [illegible] %
Damping: ☐Off ☒On 200 %

Rep Rate 1000 Hz

Cal Standard
ID# 68
Size [illegible] Sch. [illegible]
Thickness [illegible]
E/S CS
Temp 68 °F

System Check
☐(Exit) Point
☐Angle +/- 2° NA

Date 12/14/92

Search Unit
ID# [illegible]
Type [illegible]
Freq. 5 MHZ
Size .5"
Angle 0 Meas Deg

Cal Direction
☐Axial ☐Both
☐Circ. ☐Normal

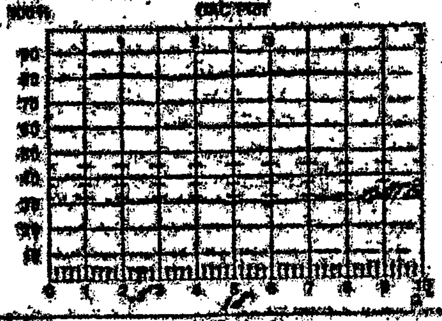
Time 1500

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

Search Unit Cable
Type [illegible] Length [illegible]

Couplant
Make [illegible] Batch [illegible]

Thermometer
S/N [illegible] Cal Due [illegible]



Time/Date	[illegible]		[illegible]		[illegible]	
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5	80	.5	80	.5	80	.5
.75	80	.75	80	.75	80	.75
1.0	80	1.0	80	1.0	80	1.0
Initials	[illegible]		[illegible]		[illegible]	

Remarks:
[illegible]
at 80% FSH

Components Examined:
[illegible]

ANI Review

Technical Review
Reviewed By [illegible]
Level III Date 12-16-92

NDE Request# 92-072

[illegible] (05-90)

GPU Nuclear

Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2	Class: N/A	Item: N/A	NDE Request: 92-072
Data Sheet No.: 92-072-C			
Task Description: DRY WALL LINER MOCK-UP		Task No.: N/A	Date: 12-16-92
Comp. Desc.: WELD OVERLAY TEST PLATE	System: 187		Code/Spec.: ASME SECT VIII
Procedure/Rev.: 6100-QAP-7209.07 / D		Drawing No./Rev.: -N/A-	
Test Surface: OD		Thickness: 3/4"	Material: C/S
Examiner Sign:	Print: J. Vanecke Lutz	ID No.: [redacted]	Level: II
Examiner Sign:	Print: JAMES PHILLIPPI	ID No.: [redacted]	Level: II

Thermometer S/N 92-023 Part Temperature 66° F D-Meter S/N 92-010

Cal. Blk. S/N 214

Cal. Blk. Temp. 66° F

Cal. In: N/A AM 1420 PM

Cal. Out: N/A AM 1440 PM

Calibration Readings (Inches)

Cal. Blk.	.502	.751	1.001	1.251		
D-Meter	.502	.751	1.000	1.250		

Technique

☐ CRT ☒ D-Meter

Other -N/A-

Position #/Reading In Inches

Drawing

	A-SCAN	2C DL
BASE METAL	.73	.728
1 PASS	.94	.927
2 PASS	1.12	1.119

Reviewed by: | Level: II | Date: 1-27-92 | Page 1 of 1

10431 (03-92)

GPU Nuclear

Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2

Class: n/a

Item: n/a

NDE Request: 92-072

Data Sheet No.: 92-072-9

Task Description: DRY WALL LINER MOCK-UP

Task No.: n/a

Date: 12-16-92

Comp. Desc.: WELD OVERLAY TEST PLATE

System: 187

Code/Spec: ASME SECT VIII

Procedure/Rev.: 6100-QAP-7209.07 / D

Drawing No/Rev.: -N/A-

Test Surface: OD

Thickness: 3/4"

Material: C/S

Examiner Sign: Print: J. [illegible] ID No.: [redacted] Level: II

Examiner Sign: Print: JAMES PHILLIPPI ID No.: [redacted] Level: I

Thermometer S/N 92-013 Part Temperature 68° F D-Meter S/N 92-010

Cal. Blk. S/N 217 Cal. In N/A AM 14:20 PM

Cal. Blk. Temp. 68° F Cal. Out N/A AM 14:40 PM

Calibration Readings (inches)

Cal. Blk.	.502	.752	1.001	1.251		
D-Meter	.502	.751	1.000	1.250		

Technique: ☐ CRT ☒ D-Meter

Other -BA-

Position #: Reading In Inches

Drawing

	A SCAN	28 DL
BASE METAL	.73	.727
1 PASS	.94	.927
2 PASS	1.12	1.112

Reviewed by: Level: II Date: 11-27-92 Page 1 of 1

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	Calc No. C-1302-187-5320-024	Rev. No. 1	Sheet No. 167 of 183
Originator Pete Tamburro	Date 3/21/07	Reviewed by	Date

GPU Nuclear

Calibration Sheet

Cal Sheet# 92-272

System 187	Component DRYWELL LINER	Procedure 6100-QAP-7209.07			Rev. 0
Examiner	Signature:	Print: J. Vanderlaan	Initial: JV	ID# [redacted]	Level: II
Examiner	Signature: James Phil	Print: JAMES PHILIPPI	Initial: JP	ID# [redacted]	Level: II

Instrument Settings
ID# 137-113
Model/Manuf SONIC 137 / STAVELEY

Gain:
Coarse 60.2 dB
Fine N/A
Uncal N/A

Sweep Circuit
Coarse 2.0" (VEL = .231 "/µs) (Range)
Fine N/A
Delay 1.0
Screen Depth 2"

Operation
T&R Normal
Frequency: 2.25 MHz
Reject: ☒Off ☐On N/A %
Filter: ☐Off ☒On FLT 1 %
Damping: ☐Off ☒On 200 Ω %

Rep Rate:

Cal Standard
ID# 2-11
Size N/A Sch. N/A
Thickness .5-1.25
S/S (CS) N/A
Temp 65 °F

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

Search Unit
ID# A09524
Type ALPHA
Freq 2.0 MHz
Size .5"
Angle 0° Mode Long

Cal Direction
☐Axial ☐Both
☐Circ. ☒Normal

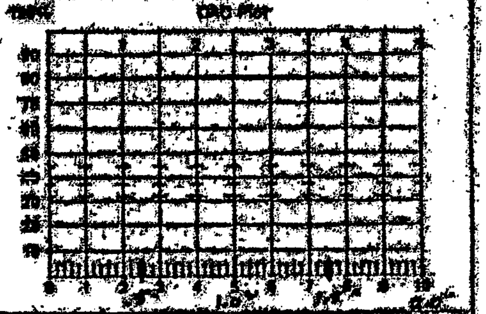
Date 12-18-92 Time 1410

Search Unit Cable
Type Dual Lemo Length 6'

Couplant
Name Soundsafe Batch# SSP-89-1-02

Thermometer
S/N 92-083 Cal Due 4-24-93

Reflector	Amplitude % of FSH	Screen Reading in Inches
.5	80	.5
.75	80	.75
1.0	80	1.0
1.25	80	1.25



Time/Date	1415 / 12-18-92		1425 / 12-18-92			
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5	80	.5	80	.5		
.75	80	.75	80	.75		
1.0	80	1.0	80	1.0		
1.25	80	1.25	80	1.25		
Initials	JV		JV			

Remarks:

Components Examined:
Drywell Liner wall verify
T.S. with

ANI Review

Technical Review
Reviewed By:
Level: Date 12-22-92

NDE Request# 92-272

00027 (05-90)

GPU Nuclear

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

Examiner	Signature:	Print: JAMES PHILLIPPI	Initial: JP	ID: [redacted] Level: II

Instrument Settings
ID#: 92-010
Model/Manuf: DL-26 PARAMETRICS
Gain
Coarse: N/A
Fine: N/A
Uncal: N/A
Sweep Circuit
Coarse: N/A (Range)
Fine: N/A
Delay: N/A
Screen Depth: N/A
Operation
T&R Normal
Frequency: N/A MHz
Reject: ☐Off ☐On N/A %
Filter: ☐Off ☐On N/A %
Damping: ☐Off ☐On N/A %
Rep Rate: N/A

Cal Standard
ID#: 214
Size: N/A Sch. N/A
Thickness: .5–1.25
SS [✓ CS] N/A
Temp: 72 °F

Search Unit
ID#: 92-038
Type: D790 SM
Freq: 5 MHz
Size: .312
Angle: 0 Mode Long

Search Unit Cable
Type: 5 ft Coaxial Length: 2×6'

Couplant
Make: SONOTRACE Batch#: 85D-21-1-93

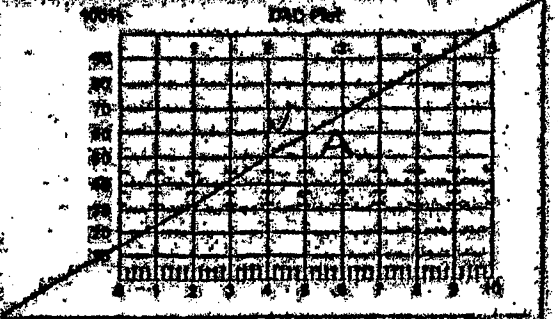
Thermometer
S/N: 92-063 Cal Due: 4-29-93

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

Cal Direction
☐Axial ☐Both
☐Circ. ☒Normal

Date: 12-16-92 Time: 1412

Reflector	Amplitude % of FSH	Screen Reading in Inches
.5	N/A	N/A
.75	N/A	N/A
1.0	N/A	N/A
1.25	N/A	N/A



Time/Date	1420 12-16-92		1440 12-16-92			
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5	N/A	.5	N/A	.5		
.75	N/A	.75	N/A	.75		
1.0	N/A	1.0	N/A	1.0		
1.25	N/A	1.25	N/A	1.25		
Initials	JP		JP			

Remarks:

Components Examined:
Drywell Liner weld overlay
Test plate

ANI Review

Technical Review
Reviewed By:
Level: II Date: 12-22-92

NDE Request#: 92-072

ND027 (03/92)

IR21CR-032
Pg 2 of 2
[illegible] 10-22-06

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	D48	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	0.899	
	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 92-072-19 page 1 of 1
All horizonal measurements taken 13" to the right of the centerline of the reinforcement ring (Boss).
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 6, based on surface curvature.

10-22-06

IR21CR-0012 Pg 2 of 2

CIII 10-26-06

BAY 3

	Point	Vertical	Horizontal	1992 value	2006 Value	Comments
	1	D16	R63	0.795	0.795	N/A
	2	D18	R48	1	0.999	
	3	D17	R33	0.857	0.850	
	4	D13	L5	0.898	0.903	
	5	D25	L6	0.823	0.819	
	6	D15	L56	0.968	0.972	
	7	D28	R4	0.826	0.818	
	8	D34	L4	0.78	0.784	

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 6, based on surface curvature.

Appendix E
Bay 3 2006 UT data

1R21CR-019 pg 2 of 2
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	0.965	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

R2112-005 Pg 2 of 2
[illegible]
[illegible]

Appendix E
Bay 7 2006 UT data

BAY 7

	Point	Vertical	Horizontal	1992 value	2006 Value	Comments
	1	D21	R39	0.92	N/A	Could not locate area
	2	D21	R32	1.018	N/A	Could not locate area
	3	D10	R20	0.984	0.984	up/dn ranged from 0.956 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.

Appendix E
Bay 9 2006 UT data

1R21CR-006 Pg 2 of 2

[illegible]
10-22-06

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	0.994	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.

1R21LR-008 Pg 2 of 2

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 6, based on surface curvature.

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GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 3	**Sheet No.** 175 of 183
Originator Pete Tamburro **Date** 3/21/07	**Reviewed by**		**Date**

Appendix E
Bay 13 2006 UT data

BAY 13

	Point	Vertical	Horizontal	1992 value	2006 Value	Comments
	1	U1	R45	0.872	N/A	Could not locate area
	2	U1	R38	0.729	N/A	Could not locate area
	3	D21	R48	0.941	0.923	
	4	D12	R38	0.915	0.873	
	5	D21	R6	0.718	0.708	
	6	D24	L6	0.855	0.858	
	7	D17	L23	0.818	0.802	
	8	D24	L20	0.718	0.704	
	9	D28	R41	0.924	0.915	
	10	D28	R12	0.728	0.741	
	11	D28	L15	0.865	0.869	
	12	D28	L23	0.885	0.886	
	13	D18	D40	0.932	0.814	
	14	D18	R8	0.868	0.870	
	15	D20	L9	0.683	0.666	
	16	D20	L28	0.829	0.814	
	17	D9	R38	0.807	N/A	Could not locate area
	18	D22	R38	0.825	N/A	Could not locate area
	19	D37	R38	0.812	0.916	

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 curvature.

IR21LG-015 & 2006

Appendix E
Bay 15 2006 UT data

BAY 15

	Point	Vertical	Horizontal	1992 value	2006 Value	Comments
	1	D12	R26	0.788	0.779	0.711 to 0.779
	2	D22	R21	0.829	0.798	0.777 to 0.798
	3	D33	R17	0.932	0.835	
	4	D30	R7	0.795	0.791	
	5	D28	L3	0.85	0.855	0.817 to 0.855
	6	D6	L8	0.794	0.787	0.715 to 0.787
	7	D28	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	L55	0.825	0.843	0.798 to 0.843

Data obtained from
NDE Data Sheets 02-072-21 page 1 of 1
Note: scanned 0.25" area around recorded 2006 value number - see comments for ranges.

Report# 1E2112-031 -0140
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11-12-06

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 .663
	3	D16	R26	0.898	0.894	
	4	D34	R24	0.961	0.963	
	5	D8	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

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BAY 19

Point	Vertical	Horizontal	1992 value	2006 Value	Comments
1	D30	R60	0.932	0.904	up .897 dn .867
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.

10/22/06

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: Morris 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 11, 15 and 13. 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. <u>Drywell Shell</u>
   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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Appendix F

J. C. Flynn - Manager, Special Projects, Engineering Projects
January 28, 1993
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Page 2

(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 about 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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J. C. Flynn - Manager, Special Projects, Engineering Projects
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Appendix F

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. C. Whitmore
Extension 7546

/rw

cc: A. R. Baig - Engineer, Engineering Projects
J. J. Colitz - Director, Engineering Projects
J. H. Horton - Mechanical Analysis Manager
S. K. Saha - Engineer, Engineering & Design
D. G. Slear - Director, Engineering & Design
S. C. Tumminelli - Manager, Engineering Mechanics
M. Yekta - Engineer, Engineering & Design

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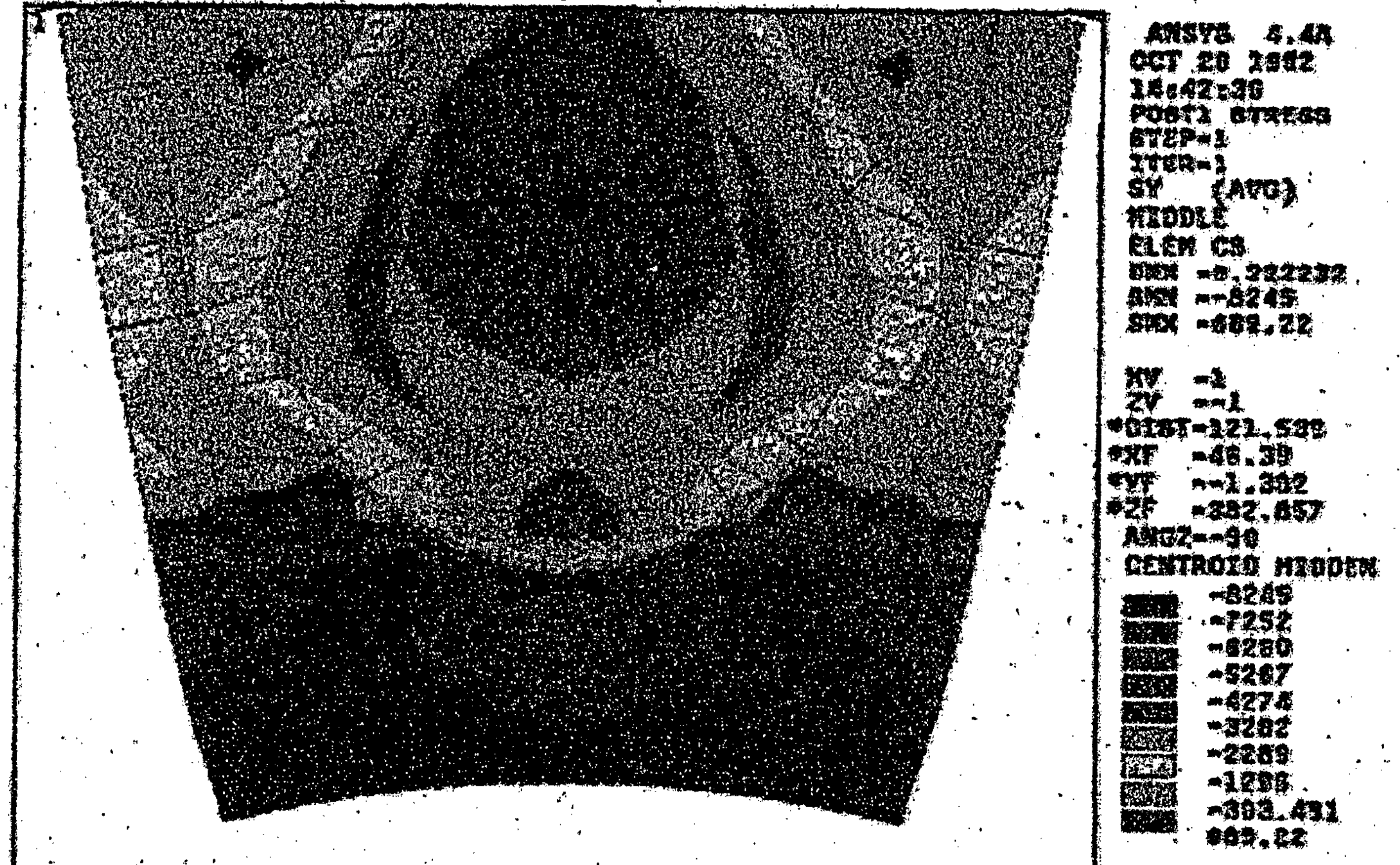
Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	3	182 of 183
Originator Pete Tamburro	Date 3/21/07	Reviewed by		Date



Appendix G
Figure 3-11 from reference 3.4

Figure 3-11 Lower Drywell Meridional Stresses - Refueling Case

OYSTER CREEK DRYWELL ANALYSIS - SYM-SYM, MOBRED, REFUELING

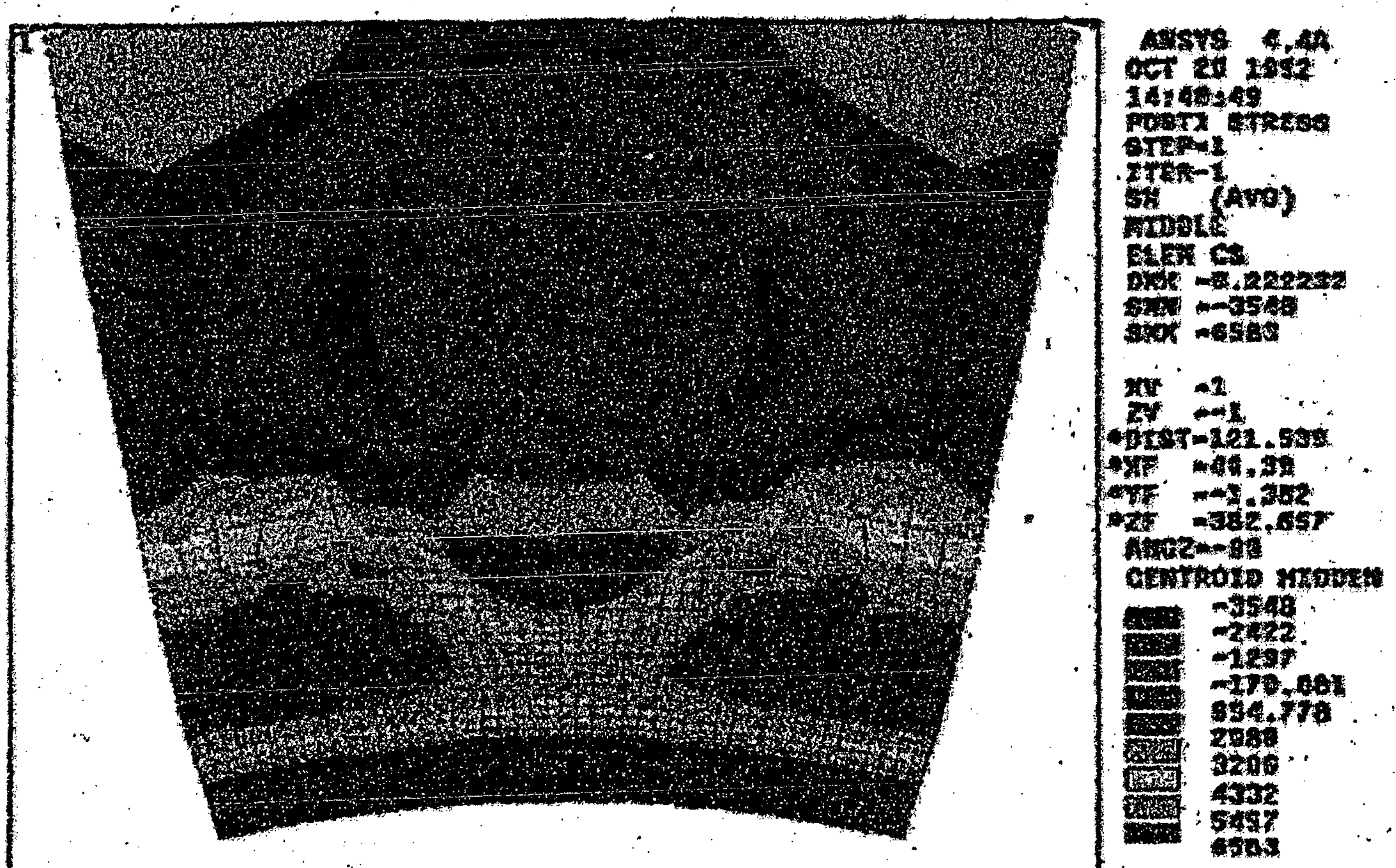


Figure 3-33 . Lower Drywell Circumferential Stresses - Refueling Case

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

APPLICANT'S EXH. 17

DAF 143071

GPU Nuclear

Calculation Sheet

Subject	Calc No.	Rev. No.	Sheet No.
O.C Drywell Ext. Ut Evaluation in Sandbed	C-1302-187-5320-024	0	1 of 54

Originator	Date	Reviewed by	Date
MARK YEKTA	01/12/93	S. C. Tumminelli	04/16/93

1.0 PROBLEM STATEMENT:

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

2.0 SUMMARY OF RESULTS:

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

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

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

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

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

GPU Nuclear Calculation Sheet

Subject O.C Drywell Ext. Ut Evaluation in Sandbed		Calc No. C-1302-187-5320-024	Rev. No. 0	Sheet No. 2 of 54
Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli		Date 04/16/93

2.0 SUMMARY OF RESULTS (Continued):

Summary of UT Evaluations

Table (1)

BAY/UT Location	UT Measurement (1)	AVG Micrometer (2)	Mean Depth/Valley (3)	T (Evaluation) (4)=(1)+(2)-(3)	Remarks
Bay 11/ Loc. 1	0.705"	0.246"	0.200"	0.751"	Acceptable
Bay 15/ Loc. 9	0.722"	0.337"	0.200"	0.859"	Acceptable
Bay 17/ Loc. 9	0.720"	0.351"	0.200"	0.871"	Acceptable
Bay 1/ Loc. 1	0.720"	0.218"	0.200"	0.738"	Acceptable
Bay 1/ Loc. 2	0.716"	0.143"	0.200"	0.659"	Acceptable
Bay 1/ Loc. 3	0.705"	0.347"	0.200"	0.852"	Acceptable
Bay 1/ Loc. 5	0.710"	0.313"	0.200"	0.823"	Acceptable
Bay 1/ Loc. 7	0.700"	0.266"	0.200"	0.766"	Acceptable
Bay 1/ Loc. 11	0.714"	0.212"	0.200"	0.726"	Acceptable
Bay 1/ Loc. 12	0.724"	0.301"	0.200"	0.825"	Acceptable
Bay 1/ Loc. 21	0.726"	0.211"	0.200"	0.737"	Acceptable
Bay 13/ Loc. 1	0.672"	0.351"	0.200"	0.823"	Acceptable
Bay 13/ Loc. 2	0.729"	0.360"	0.200"	0.882"	Acceptable
Bay 13/ Loc. 5	0.718"	0.217"	0.200"	0.735"	Acceptable
Bay 13/ Loc. 6	0.655"	0.301"	0.200"	0.756"	Acceptable
Bay 13/ Loc. 7	0.618"	0.257"	0.200"	0.675"	Acceptable
Bay 13/ Loc. 8	0.718"	0.278"	0.200"	0.796"	Acceptable
Bay 13/ Loc. 10	0.728"	0.211"	0.200"	0.739"	Acceptable
Bay 13/ Loc. 11	0.685"	0.256"	0.200"	0.741"	Acceptable
Bay 13/ Loc. 15	0.683"	0.273"	0.200"	0.756"	Acceptable

3.0 REFERENCES:

3.1 Drywell sandbed region pictures (see 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.

4.0 ASSUMPTIONS AND BASIC DATA:

4.1 Raw UT measurements are summarized for each bay in the body of calculation.

4.2 Observations of the outside surface of the drywell shell indicate a rough surface with varying peaks and valleys. In order to characterize an average roughness representing the depth difference of peaks and valleys, two impressions were made at the two lowest UT measurements for bay 13 using Epoxy putty .
Appendix A presents the calculation of the depth of surface roughness using the drywell shell impressions taken in the roughest bay. Two locations in bay 13 were selected since it is the roughest bay. Approximately 40 locations within the two impressions were measured for depth and the average plus one standard deviation was calculated. A value of 0.200 inch was used in this calculation as a conservative depth of uniform dimples for the entire outside surface of the drywell in the sandbed region .

Subject O.C Drywell Ext. Ut Evaluation in Sandbed		Calc No. C-1302-187-5320-024	Rev. No. 0	Sheet No. 4 of 54
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5.0 CALCULATION:

ACCEPTANCE CRITERIA - GENERAL WALL:

The acceptance criteria used to evaluate the measured drywell thickness is based upon GE reports 9-3 and 9-4 (Ref. 3.2 & 3.3) as well as other GE studies (Ref. 3.5) plus visual observations of the drywell surface (Ref. 3.6 and Appendix C). The GE reports used an assumed 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. Therefore, if all the UT measurements for thickness in one bay are greater than 0.736 inches the bay is evaluated to be acceptable. In bays where measurements are below 0.736 inches, more detailed evaluation is performed.

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

5.0 CALCULATION:

ACCEPTANCE CRITERIA - GENERAL WALL: (Continued)

The inspection focused on the thinnest portion of the drywell, even if it was very local, i.e., the inspection did not attempt to define a shell thickness suitable for structural evaluation. Observations indicate that some inspected spots are very deep. They are much deeper than the normal dimples found, and very local, not more than 1 to 2 inches in diameter. (Typically these observations were made after the spot was surface prepped for UT measurement. This results in a wide dimple to accommodate the meter and slightly deeper than originally found by 0.030 to 0.100 inches). The depth of these areas was measured and averaged with respect to the top of local areas as shown in Appendix A. These depths are referred to herein as the AVG micrometer measurements. The thickness for evaluation is then computed from the above information as:

T (evaluation) = UT (measurement) + AVG (micrometer) - 0.200 inches

where:

T (evaluation) = thickness for evaluation

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

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

0.200 inch = a conservative value of depth of typical dimple on the shell surface.

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

5.0 CALCULATION:

ACCEPTANCE CRITERIA - LOCAL WALL:

If the thickness for evaluation is less than 0.736 inches, then the use of specific GE studies is employed (Ref. 3.5). These studies contain analyses of the drywell using the pie slice finite element model, reducing the thickness by 0.200 inches in an area 12 x 12 inches in the sandbed region, tapering to original thickness over an additional 12 inches, located to result in the largest reduction possible. This location is selected at the point of maximum deflection of the eigenvector shape associated with the lowest buckling load. The theoretical buckling load was reduced by 9.5% from 6.41 to 5.56. Also, the surrounding areas of thickness greater than 0.736 inches is also used to adjust the actual buckling values appropriately. Details are provided in the body of the calculation.

ACCEPTANCE CRITERIA - VERY LOCAL WALL (2½ Inches In DIAMETER):

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

The acceptance criteria for these measurements confined to an area less than 2½ inches in diameter is based on the ASME Section III Subsection NE Class MC Components paragraph NE 3332.1 and NE 3335.1 titled "OPENING NOT REQUIRING REINFORCEMENT AND REINFORCEMENT OF MULTIPLE OPENINGS".

These Code provisions allow holes up to 2½ inches in diameter in Class MC vessels without requiring reinforcement. Therefore, thinned areas less than 2½ inches in diameter need not be provided with reinforcement and are considered local. Per NE 3213.10 the stresses in these regions are classified as local primary membrane stresses which are limited to an allowable value of 1.5 Sm. Local areas not exceeding 2½ inches in diameter have no impact on the buckling margins. Using the 1.5 Sm criteria given above, the required minimum thickness in these areas is:

$$T\ (\text{ required }) = (2/3) * (0.736) = 0.490 \text{ inches}$$

Where 2/3 is Sm/1.5Sm and is the ratio of the allowable stresses.

UT thickness measurements for all ten bays are above 0.490 inches.

5.0 CALCULATION:

UT EVALUATION:

BAY # 1:

The outside surface of this bay is rough and full of dimples similar to the outside surface of golf ball. This observation is made by the inspector who located the thinnest areas for the UT examination. This inspection focused on the thinnest areas of the drywell, even if it was very local, i.e., the inspection did not attempt to define a shell thickness suitable for structural evaluation. The shell appears to be relatively uniform in thickness except for a band of corrosion which looks like a "bathtub" ring, located 15 to 20 inches below the vent pipe reinforcement plate, i.e, weld line as shown in Figure 1. (Figure 1 and others like figures presented in this calculation are NOT TO SCALE). The bathtub ring is 12 to 18 inches wide and about 30 inches long located in the center of the bay. Beyond the bathtub ring on both sides, the shell appears to be uniform in thickness at a conservative value of 0.800 inches. Above the bathtub ring the shell exhibits no corrosion since the original lead primer on the vent pipe/reinforcement plate is intact. Measurements 14 and 15 confirm that the thickness above the bathtub ring is at 1.154 inches starting at elevation 11'-00". Below the bathtub ring the shell is uniform in thickness where no abrupt changes in thicknesses are present. Thickness measurements below the bathtub ring are all above 0.800 inches except location 7 which is very local area.

Therefore, a conservative mean thickness of 0.800 inches is estimated to represent the evaluation thickness for this bay. Given a uniform thickness of 0.800 inches, the buckling margin for the refueling load condition can be recalculated based on the GE report 9-4 (Ref. 3.3). The theoretical buckling strength from report 9-4 (ANSYS Load Factor) is a square function of plate thicknesses. Therefore, a new buckling capacity for the controlling refueling load combination is calculated to be at 13% above the ASME factor of safety of 2 as shown in Appendix B.

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Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli		Date 04/16/93

5.0 CALCULATION:

UT EVALUATION:

BAY # 1 (Continued):

Locations 1, 2, 3, 4, 5, 10, 11, 12, 13, 20, and 21 are confined to the bathtub ring as shown in Figure 1. An average value of these measurements is an evaluation thickness for this band as follows;

Location	Evaluation Thickness
1	0.738"
2	0.659"
3	0.852"
4	0.760"
5	0.823"
10	0.839"
11	0.726"
12	0.825"
13	0.792"
20	0.965"
21	0.737"

Average = 0.792"

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

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

5.0 CALCULATION:

UT EVALUATION:

BAY # 1 (Continued):

Eight locations shown in Table 1-a (1, 2, 3, 5, 7, 11, 12, and 21) have measurements below 0.736 inches. Observations indicate that these locations were very deep and not more than 1 to 2 inches in diameter. The depth of each of these areas relative to its immediate surroundings was measured at 8 locations around the spot and the average is shown in Table 1-a. Using the general wall thickness acceptance criteria described earlier, the evaluation thickness for all measurements below 0.736 inches were found to be above 0.736 inches except for two locations, 2 and 11, as shown in Table 1-b. Locations 2 and 11 are in the bathtub ring and are about 4 inches apart. This area is characterized as a local area 4 x 4 inches located at about 15 to 20 inches below the vent pipe reinforcement plate with an average thickness of 0.692 inches. This thickness of 0.692 inches is 0.108 inches reduction from the conservative estimate of 0.800 inches evaluation thickness for the entire bay. In order to quantify the effect of this local region and to address structural compliance, the GE study on local effects is used (Ref. 3.5).

This study contains an analysis of the drywell shell using the pie slice finite element model, reducing the thickness by 0.200 inches (from 0.736 to 0.536 inches) in an area 12 x 12 inches in the sandbed region located to result in the largest reduction possible. This location is selected at the point of maximum deflection of the eigenvector shape associated with the lowest buckling load. The theoretical buckling load was reduced by 9.5%. The 4 x 4 inches local region is not at the point of maximum deflection. The area of 4 x 4 inches is only 11% of the 12 x 12 inches area used in the analysis. Therefore, this small 4 x 4 inches area has a negligible effect on the buckling capacity of the structure.

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

GPU Nuclear **Calculation Sheet**

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5.0 CALCULATION:

UT EVALUATION:

BAY # 1 (Continued):

Bay # 1 UT Data

Table 1-a

Location	UT Measurement (inches)	Average Micrometer (inches)
1	0.720	0.218
2	0.716	0.143
3	0.705	0.347
4	0.760	---
5	0.710	0.313
6	0.760	---
7	0.700	0.266
8	0.805	---
9	0.805	---
10	0.839	---
11	0.714	0.212
12	0.724	0.301
13	0.792	---
14	1.147	---
15	1.156	---
16	0.796	---
17	0.860	---
18	0.917	---
19	0.890	---
20	0.965	---
21	0.726	0.211
22	0.852	---
23	0.850	---

GPU Nuclear Calculation Sheet

Subject	Calc No.	Rev. No.	Sheet No.
O.C Drywell Ext. Ut Evaluation in Sandbed	C-1302-187-5320-024	0	11 of 54

Originator	Date	Reviewed by	Date
MARK YEKTA	01/12/93	S. C. Tumminelli	04/16/93

5.0 CALCULATION:

UT EVALUATION:

BAY # 1:(Continued)

SUMMARY OF Measurements BELOW 0.7

Table 1-b

Location	UT Measurement (1)	AVG Micrometer (2)	Mean Depth/Valley (3)	T (Evaluation) (4)=(1)+(2)-(3)	Remarks
1	0.720"	0.218"	0.200"	0.738"	Acceptable
2	0.716"	0.143"	0.200"	0.659"	Acceptable
3	0.705"	0.347"	0.200"	0.852"	Acceptable
5	0.710"	0.313"	0.200"	0.823"	Acceptable
7	0.700"	0.266"	0.200"	0.766"	Acceptable
11	0.714"	0.212"	0.200"	0.726"	Acceptable
12	0.724"	0.301"	0.200"	0.825"	Acceptable
21	0.726"	0.211"	0.200"	0.737"	Acceptable

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".

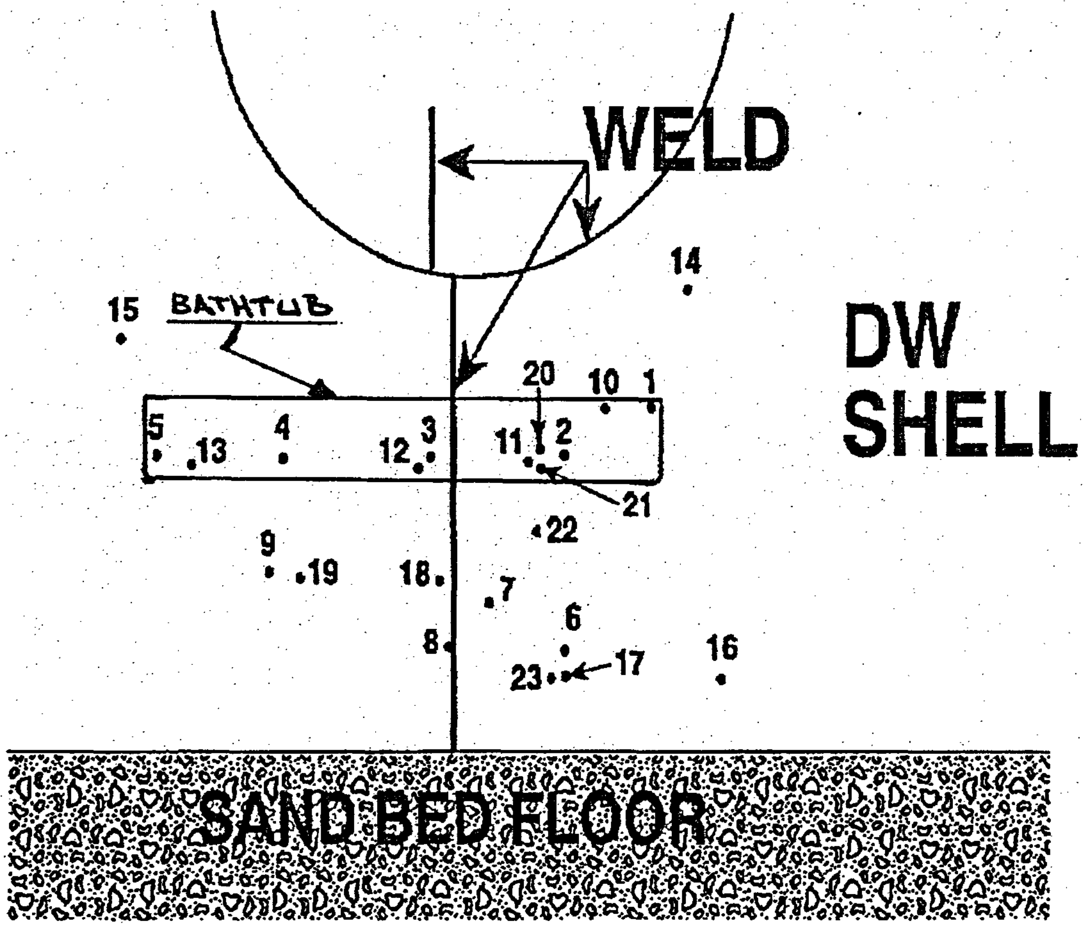

FIGURE (1)

5.0 CALCULATION:

UT EVALUATION:

BAY # 3:

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

Given the UT measurements, a conservative mean evaluation thickness of 0.850 inches is estimated for this bay and therefore, it is concluded that the bay is acceptable.

Bay # 3 UT Data

Table 3

Location	UT Measurement (inches)	Average Micrometer (inches)
1	0.795	---
2	1.000	---
3	0.857	---
4	0.898	---
5	0.823	---
6	0.968	---
7	0.826	---
8	0.780	---

GPU Nuclear **Calculation Sheet**

Subject O.C Drywell Ext. Ut Evaluation in Sandbed	Calc No. C-1302-187-5320-024	Rev. No. 0	Sheet No. 14 of 54
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BAY #3 DATA

NOTES:

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

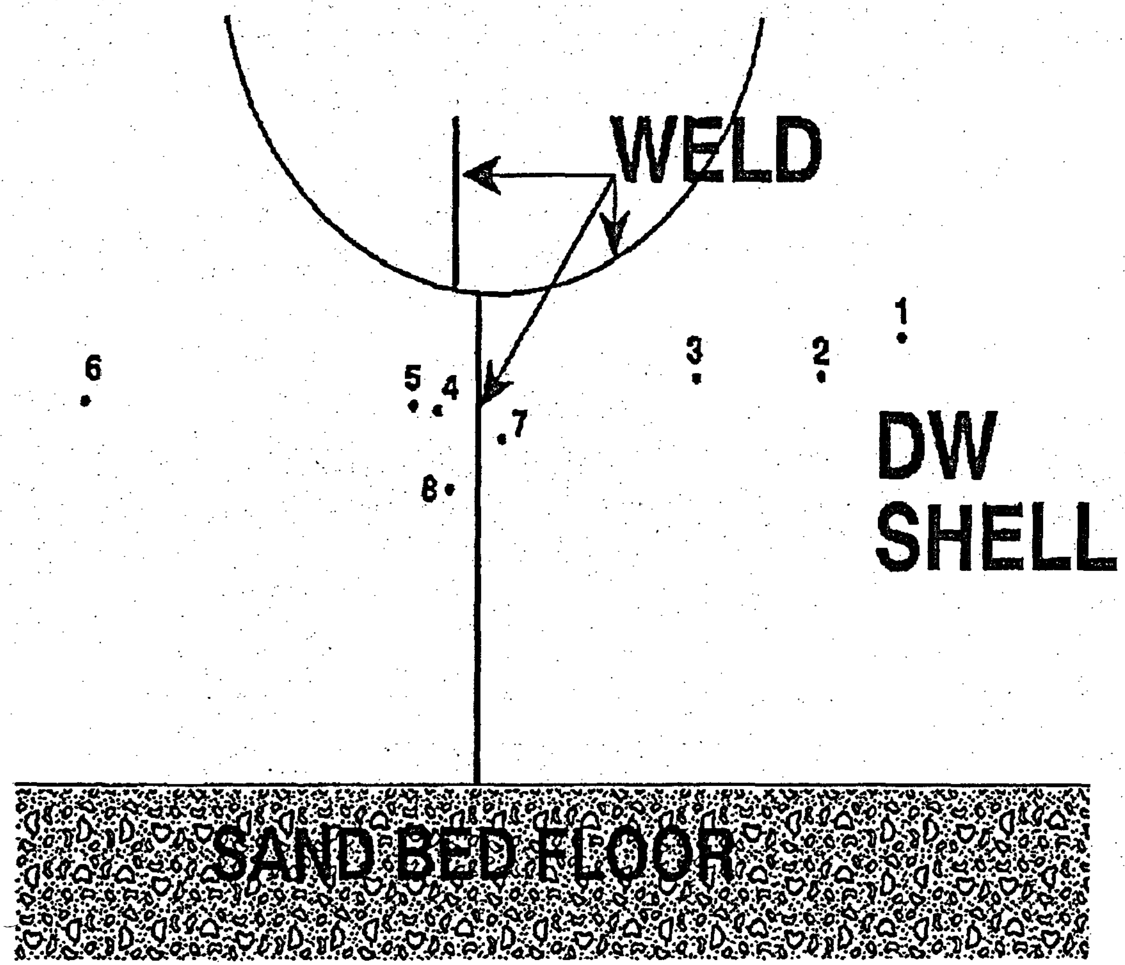

FIGURE (3)

5.0 CALCULATION:

UT EVALUATION:

BAY # 5:

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

Given the UT measurements, a conservative mean evaluation thickness of 0.950 inches is estimated for this bay and therefore, it is concluded that the bay is acceptable.

Bay # 5 UT Data

Table 5

Location	UT Measurement (inches)	Average Micrometer (inches)
1	0.970	---
2	1.040	---
3	1.020	---
4	0.910	---
5	0.890	---
6	1.060	---
7	0.990	---
8	1.010	---

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BAY #5 DATA

NOTES:

1. In this bay DW shell (butt) weld is about 8" to the right of C/L of vent tube. Therefore - all measurements were taken from a line drawn on shell which approx. coincide with vent tube C/L.

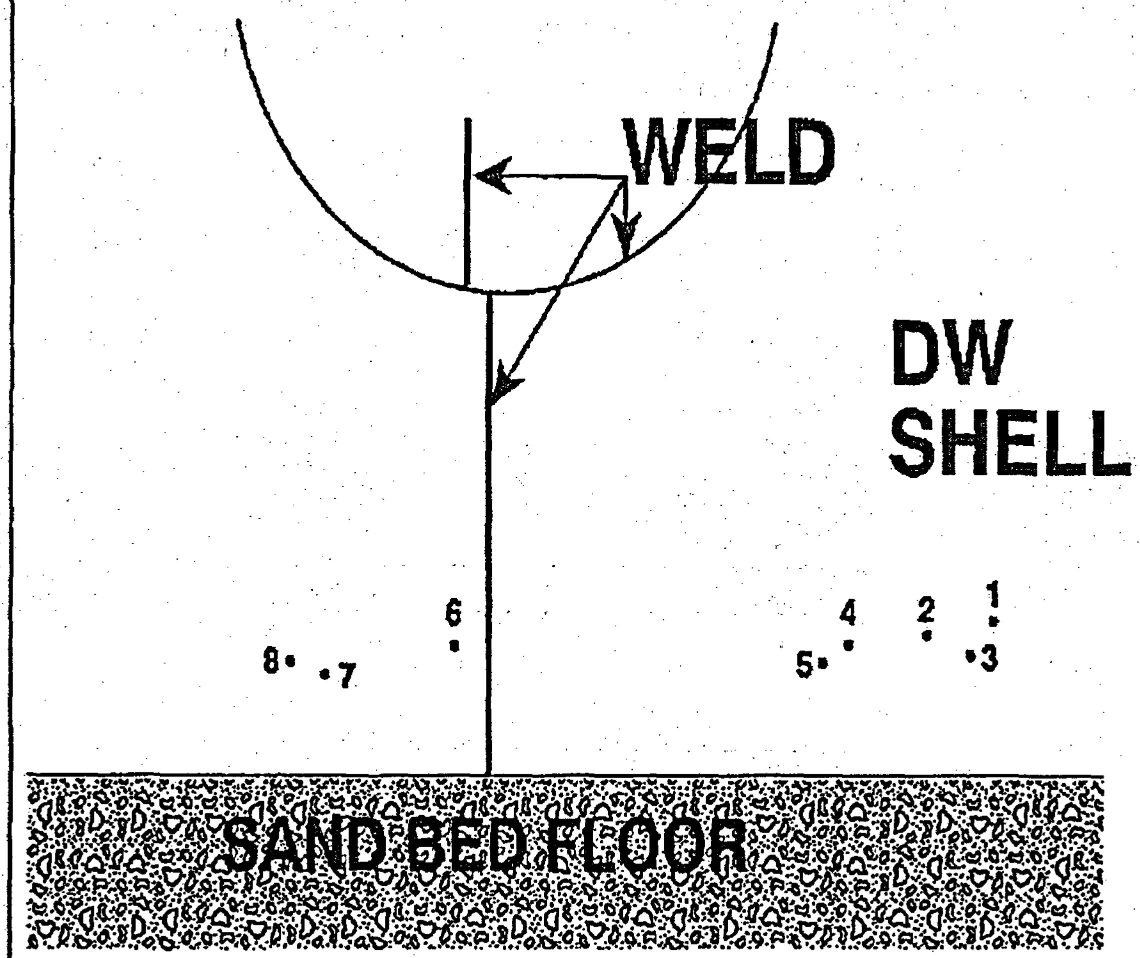

FIGURE (5)

5.0 CALCULATION:

UT EVALUATION:

BAY # 7:

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

Given the UT measurements, a conservative mean evaluation thickness of 1.00 inches is estimated for this bay and therefore, it is concluded that the bay is acceptable.

Bay # 7 UT Data

Table 7

Location	UT Measurement (inches)	Average Micrometer (inches)
1	0.920	---
2	1.016	---
3	0.954	---
4	1.040	---
5	1.030	---
6	1.045	---
7	1.000	---

BAY #7 DATA

NOTES:

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

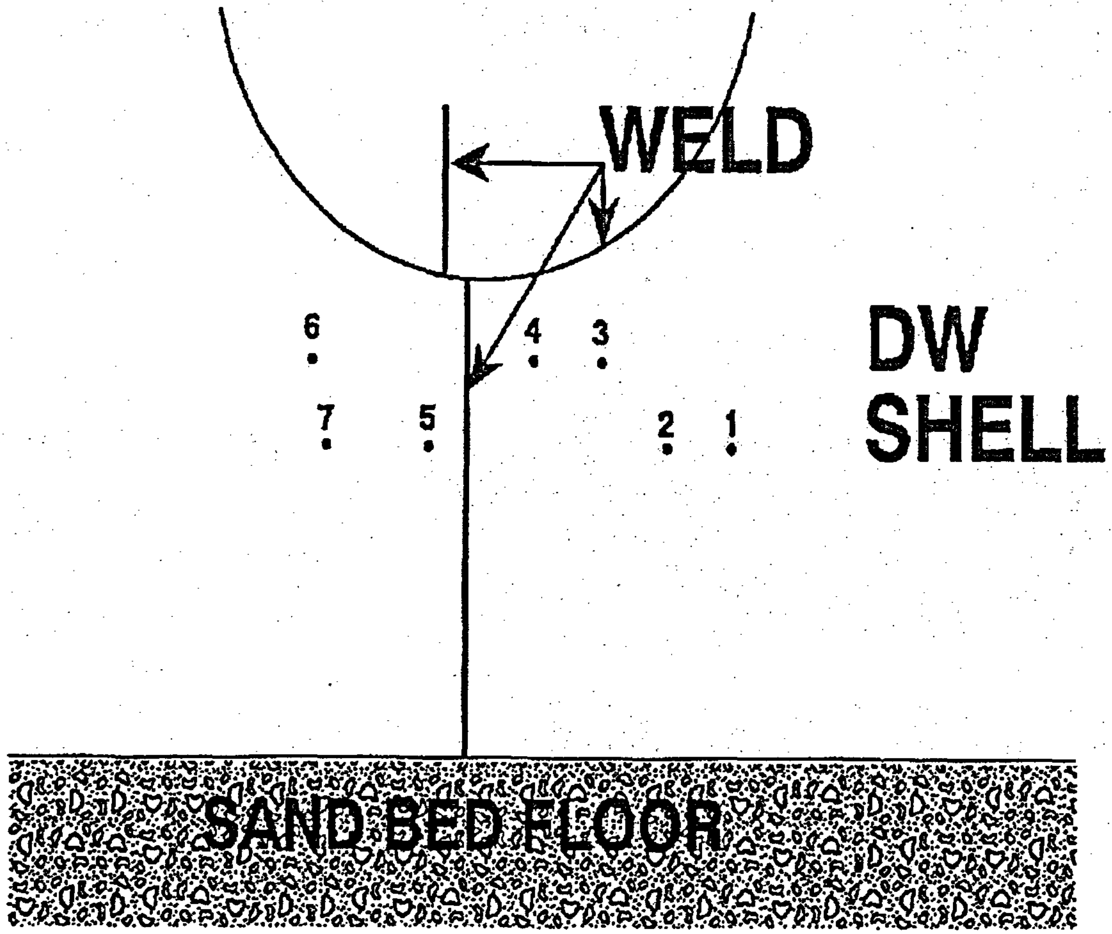

FIGURE (7)

5.0 CALCULATION:

UT EVALUATION:

BAY # 9:

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

Given the UT measurements, a conservative mean evaluation thickness of 0.900 inches is estimated for this bay and therefore, it is concluded that the bay is acceptable.

Bay # 9 UT Data

Table 9

Location	UT Measurement (inches)	Average Micrometer (inches)
1	0.960	---
2	0.940	---
3	0.994	---
4	1.020	---
5	0.985	---
6	0.820	---
7	0.825	---
8	0.791	---
9	0.832	---
10	0.980	---

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Originator	Date	Reviewed by	Date
MARK YEKTA	01/12/93	S. C. Tumminelli	04/16/93

BAY #9 DATA

NOTES:

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

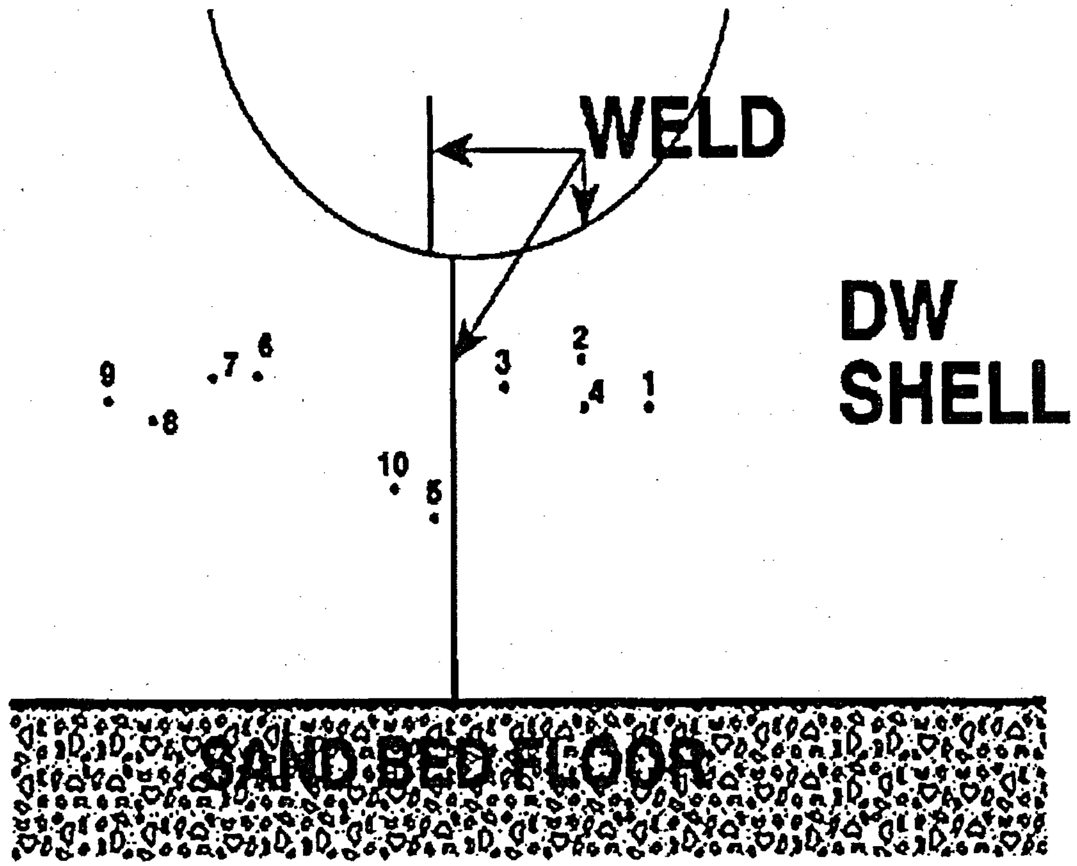

FIGURE (9)

5.0 CALCULATION:

UT EVALUATION:

BAY # 11:

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

Eight locations were selected to represent the thinnest areas based on the visual observations of the shell surface (Fig. 11). These locations are a deliberate attempt to produce a minimum measurement. Table 11-a shows readings taken to measure the thicknesses of the drywell shell using a D-meter. The results indicate that all of the areas have thickness greater than the 0.736 inches, except one location. Location 1 as shown in Table 11-a, has a reading below 0.736 inches. Observations indicate that this location was very deep and not more than 1 to 2 inches in diameter. The depth of area relative to its immediate surroundings was measured at 8 locations around the spot and the average is shown in Table 11-a. Using the general wall thickness acceptance criteria described earlier, the evaluation thickness for location 1 was found to be above 0.736 inches as shown in Table 11-b.

Given the UT measurements, a conservative mean evaluation thickness of 0.790 inches is estimated for this bay and therefore, it is concluded that the bay is acceptable.

GPU Nuclear **Calculation Sheet**

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Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli	Date 04/16/93

5.0 CALCULATION:

UT EVALUATION:

BAY # 11 (Continued):

Bay # 11 UT Data

Table 11-a

Location	UT Measurement (inches)	Average Micrometer (inches)
1	0.705	0.246
2	0.770	---
3	0.832	---
4	0.755	---
5	0.831	---
6	0.800	---
7	0.831	---
8	0.815	---

Summary of Measurements Below 0.736 Inches

Table 11-b

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

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MARK YEKTA	01/12/93	S. C. Tumminelli		04/16/93

BAY #11 DATA

NOTES:

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

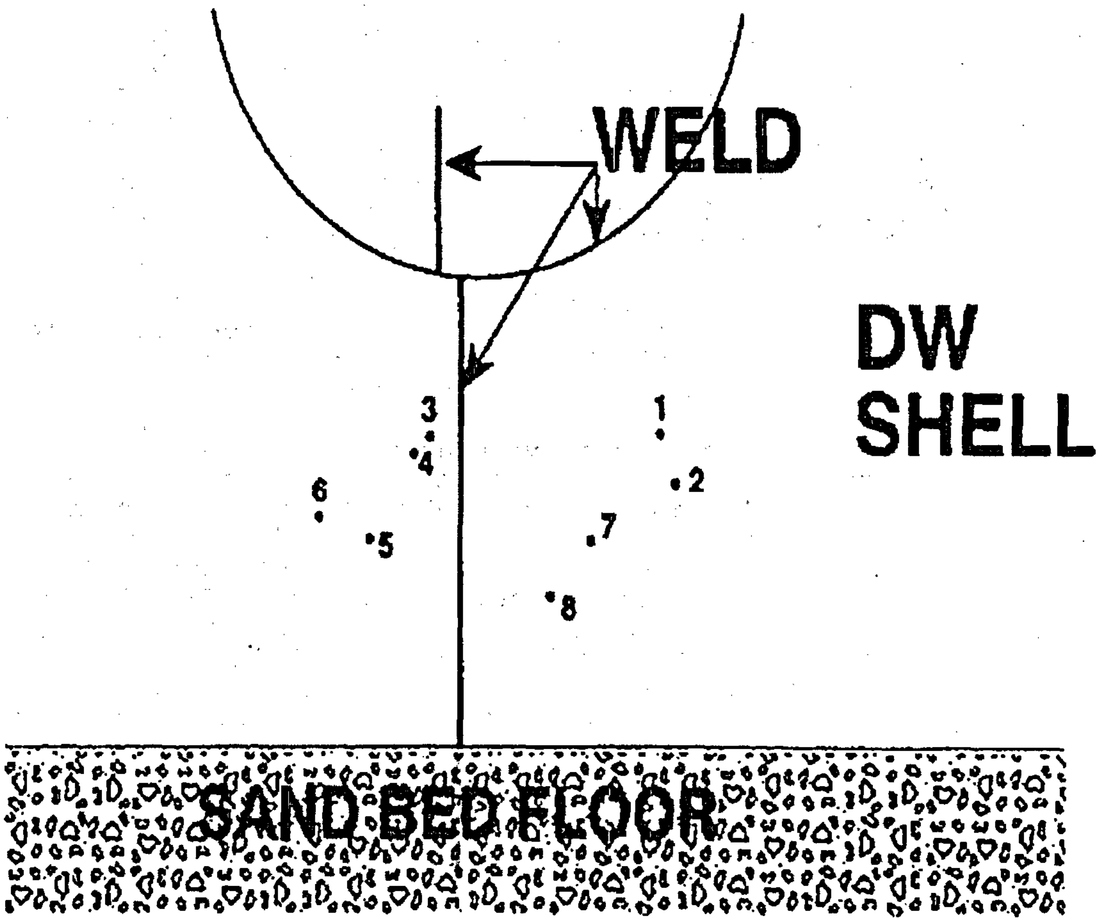

FIGURE (11)

5.0 CALCULATION:

UT EVALUATION:

BAY # 13:

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

Therefore, a conservative mean thickness of 0.800 inches is estimated to represent the evaluation thickness for this bay. Given a uniform thickness of 0.800 inches, the buckling margin for the refueling load condition is recalculated based on the GE report 9-4 (Ref. 3.3). The theoretical buckling strength from report 9-4 (ANSYS Load Factor) is a square function of plate thicknesses. Therefore, a new buckling capacity for the controlling refueling load combination is calculated to be at 13% above the ASME factor of safety of 2 as shown in Appendix B.

5.0 CALCULATION:

UT EVALUATION:

BAY # 13 (Continued):

Locations 5, 6, 7, 8, 10, 11, 14, and 15 are confined to the bathtub ring as shown in Figure 13. An average value of these measurements is an evaluation thickness for this band as follows;

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

Average = 0.778"

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

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

5.0 CALCULATION:

UT EVALUATION:

BAY # 13 (Continued):

Nine locations shown in Table 13-a (1, 2, 5, 6, 7, 8, 10, 11, and 15) have measurements below 0.736 inches. Observations indicate that these locations were very deep, overly ground, and not more than 1 to 2 inches in diameter. The depth of each of these areas relative to its immediate surroundings was measured at 8 locations around the spot and the average is shown in Table 13-a. Using the general wall thickness acceptance criteria described earlier, the evaluation thickness for all measurements below 0.736 inches were found to be above 0.736 inches except for two locations, 5 and 7, as shown in Table 13-b. In addition, subsequent measurements close to the locations identified above, were taken and they were all above 0.736 inches. Locations 5 and 7 are in the bathtub ring and are about 30 inches apart. These locations are characterized as local areas located at about 15 to 20 inches below the vent pipe reinforcement plate with an evaluation thicknesses of 0.735 inches and 0.677 inches. The location 5 is near to location 14 for an average value of 0.801 inches and therefore acceptable. Location 7 could conservatively exist over an area of 6 x 6 inches for a thickness of 0.677 inches. This thickness of 0.677 inches is a full 0.123 inches reduction from the conservative estimate of 0.800 inches evaluation thickness for the entire bay. In order to quantify the effect of this local region and to address structural compliance, the GE study on local effects is used (Ref. 3.5).

This study contains an analysis of the drywell shell using the pie slice finite element model, reducing the thickness by 0.200 inches (from 0.736 to 0.536 inches) in an area 12 x 12 inches in the sandbed region located to result in the largest reduction possible. This location is selected at the point of maximum deflection of the eigenvector shape associated with the lowest buckling load. The theoretical buckling load was reduced by 9.5%. The 6 x 6 inch local region is not at the point of maximum deflection. The area of 6 x 6 inches is only 25% of the 12 x 12 inches area used in the analysis. Therefore, this small 6 x 6 inch area has a negligible effect on the buckling capacity of the structure.

5.0 CALCULATION:

UT EVALUATION:

BAY # 13 (Continued):

In summary, using a conservative estimate of 0.800 inches for evaluation thickness for the entire bay and the presence of a bathtub ring with a evaluation thickness of 0.778 inches plus the acceptance of a local area of 6 x 6 inches based on the GE study, it is concluded that the bay is acceptable.

Bay # 13 UT Data

Table 13-a

Location	UT Measurement (inches)	Average Micrometer (inches)
1/1A	0.672/0.890	0.351
2/2A	0.722/0.943	0.360
3	0.941	---
4	0.915	---
5/5A	0.718/0.851	0.217
6/6A	0.655/0.976	0.301
7/7A	0.618/0.752	0.257
8/8A	0.718/0.900	0.278
9	0.924	---
10/10A	0.728/0.810	0.211
11/11A	0.685/0.854	0.256
12	0.885	---
13	0.932	---
14	0.868	---
15/15A	0.683/0.859	0.273
16	0.829	---
17	0.807	---
18	0.825	---
19	0.912	---
20	1.170	---

GPU Nuclear Calculation Sheet

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Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli		Date 04/16/93

5.0 CALCULATION:

UT EVALUATION:

BAY # 13 (Continued):

Summary of Measurements Below 0.736 Inches

Table 13-b

Location	UT Measurement (1)	AVG Micrometer (2)	Mean Depth/Valley (3)	T (Evaluation) (4)=(1)+(2)-(3)	Remarks
1	0.672"	0.351"	0.200"	0.823"	Acceptable
2	0.722"	0.360"	0.200"	0.882"	Acceptable
5	0.718"	0.217"	0.200"	0.735"	Acceptable
6	0.655"	0.301"	0.200"	0.756"	Acceptable
7	0.618"	0.257"	0.200"	0.675"	Acceptable
8	0.718"	0.278"	0.200"	0.796"	Acceptable
10	0.728"	0.211"	0.200"	0.739"	Acceptable
11	0.685"	0.256"	0.200"	0.741"	Acceptable
15	0.683"	0.273"	0.200"	0.756"	Acceptable

GPU Nuclear Calculation Sheet

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Originator	Date	Reviewed by	Date
MARK YEKTA	01/12/93	S. C. Tumminelli	04/16/93

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. IA 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".

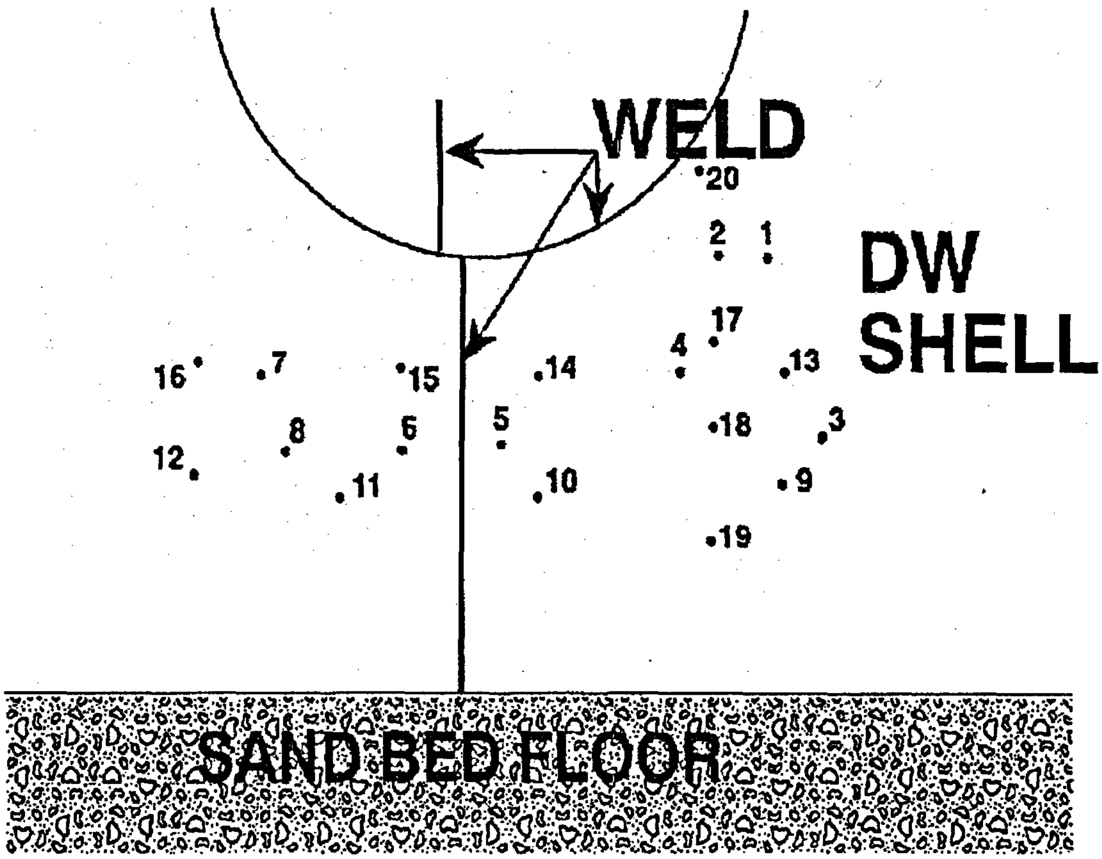


FIGURE (13)

5.0 CALCULATION:

UT EVALUATION:

BAY # 15:

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

Eleven locations were selected to represent the thinnest areas based on the visual observations of the shell surface (Fig. 15). These locations are a deliberate attempt to produce a minimum measurement. Table 15-a shows readings taken to measure the thicknesses of the drywell shell using a D-meter. The results indicate that all of the areas have thickness greater than the 0.736 inches, except one location. Location 9 as shown in Table 15-a, has a reading below 0.736 inches. Observations indicate that this location was very deep and not more than 1 to 2 inches in diameter. The depth of area relative to its immediate surrounding was measured at 8 locations around the spot and the average is shown in Table 15-a. Using the general wall thickness acceptance criteria described earlier, the evaluation thickness for location 9 was found to be above 0.736 inches as shown in Table 15-b.

Given the UT measurements, a conservative mean evaluation thickness of 0.800 inches is estimated for this bay and therefore, it is concluded that the bay is acceptable.

5.0 CALCULATION:

UT EVALUATION:

BAY # 15:

Bay #15 UT Data

Table 15-a

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

Summary of Measurements Below 0.736 Inches

Table 15-b

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

BAY #15 DATA

NOTES:

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

2. Pit depths are average of four readings taken at 0/45°/90°/135° within 1" distance around ground spots. Taken only when remaining wall thickness shown below 0.736".

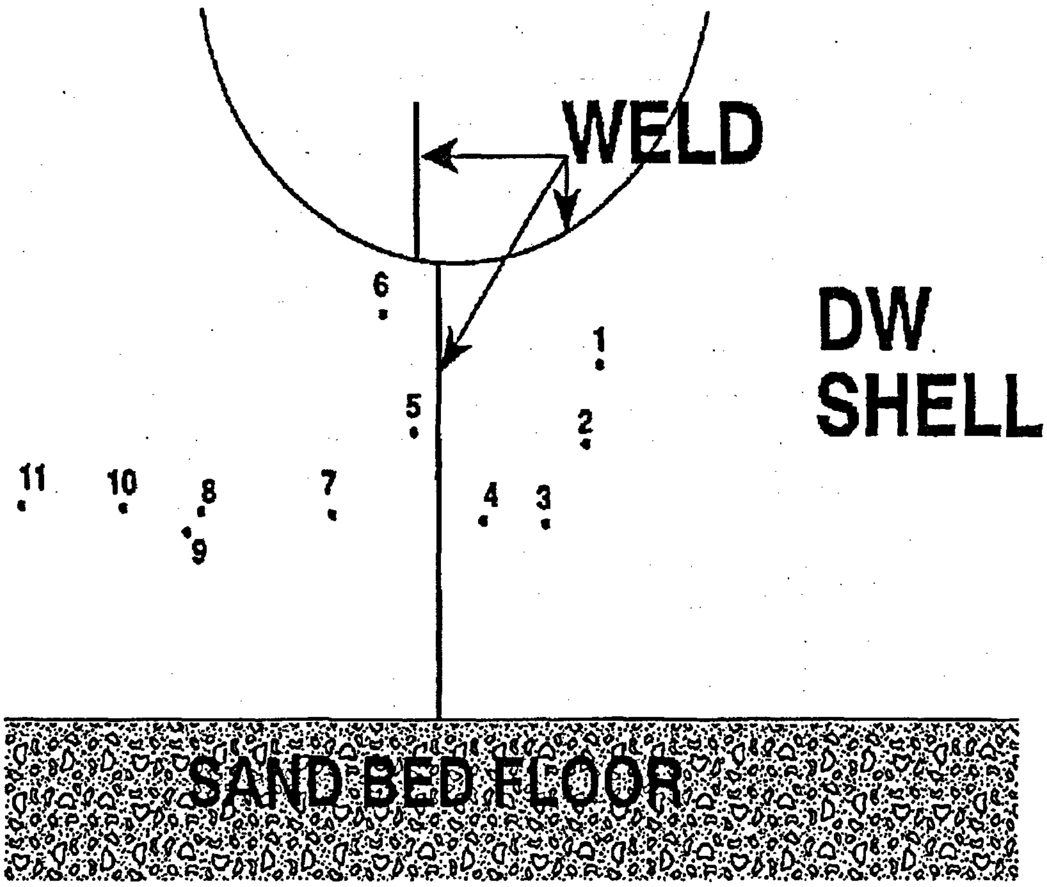


FIGURE (15)

5.0 CALCULATION:

UT EVALUATION:

BAY # 17:

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

Eleven locations were selected to represent the thinnest areas based on the visual observations of the shell surface (Fig. 17). These locations are a deliberate attempt to produce a minimum measurement. Table 17-a shows readings taken to measure the thicknesses of the drywell shell using a D-meter. The results indicate that all of the areas have thickness greater than the 0.736 inches, except one location. Location 9 as shown in Table 17-a, has a reading below 0.736 inches. Observations indicate that this location is very deep and not more than 1 to 2 inches in diameter. The depth of area relative to its immediate surroundings was measured at 8 locations around the spot and the average is shown in Table 17-a. Using the general wall thickness acceptance criteria described earlier, the evaluation thickness for location 9 was found to be above 0.736 inches as shown in Table 17-b.

Given the UT measurements, a conservative mean evaluation thickness of 0.900 inches is estimated for this bay and therefore, it is concluded that the bay is acceptable.

5.0 CALCULATION:

UT EVALUATION:

BAY # 17 (Continued):

Bay #17 UT Data

Table 17-a

Location	UT Measurement (inches)	Average Micrometer (inches)
1	0.916	---
2	1.150	---
3	0.898	---
4	0.951	---
5	0.913	---
6	0.992	---
7	0.970	---
8	0.990	---
9	0.720	0.351
10	0.830	---
11	0.770	---

Summary of Measurements Below 0.736 Inches

Table 17-b

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

GPU Nuclear **Calculation Sheet**

Subject		Calc No.	Rev. No.	Sheet No.
O.C Drywell Ext. Ut Evaluation in Sandbed		C-1302-187-5320-024	0	35 of 54
Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli		Date 04/16/93

BAY #17 DATA

NOTES:

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

2. Pit depths are average of four readings taken at 0/45°/90°/135° within 1" distance around ground spots. Taken only when remaining wall thickness was below 0.736".

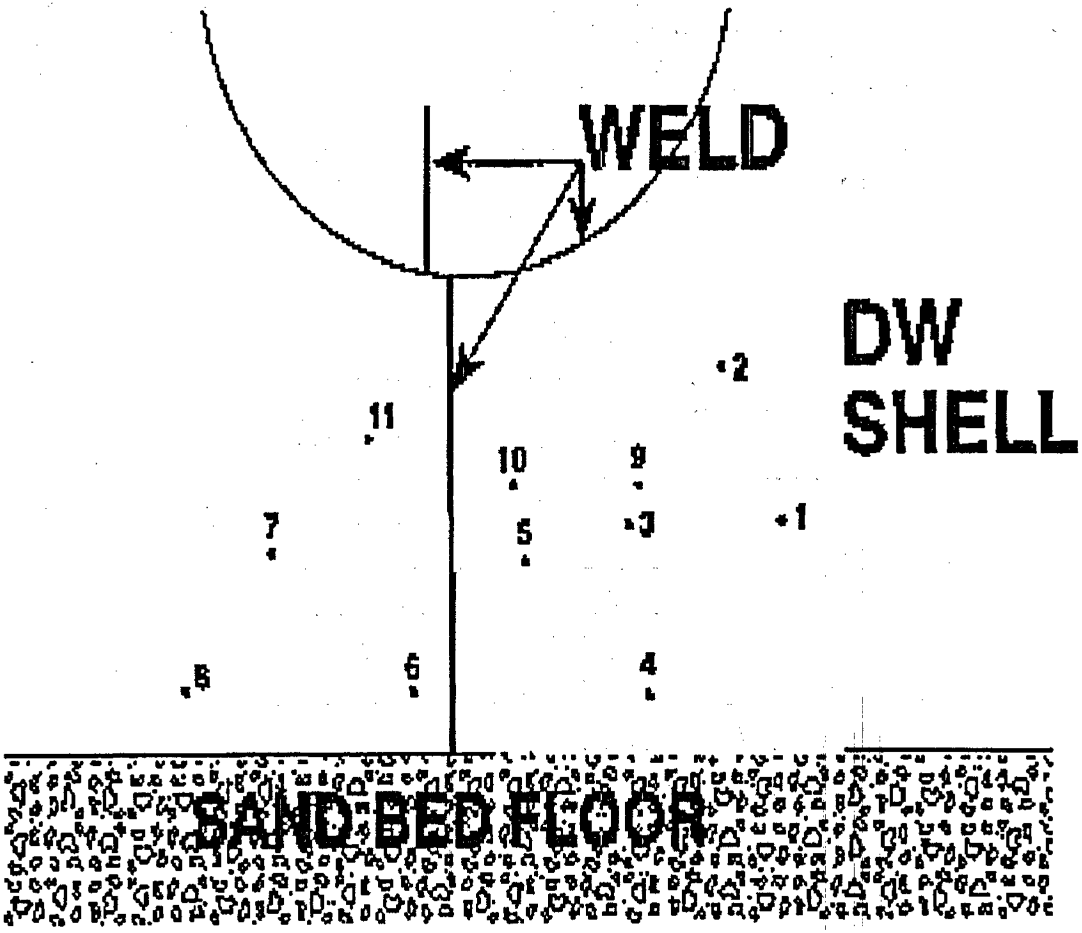


FIGURE (17)

5.0 CALCULATION:

UT EVALUATION:

BAY # 19:

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

Given the UT measurements, a conservative mean evaluation thickness of 0.850 inches is estimated for this bay and therefore, it is concluded that the bay is acceptable.

Bay #19 UT Data

Table 19

Location	UT Measurement (inches)	Average Micrometer (inches)
1	0.932	---
2	0.924	---
3	0.955	---
4	0.940	---
5	0.950	---
6	0.860	---
7	0.969	---
8	0.753	---
9	0.776	---
10	0.790	---

GPU Nuclear Calculation Sheet

Subject	Calc No.	Rev. No.	Sheet No.
O.C Drywell Ext. Ut Evaluation in Sandbed	C-1302-187-5320-024	0	37 of 54

Originator	Date	Reviewed by	Date
MARK YEKTA	01/12/93	S. C. Tumminelli	04/16/93

BAY #19 DATA

NOTES:

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

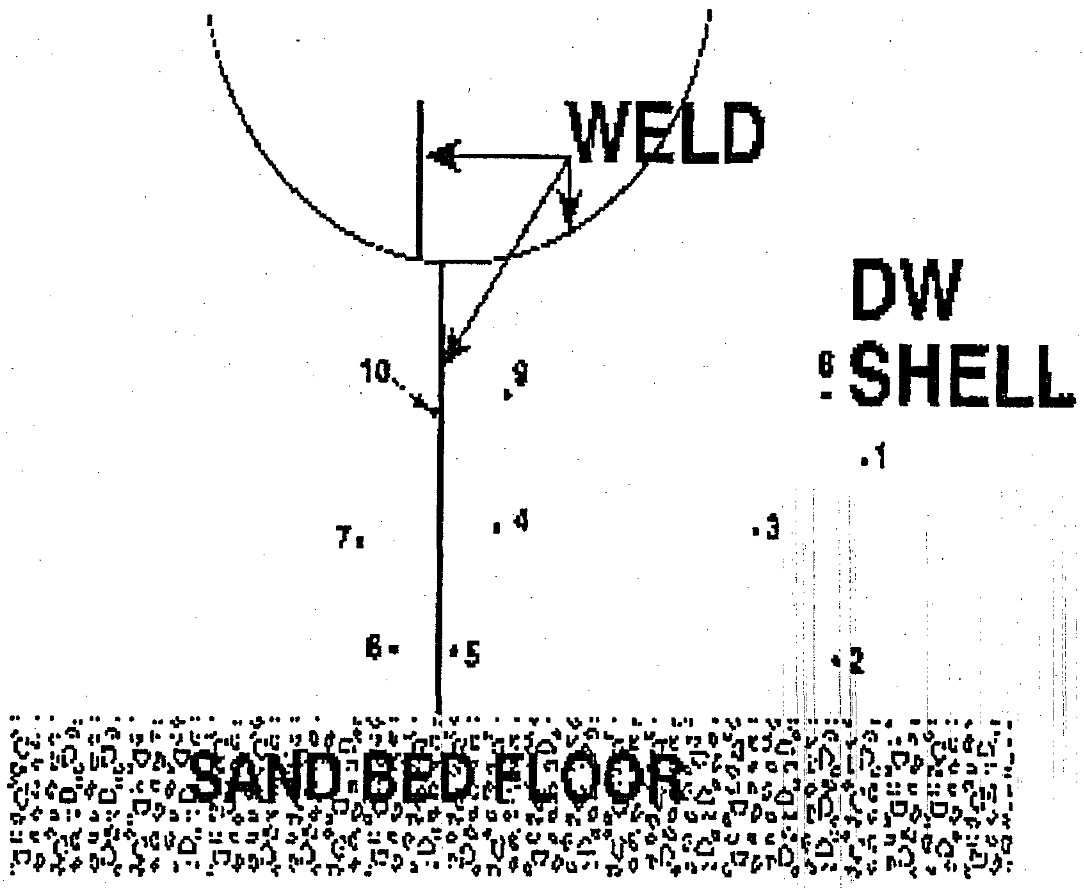


FIGURE (19)

GPU Nuclear **Calculation Sheet**

Subject		Calc No.	Rev. No.	Sheet No.
O.C Drywell Ext. Ut Evaluation in Sandbed		C-1302-187-5320-024	0	38 of 54
Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli		Date 04/16/93

APPENDIX A

SUMMARY OF MEASUREMENTS

OF

IMPRESSIONS TAKEN FROM BAY #13

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	**DEPTH # 10**	**DEPTH # 7**
(Location)	(inches)	(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

GPU Nuclear **Calculation Sheet**

Subject O.C Drywell Ext. Ut Evaluation in Sandbed	Calc No. C-1302-187-5320-024	Rev. No. 0	Sheet No. 40 of 54
Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli	Date 04/16/93

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.

GPU Nuclear **Calculation Sheet**

Subject		Calc No.	Rev. No.	Sheet No.
O.C Drywell Ext. Ut Evaluation in Sandbed		C-1302-187-5320-024	0	41 of 54
Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli		Date 04/16/93

APPENDIX B

BUCKLING CAPACITY EVALUATION

FOR VARYING

UNIFORM THICKNESS

GPU Nuclear **Calculation Sheet**

Subject O.C Drywell Ext. Ut Evaluation in Sandbed		Calc No. C-1302-187-5320-024	Rev. No. 0	Sheet No. 42 of 54
Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli		Date 04/16/93

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,i,mod		0.326	
14	Reduced Elastic Instability Stress, Se	(ksi)	15.182	2.001
	*** PLASTICITY REDUCTION FACTOR CALCULATION			
15	Yield Stress Ratio, DELTA=Se/Sy		0.400	
16	Plasticity Reduction Factor, NUi		1.000	
17	Inelastic Instability Stress, Si = NUi x Se	(ksi)	15.182	2.001
	*** ALLOWABLE COMPRESSIVE STRESS CALCULATION			
18	Allowable Compressive Stress, Sall = SI/FS	(ksi)	7.591	1.000
19	Compressive Stress Margin, M=(Sall/Sm -1) x 100%	(%)	0.0	

GPU Nuclear

Calculation Sheet

Subject O.C Drywell Ext. Ut Evaluation in Sandbed	Calc No. C-1302-187-5320-024	Rev. No. 0	Sheet No. 43 of 54
Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli	Date 04/16/93

CALCULATION OF BUCKLING MARGIN - REFUELING CASE, NO SAND
GE OCRFST01 - 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,i,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)	15.583	2.165
	ALLOWABLE COMPRESSIVE STRESS CALCULATION			
18	Allowable Compressive Stress, Sall = SI/FS	(ksi)	7.792	1.082
19	Compressive Stress Margin, M=(Sall/Sm -1) x 100%		8.2	

GPU Nuclear **Calculation Sheet**

Subject O.C Drywell Ext. Ut Evaluation in Sandbed	Calc No. C-1302-187-5320-024	Rev. No. 0	Sheet No. 44 of 54
Originator MARK YEKTA Date 01/12/93	Reviewed by S. C. Tumminelli		Date 04/16/93

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 6.857 * (0.800/0.776)^2 = 7.288	(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,i,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	

Subject		Calc No.	Rev. No.	Sheet No.
O.C Drywell Ext. Ut Evaluation in Sandbed		C-1302-187-5320-024	0	45 of 54
Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli		Date 04/16/93

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
	6.857 * (0.800/0.776)^2 = 7.288			
	*** 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,i,mod		0.300	
14	Reduced Elastic Instability Stress, Se	(ksi)	16.257	2.474
	*** PLASTICITY REDUCTION FACTOR CALCULATION			
15	Yield Stress Ratio, DELTA=Se/Sy		0.428	
16	Plasticity Reduction Factor, NUi		1.000	
17	Inelastic Instability Stress, Si = NUi x Se	(ksi)	16.257	2.474
	ALLOWABLE COMPRESSIVE STRESS CALCULATION			
18	Allowable Compressive Stress, Sall = SI/FS	(ksi)	8.128	1.237
19	Compressive Stress Margin, M=(Sall/Sm -1) x 100%		23.7	

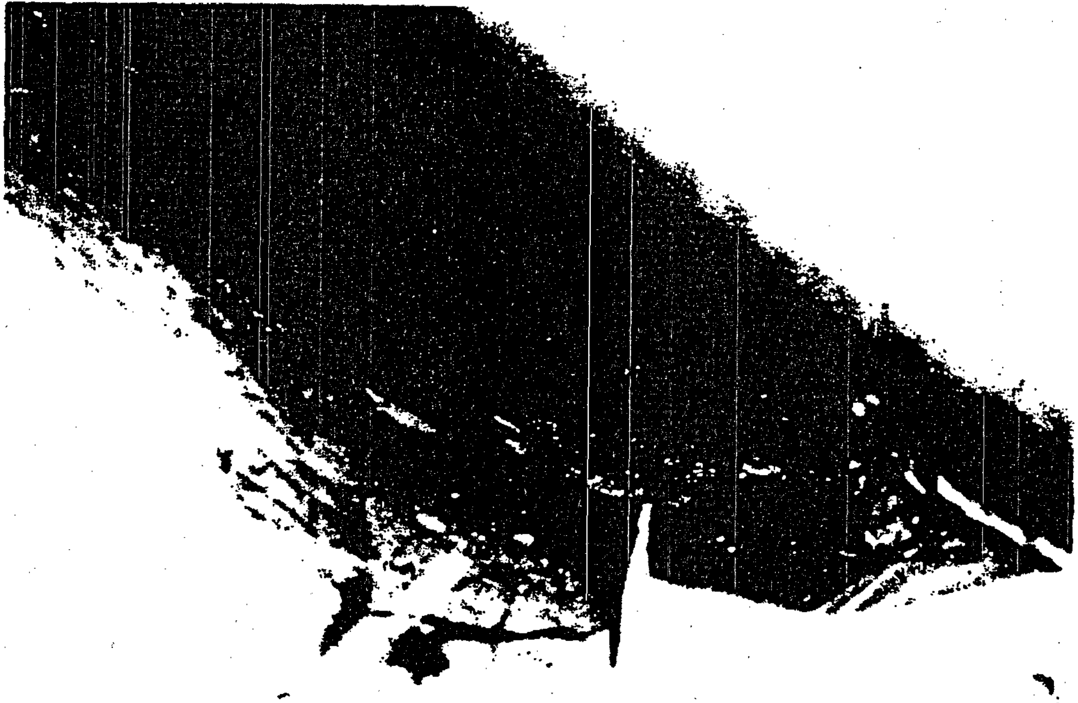
APPENDIX C

PICTURES SHOWING CONDITION

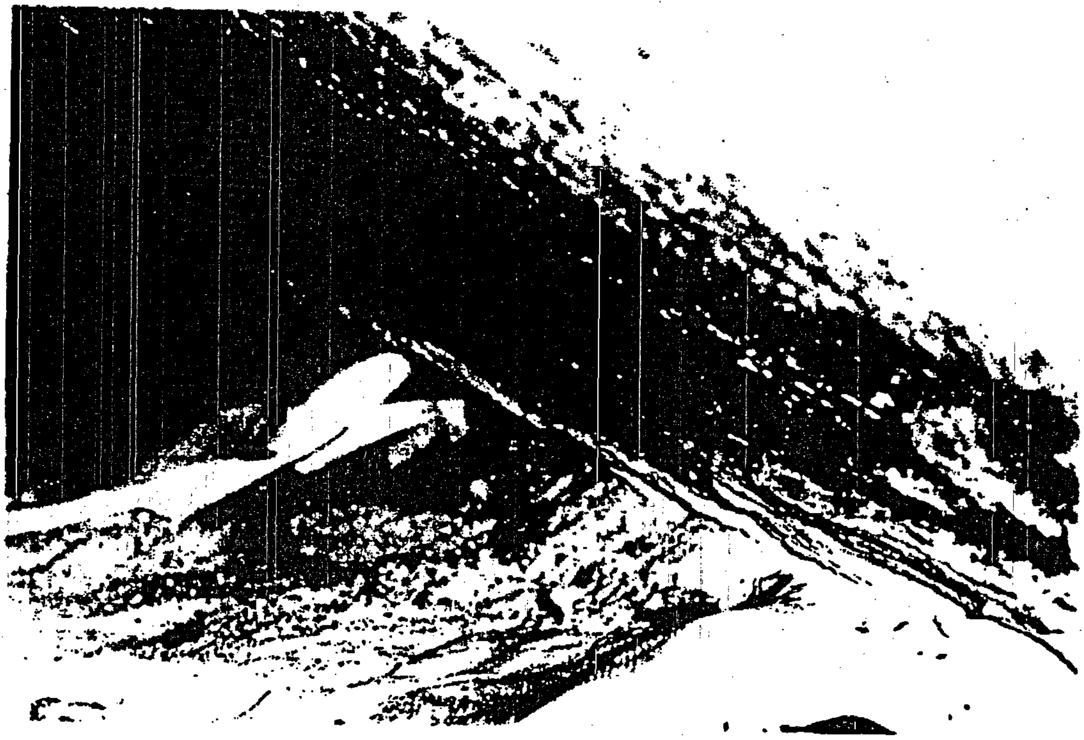
OF THE DRYWELL

IN THE SANDBED REGION

Subject		Calc No.	Rev. No.	Sheet No.
O.C Drywell Ext. Ut Evaluation in Sandbed		C-1302-187-5320-024	0	47 of 54
Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli		Date 04/16/93



Sand Bed Region - Typical condition found on initial entry.

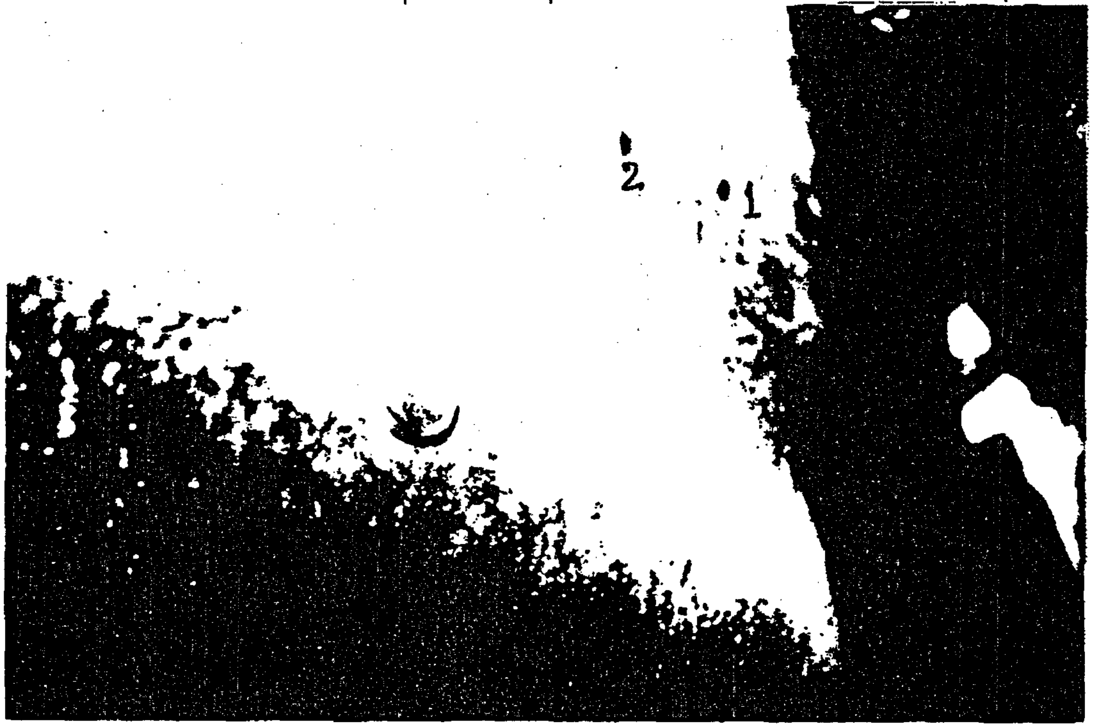


Corrosion product on drywell vessel

GPU Nuclear

Calculation Sheet

Subject O.C Drywell Ext. Ut Evaluation in Sandbed	Calc No. C-1302-187-5320-024	Rev. No. 0	Sheet No. 48 of 54
Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli	Date 04/16/93

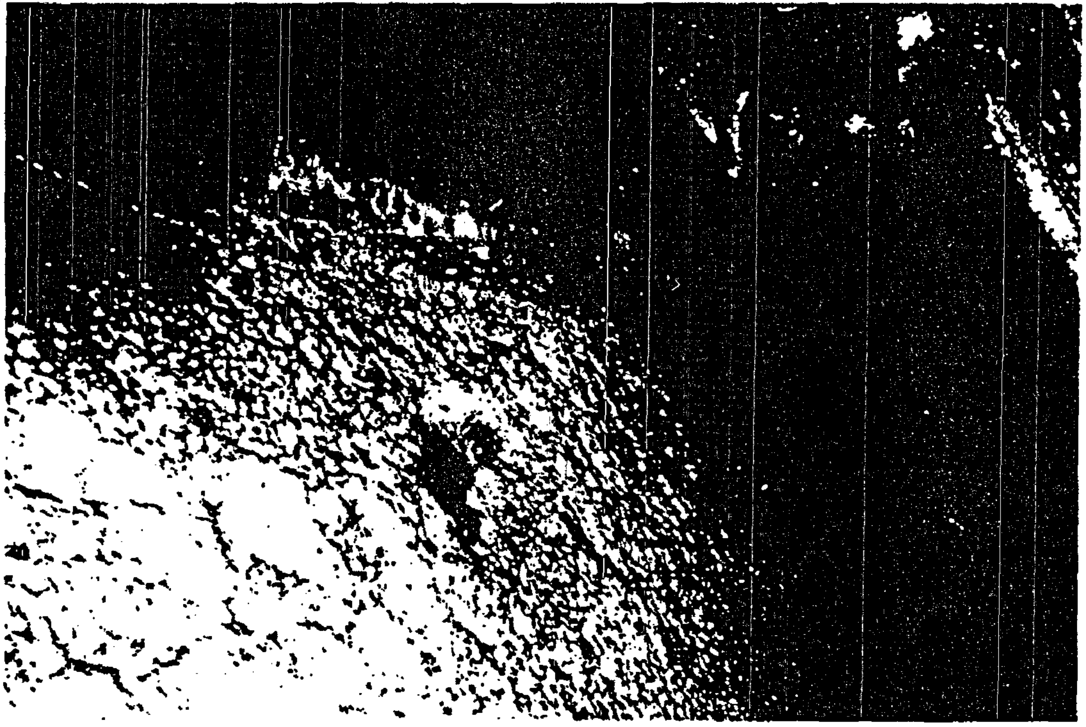


Bay #13 - D/W shell showing plug . The plug is located in the middle of the worst corroded area of the shell The plug showed no sign of corrosion.

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

GPU Nuclear **Calculation Sheet**

Subject O.C Drywell Ext. Ut Evaluation in Sandbed	Calc No. C-1302-187-5320-024	Rev. No. 0	Sheet No. 49 of 54
Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli	Date 04/1[illegible]3

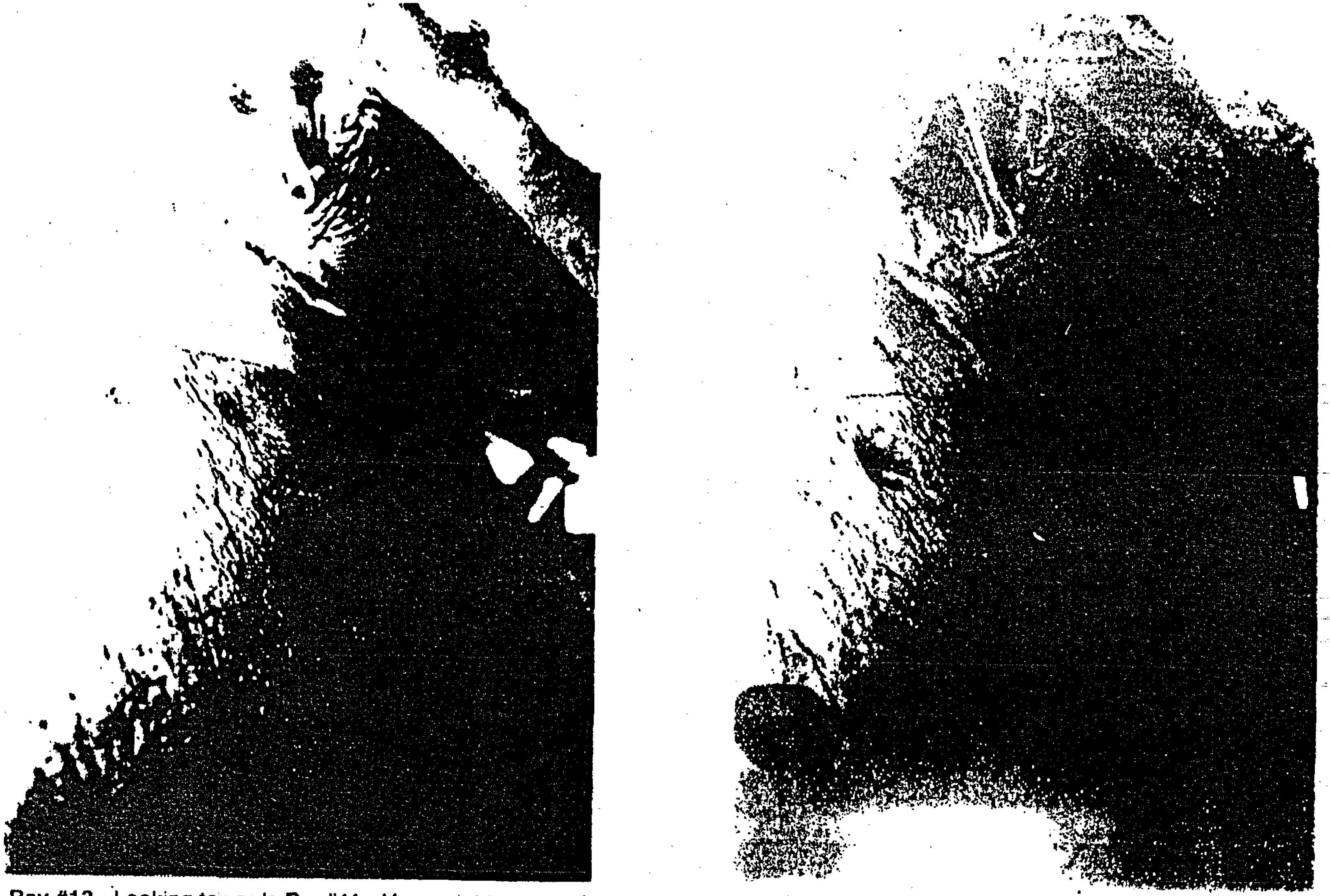


Bay #1 - Looking at the worst corroded area on shell near vent tube collar/ring. The ground spots seen here correspond to UT spot 20/21/2/3

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

GPU Nuclear **Calculation Sheet**

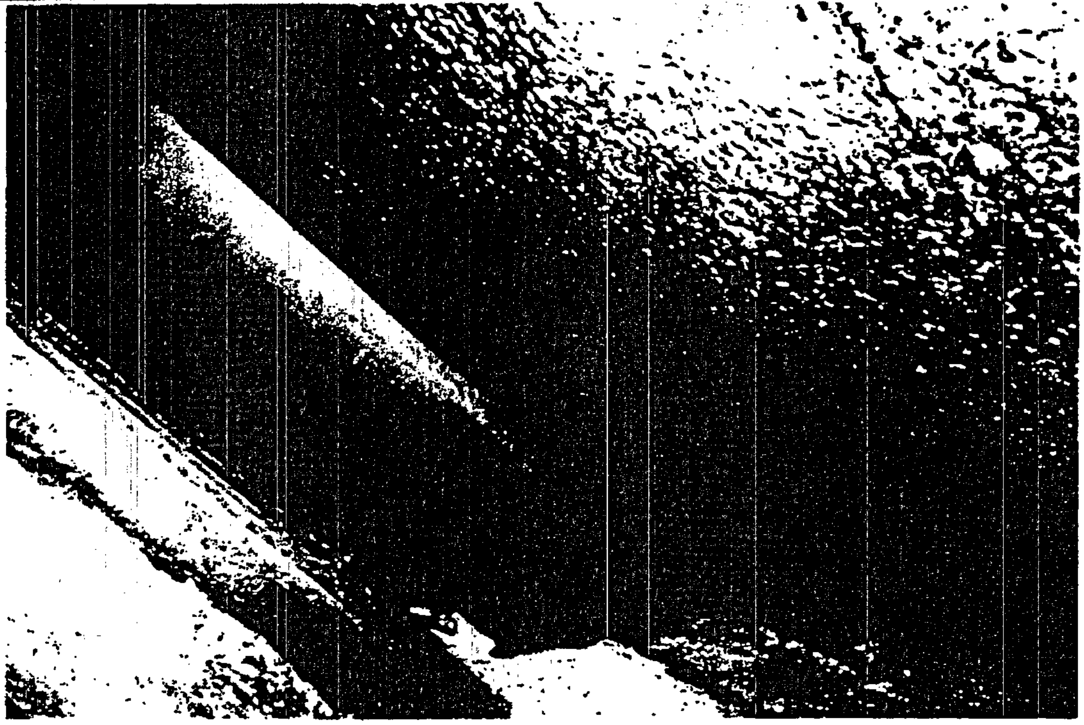
Subject O.C Drywell Ext. Ut Evaluation in Sandbed	Calc No. C-1302-187-5320-024	Rev. No. 0	Sheet No. 50 of 54
Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli	Date 04/16/93



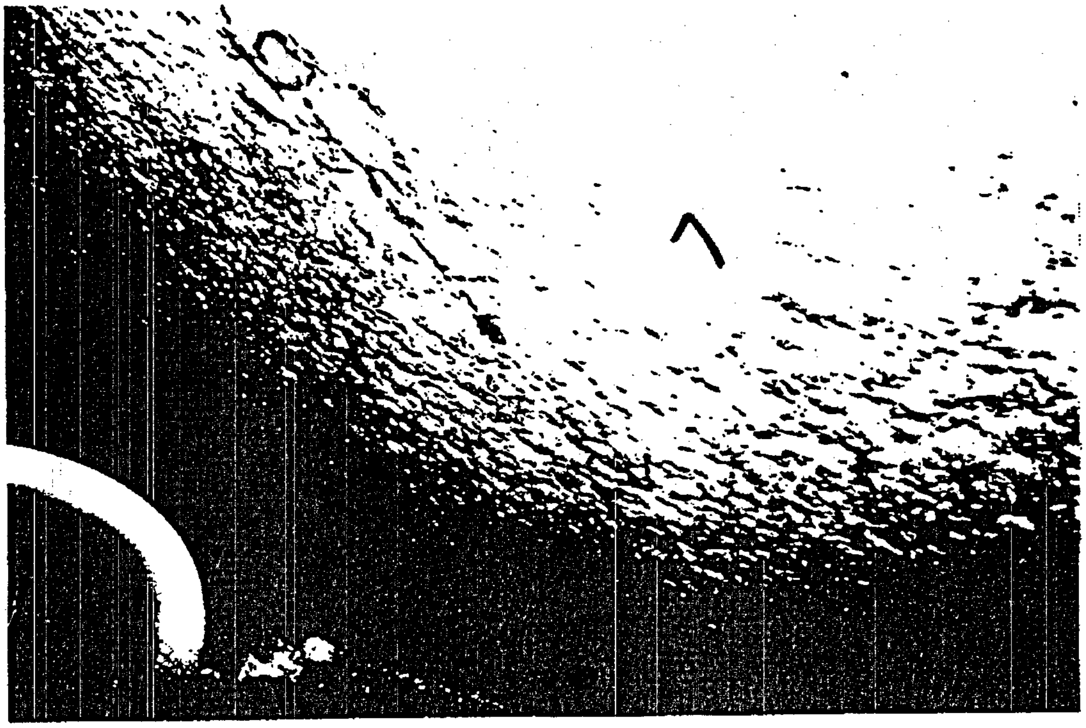
Bay #13 - Looking towards **Bay#11** - Upper right corner of D/W shell. Note ① - Grinding depth on UT spot #1 & 2, ② - A part of "Bath Tub Ring" as delineated by marking and ③ locations of UT spots 3,4,13 & 17. The photo on right (although blurred by flash reflection) shows 1/8" projection of plug.

GPU Nuclear **Calculation Sheet**

Subject O.C Drywell Ext. Ut Evaluation in Sandbed	Calc No. C-1302-187-5320-024	Rev. No. 0	Sheet No. 51 of 54
Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli	Date 04/16/93



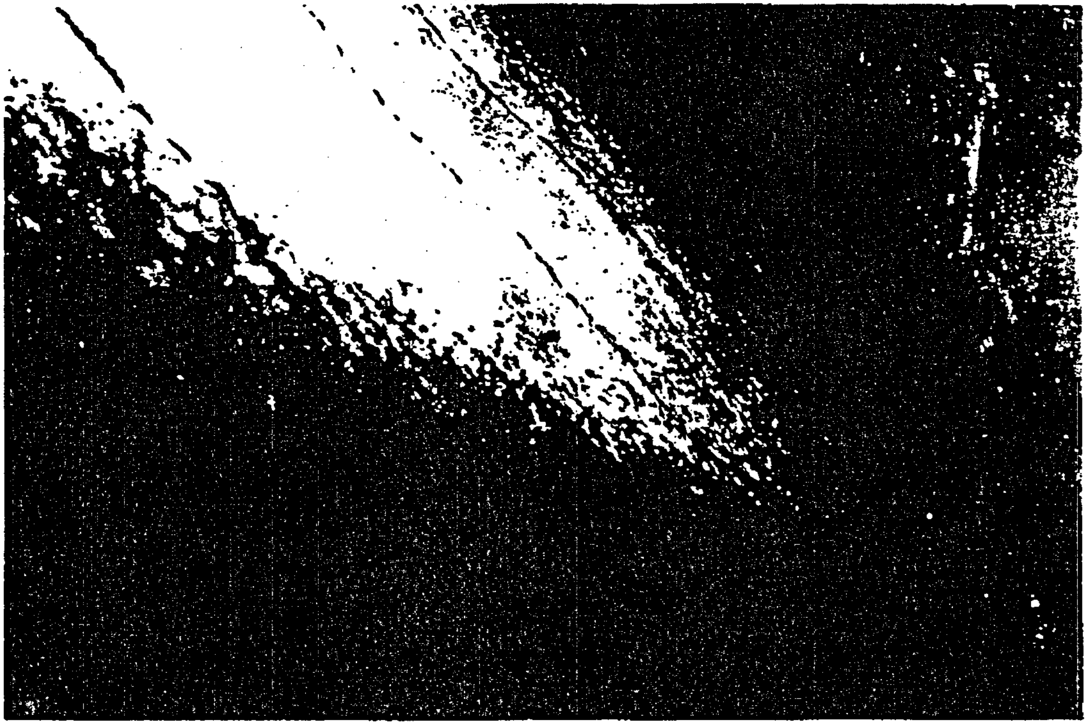
Bay #15 Looking towards **Bay#17** which has been closed with foam for coating work in **Bay #17**. Note the typical surface of the D/W shell and localized corroded spot



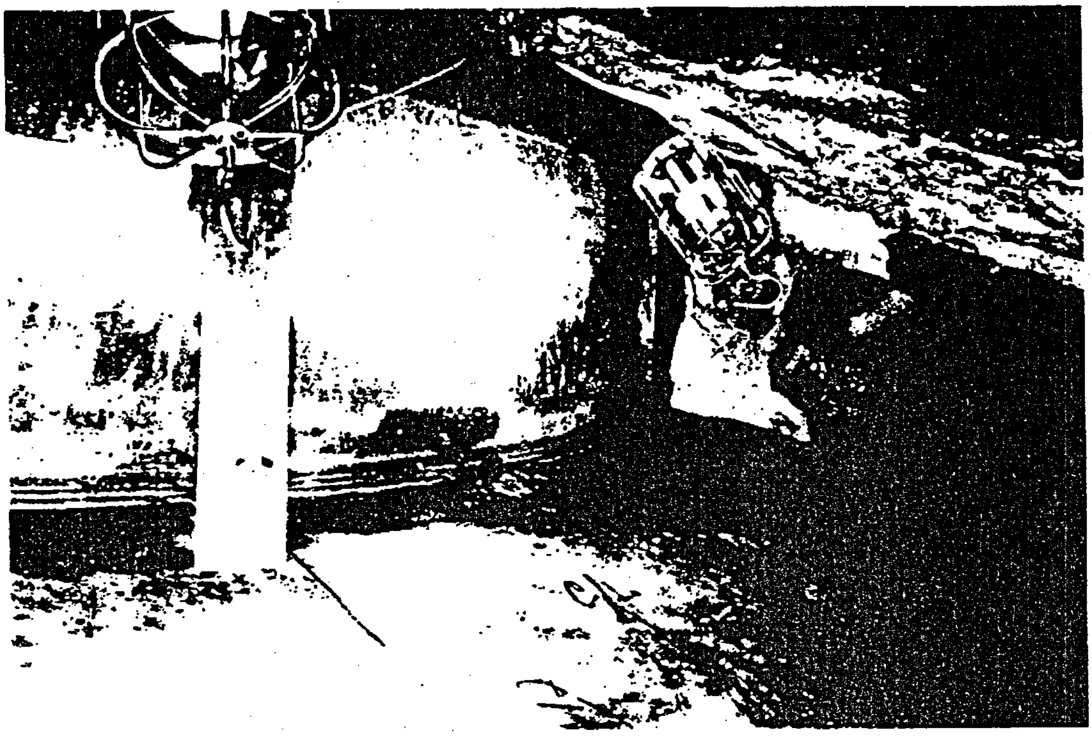
Bay #13 - Looking toward Bay #15 - Lower left corner showing UT spot #7,12 & 16. This close up has captured the peaks and valleys of the corroded shell in vivid detail. Later NDE inspection revealed depth between peaks and valleys in the 0.25" - 0.40"

Calculation Sheet

Subject O.C Drywell Ext. Ut Evaluation in Sandbed		Calc No. C-1302-187-5320-024	Rev. No. 0	Sheet No. 52 of 54
Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli		Date 04/16/93



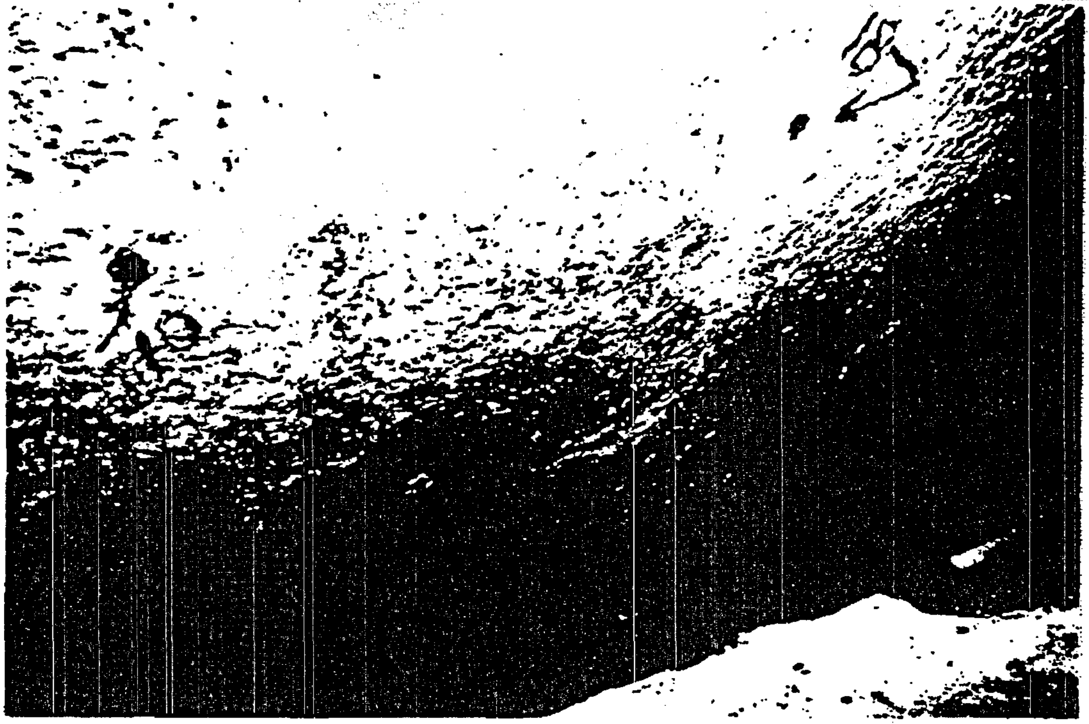
Bay #15 Looking toward Bay #13 showing portions of D/W shell and concrete floor, after removal of loose debris / sand / rust. The concrete floor in this bay is one of the better ones. However - Note ① no drainage channel and ② cratered holes near shell corner.



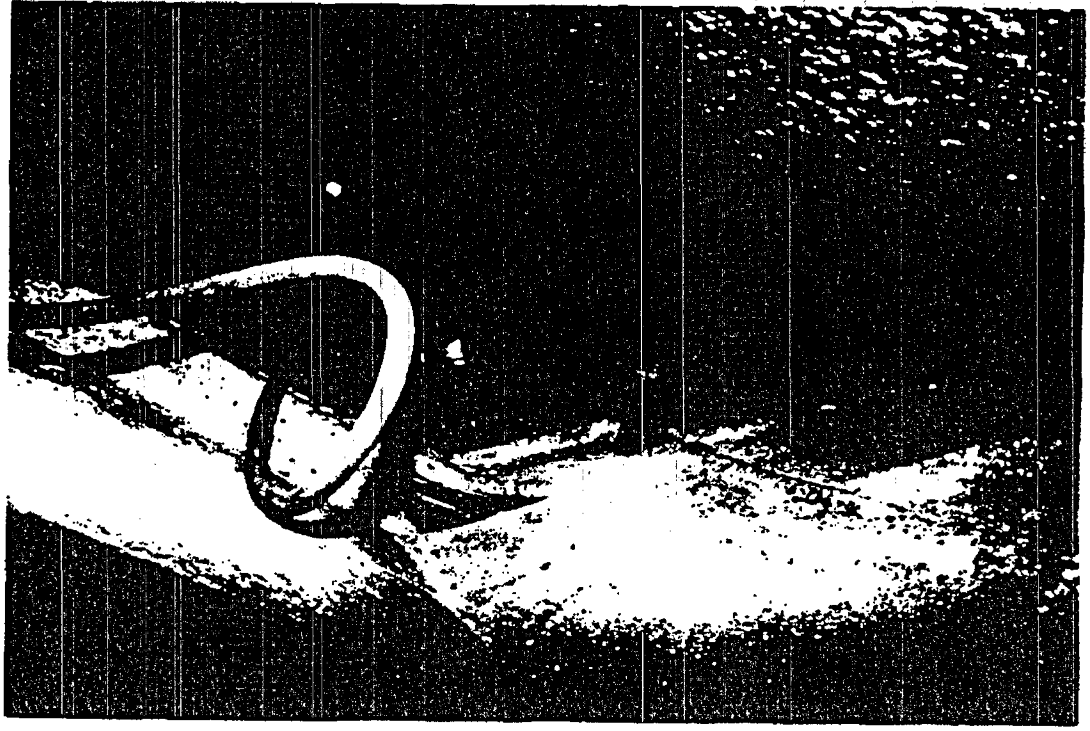
Bay #15 - Note the original lead primer on vent tube OD surface. The "Tub Ring" was less prominent on the shell in this bay except a portion in lower left corner. Also note presence of lead primer on vent collar/ring plate.

GPU Nuclear **Calculation Sheet**

Subject O.C Drywell Ext. Ut Evaluation in Sandbed		Calc No. C-1302-187-5320-024	Rev. No. 0	Sheet No. 53 of 54
Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli		Date 04/16/93



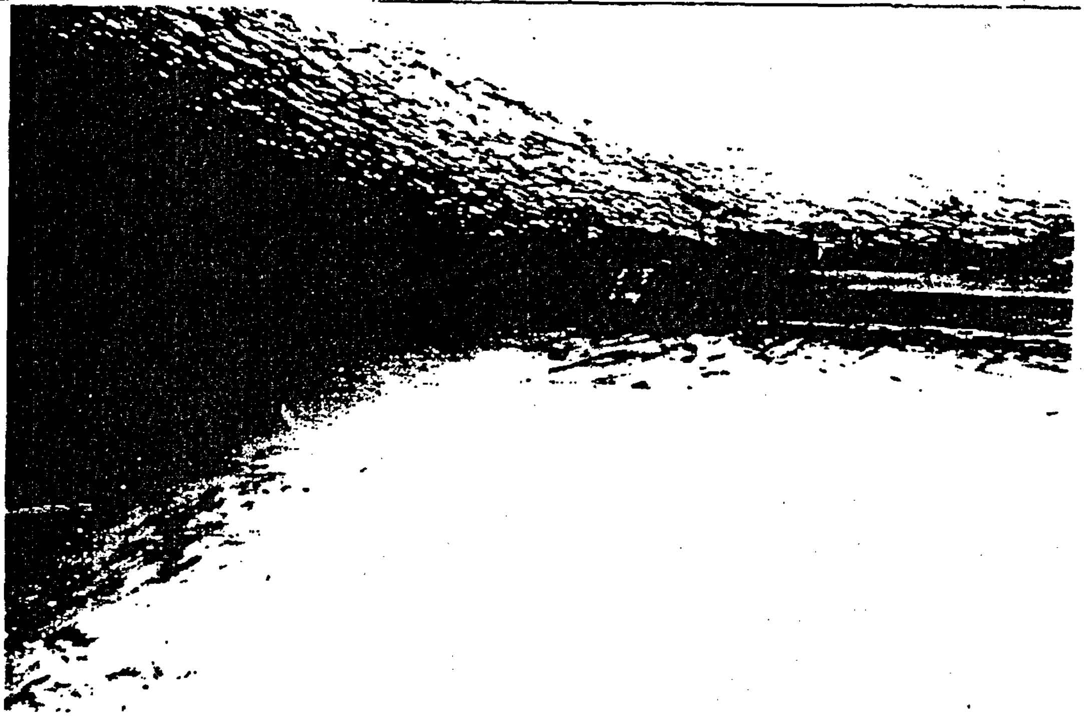
Bay #13 - Looking toward **Bay #11** - Lower right corner of D/W shell showing UT spots 9, 10, 18 & 19 Note the location of these spots - all are located in the valleys of the corroded surface This photo also shows the condition of the concrete floor. It appears



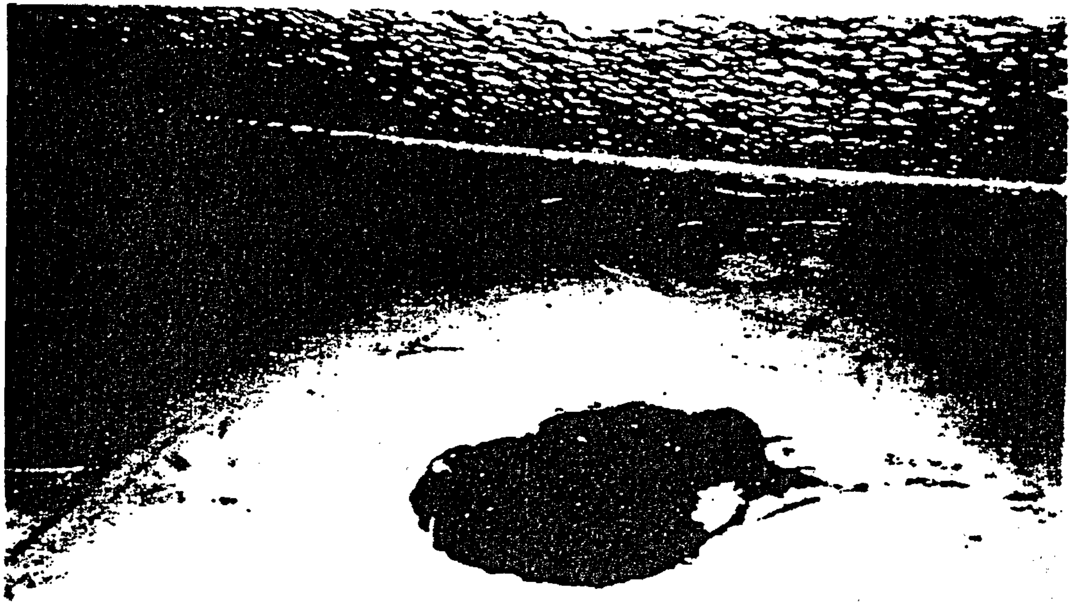
Bay #13 - Looking toward **Bay #15** - This photo captures the concrete floor condition and a portion of lower shell corroded surface in very great detail. The floor in this area

GPU Nuclear **Calculation Sheet**

Subject O.C Drywell Ext. Ut Evaluation in Sandbed	Calc No. C-1302-187-5320-024	Rev. No. 0	Sheet No. 54 of 54
Originator MARK YEKTA	Date 01/12/93	Reviewed by S. C. Tumminelli	Date 04/16/93



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



Drain after floor has been refurbished

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APPLICANT'S EXH. 18

ATTACHMENT 1
Design Analysis Cover Sheet
Page 1 of 117

Design Analysis (Major Revision)	**Last Page No.:** [6] 117
Analysis No.: [1] C-1302-187-5320-024	**Revision:** [2] 1
Title: [3] OC Drywell Ext. UT Evaluation in Sandbed	
EC/ECR No.: [4] 06-00634	**Revision:** [5] 0

		Component(s): [14]	
Station(s): [7]	Oyster Creek		
Unit No.: [8]	1	187	
Discipline: [9]	Mechanical/Structural Eng.		
Descrip. Code/Keyword: [10]	UT Data Assessments		
Safety/QA Class: [11]	Q		
System Code: [12]	187		
Structure: [13]	Drywell Vessel		

CONTROLLED DOCUMENT REFERENCES [15]

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

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

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

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

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

ALL PAGES CHANGED.
on

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

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

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

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

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

	Print Name	Sign Name	Date
(For External Analyses Only) **External Approver:** [24]	Don Shivas (Enercon)	Donald	07/21/06
Exelon Reviewer: [25]	PT 8/3	Peter Tamburro	~~8/3/06~~ 9/21/06

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

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

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

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

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DESIGN ANALYSIS NO. C-1302-187-5320-024 **REV:** 002

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

EXELON REVIEWER: Peter Tamburro / P. T.
Print / Sign

DATE: 8/2/06

AmerGen	DOCUMENT NO. C-1302-187-5320-024
TITLE: OC Drywell Ext. UT Evaluation in Sandbed	

REV	SUMMARY OF CHANGE	APPROVAL	DATE
0	Initial Issue	GPU Nuclear Signatures on File	04/16/93
1 ALL PGS. CHANGED. PT	Revised Calculation to clarify methods used to evaluate UT Measurements of the external Drywell Shell. Also, reformatted portions of the calculation to bring it inline with the existing calculation procedure at Oyster Creek Generating Station. ~~Revised or added the following pages: 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 23, 25, 27, 30, 32, 33, 34, 35, 36, 37, 39, 40, 42, 43, and 45.~~ Also added Appendix D, NDE Inspection Sheets A Complete Revision PT 9/21/06 REVISION PERFORMED UNDER ECR# 06-00634. PT	Jeffrey H. Horton Enercon Services Omesh Abhat Enercon Services Don Shivas Enercon Services	07/24/06 07/24/06 07/24/06
	Please Note Originator and Reviewer at the Top of Pages 3 through 117 are associated with Revision 0. Revision 1 originator and Reviewer are documented on page I & above. 9/21/06	Peter Tamburro T. NICKERSON (ACTING MGR. FOR F.H. RAY)	9/21/06 9/21/06

Table of Contents

Section **Page**

PT 9/21/06

PT 9/21/06

1.0 PROBLEM STATEMENT:

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

2.0 SUMMARY OF RESULTS:

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

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

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

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

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

GPU Nuclear

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

SUMMARY OF UT EVALUATIONS
TABLE (2-1)

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

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

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

3.0 REFERENCE:

3.1 Drywell sandbed region pictures (Appendix C).

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

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

3.4 ASME Section III Subsection NE Class MC Components 1989.

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

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

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

4.0 ASSUMPTIONS AND BASIC DATA:

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

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

5.0 DESIGN INPUTS:

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

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

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

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

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

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

R = Inside Radius of the Shell = 420 inches

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

Substituting values in the equation we have:

$$t = \frac{(44.0\text{psig})(420.0'')}{2(19{,}300\text{psi}) - 0.2(44.0\text{psig})} = 0.4789 \text{ inches}$$

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

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

6.0 METHODS OF ANALYSIS:

<u>Development of "Evaluation Thickness"</u>

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

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

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

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

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Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 9 of 117
Originator Mark Yekta **Date** 01/12/93	**Reviewed by** S. C. Tumminelli		**Date**

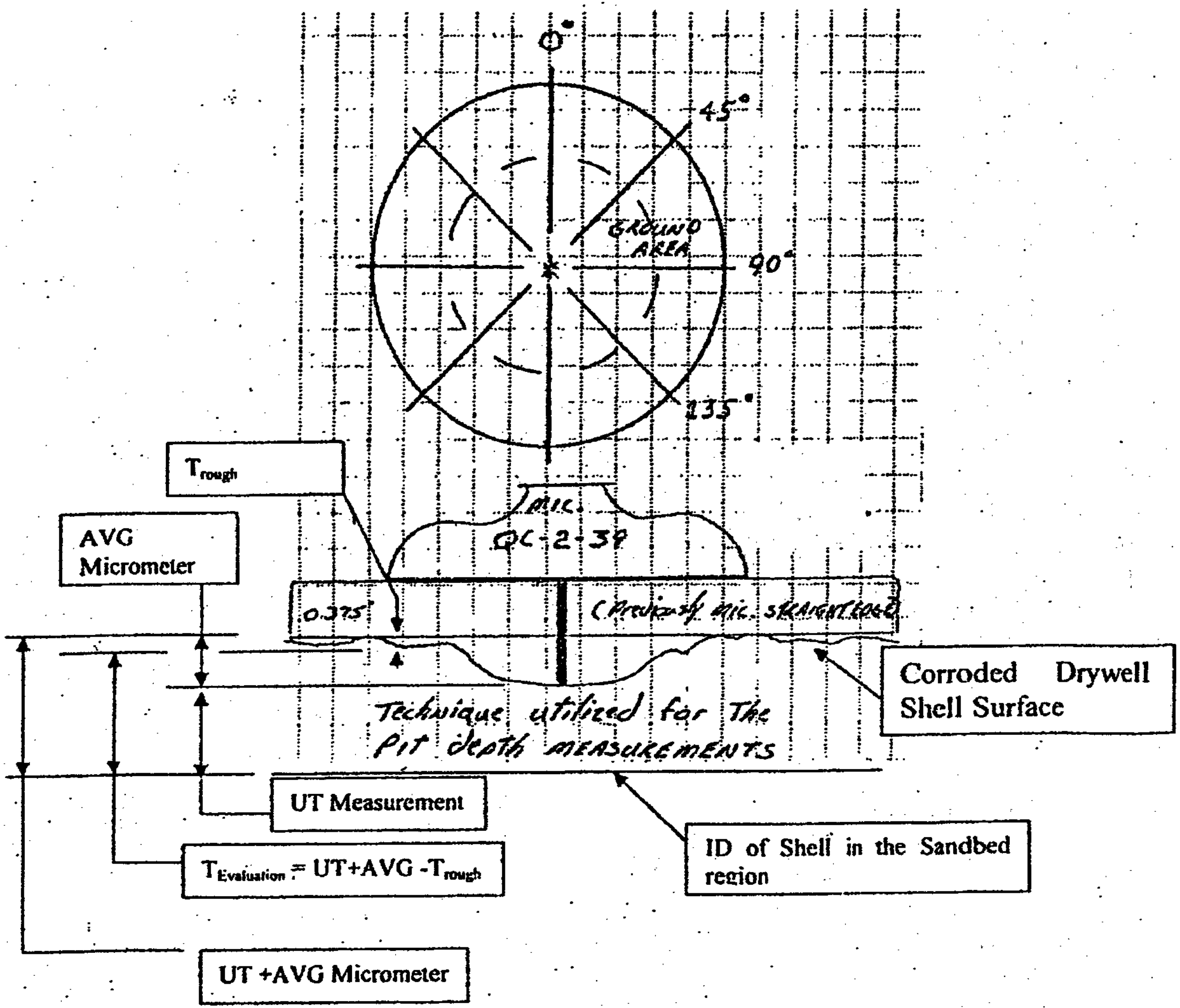

FIGURE 6.1

Sandbed General Wall Criteria:

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

Local Wall Criteria:

If the thickness for evaluation is less than 0.736 inches, then the use of specific GE studies is employed (Ref. 3.5). The studies in Reference 3.5 do not reflect actual drywell shell conditions but are used as assessment tools for areas of the sandbed region that have reduced thicknesses. The methodology used in these studies is provided in reference 3.3 with a excerpt provided here. The studies contain a two step eigenvalue formulation procedure to perform linear elastic buckling analysis of the drywell shell with local areas of reduced thickness. The first step is a static analysis of the structure with all the anticipated loads applied. The structural stiffness matrix, [K], the stress stiffness matrix, [S], and the applied stresses, $\lfloor \sigma_{ap} \rfloor$, are developed and saved from this static analysis. A buckling pass is then run to solve for the lowest eigenvalue or load factor, 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, to the reported result for the 0.536" or a 27% reduction in thickness buckling analysis, a second buckling analysis was performed for a wall thickness reduction of 13.5% or a thickness 0.636 inches over a one square foot area. The results of this case reduced the load factor and theoretical buckling stress by 3.9% in Reference 3.5. The center of the thinned area was located close to the maximum displacement point in the buckling analysis with uniform thickness 0.736" as per Reference 3.5. Again, although this reduction of 13.5% or 0.636 inches is over a 144 square inch area of the shell, the actual surface area including the tapering of the thickness is a 36 by 36 inch or 1,296 square inch area with thicknesses that are below the buckling design thickness. This additional tapered area and its reduced thicknesses also contribute to the 3.9% reduction in load factor stated previously.

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

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

Primary Membrane Plus Bending

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

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

Buckling

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

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

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

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

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

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

7.0 CALCULATIONS:

UT EVALUATION BAY #1:

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

Bay #1 General Wall (Sandbed Region) Thickness Evaluation

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

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

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

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

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

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

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

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

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

<u>Bay 1 AVG Micrometer Calculations</u>
<u>Table 1-a</u>

Location	Azimuth[1]				AVG
	0⁰	45⁰	90⁰	135⁰	
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"

<u>NOTES: 1. AZIMUTH DATA TAKEN FROM APPENDIX D, CALCULATION PAGE 74.</u>

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

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

Average = 0.792"

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

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

Bay #1 Local Wall and Very Local Wall Thickness Evaluation

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

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

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

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

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

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

Remaining Very Local Areas:

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

Conclusion

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

Bay # 1 UT Data
Table 1-b

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

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Summary Of Measurements Below 0.736"
Table 1-c

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

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BAY #1 DATA

NOTES:

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

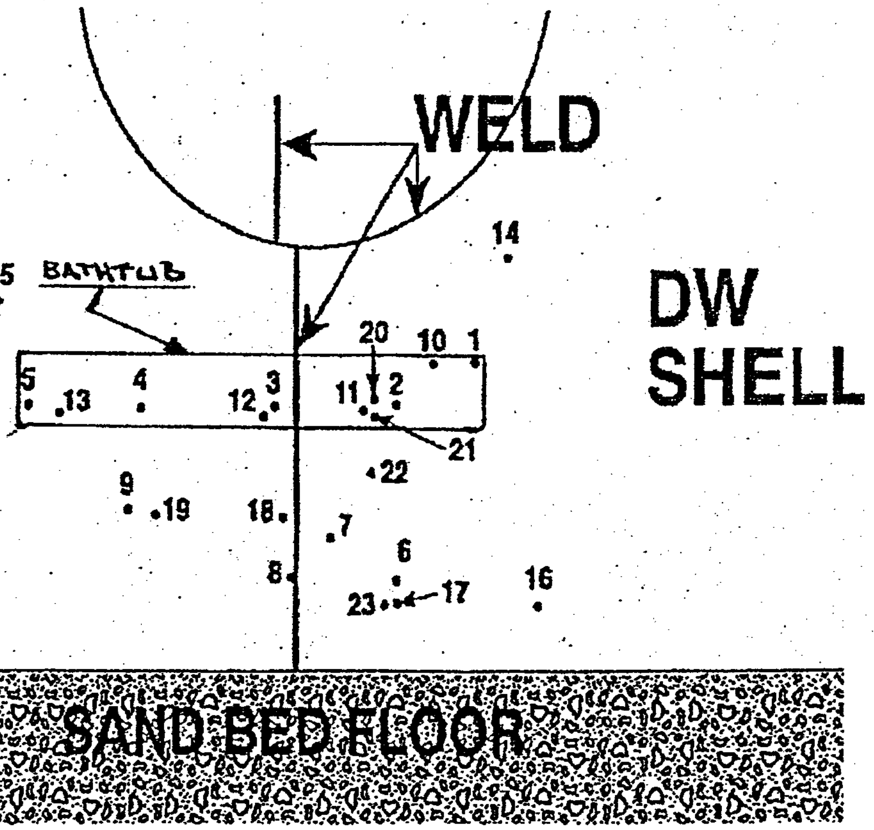

FIGURE (1)

UT EVALUATION BAY #3:

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

Bay #3 General Wall (SandBed Region) Thickness Evaluation

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

Bay # 3 UT Data
Table 3

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

BAY #3 DATA

NOTES:

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

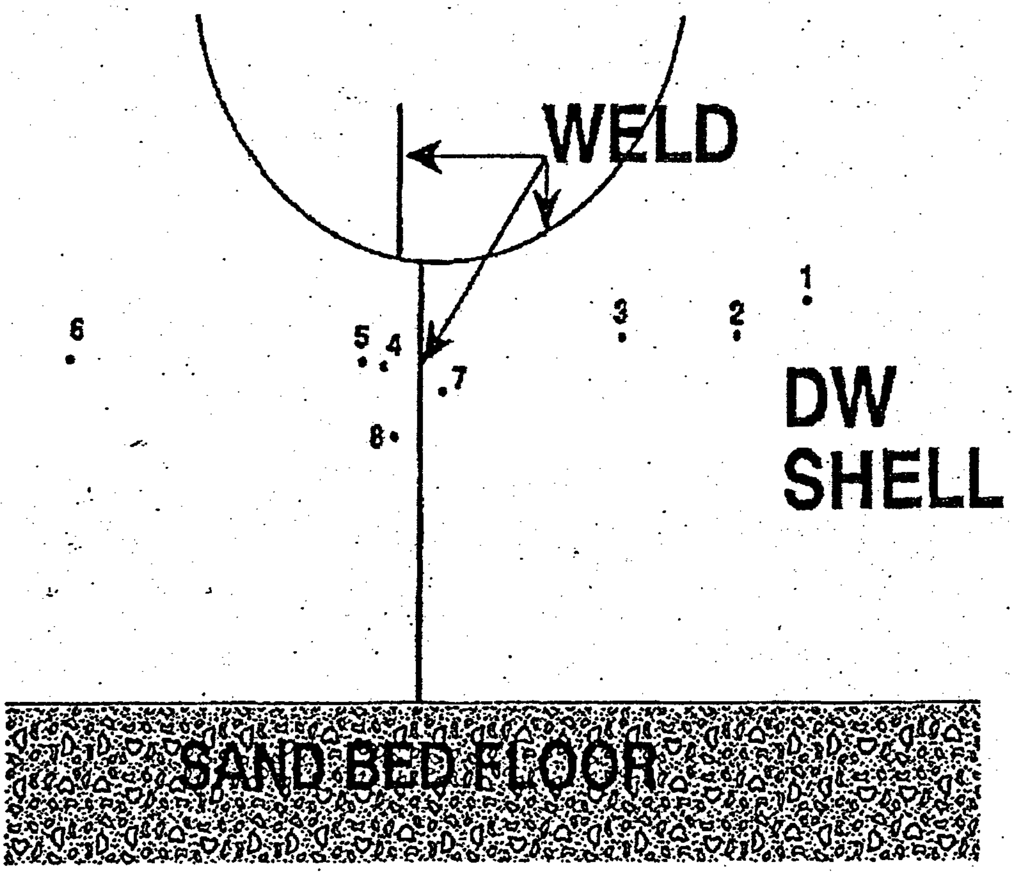

FIGURE (3)

UT EVALUATION BAY #5:

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

Bay #5 General Wall (Sandbed Region) Thickness Evaluation

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

Bay # 5 UT Data
Table 5

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

BAY #5 DATA

NOTES:

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

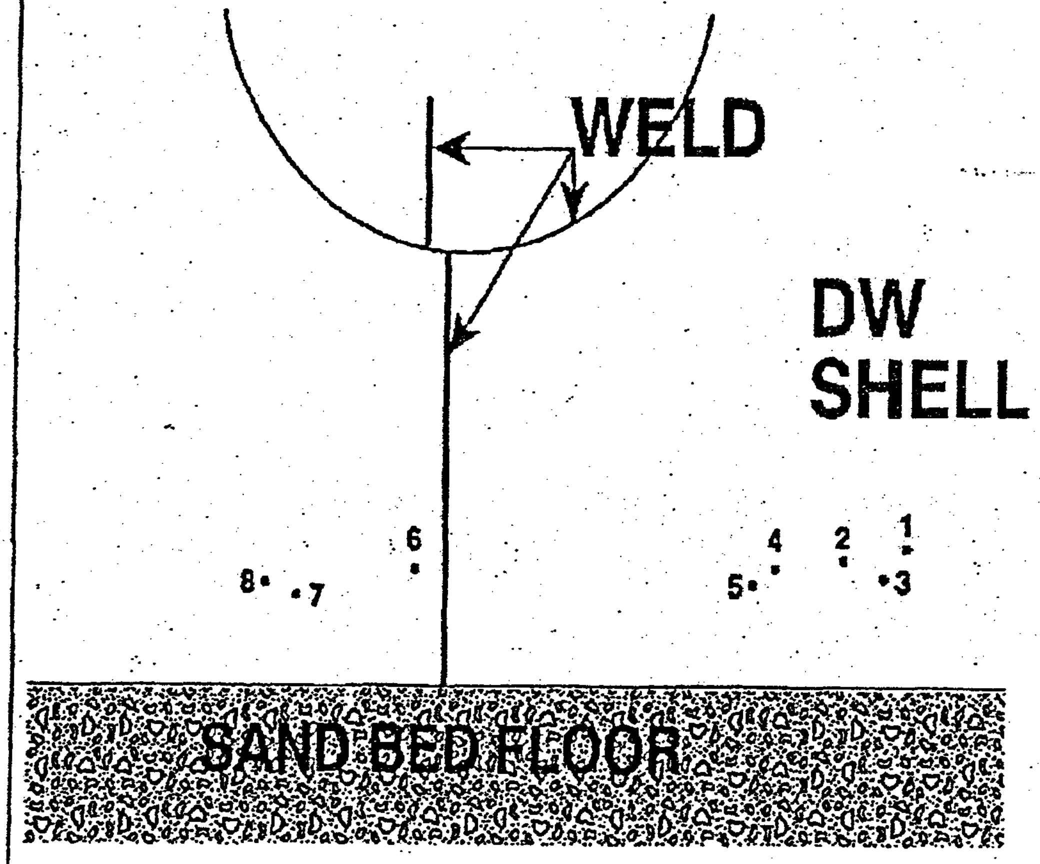

FIGURE (5)

UT EVALUATION BAY #7:

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

Bay #7 General Wall (Sandbed Region) Thickness Evaluation

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

Bay # 7 UT Data
Table 7

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

BAY #7 DATA

NOTES:

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

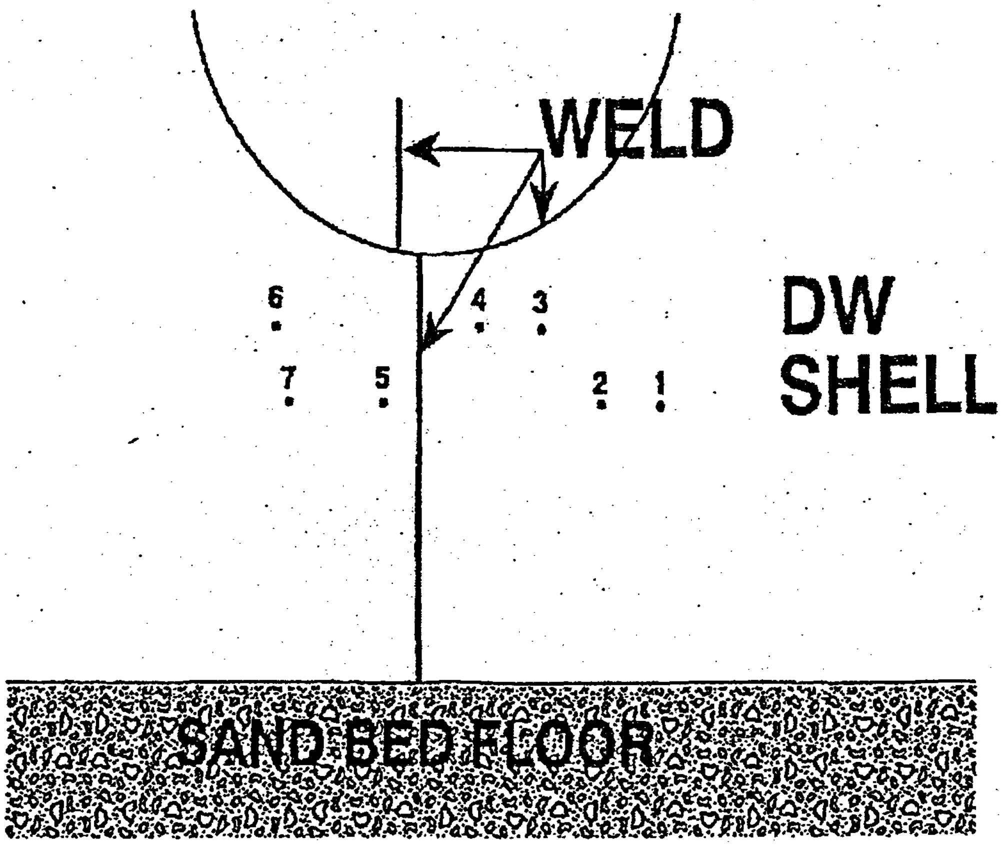

FIGURE (7)

UT EVALUATION BAY #9:

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

Bay #9 General Wall (Sandbed Region) Thickness Evaluation

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

Bay # 9 UT Data
Table 9

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

BAY #9 DATA

NOTES:

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

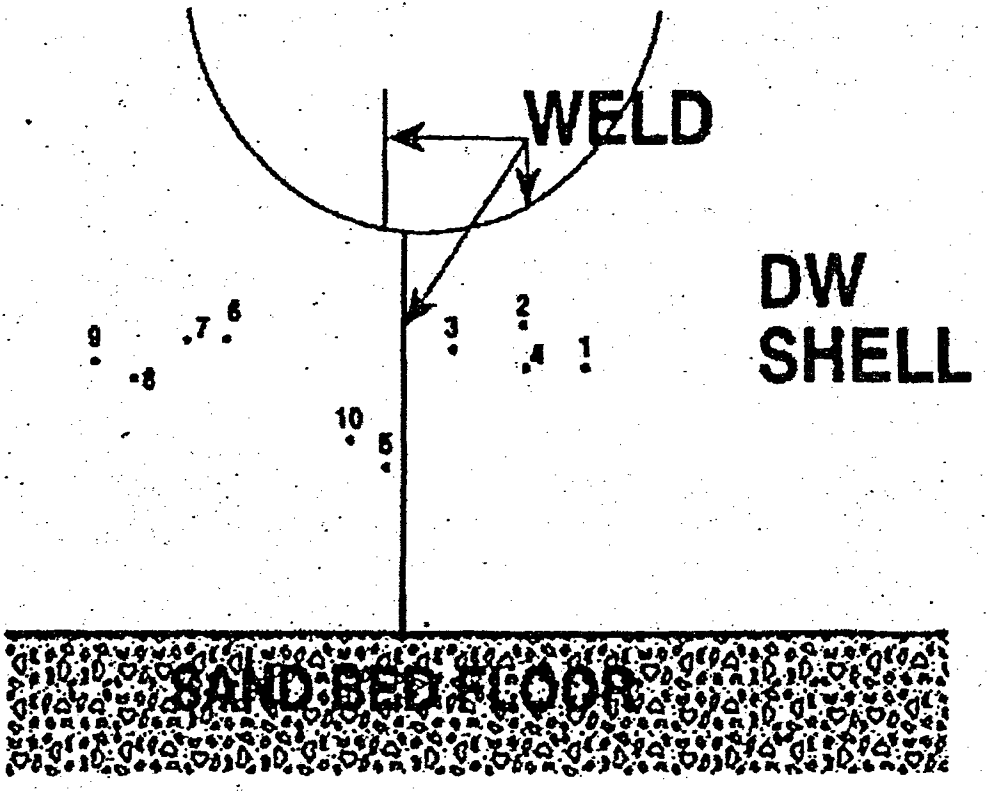

FIGURE (9)

UT EVALUATION BAY #11:

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

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

Bay #11 General Wall (Sandbed Region) Thickness Evaluation

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

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

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

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

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

Bay # 11 UT Data
Table 11-a

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

Summary of Measurements Below 0.736 Inches
Table 11-b

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

BAY #11 DATA

NOTES:

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

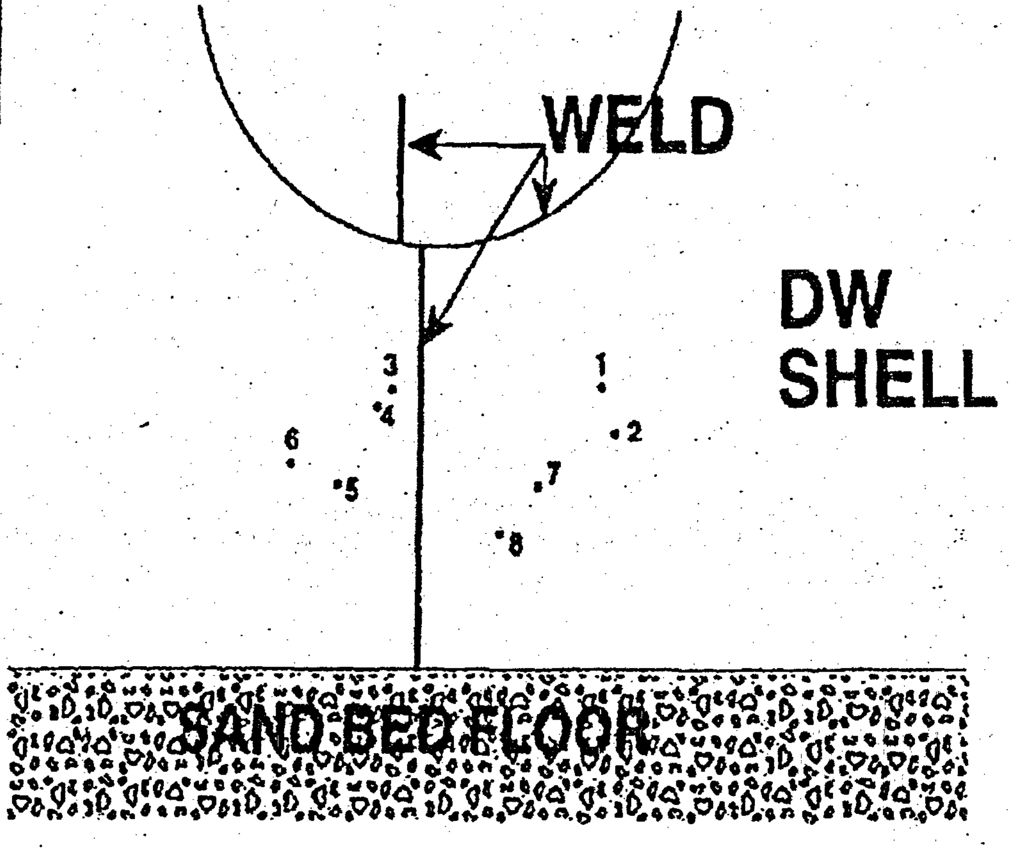

FIGURE (11)

UT EVALUATION BAY #13:

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

Bay #13 General Wall (Sandbed Region) Thickness Evaluation

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

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

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

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

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

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

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

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

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

Bay 13 AVG Micrometer Calculations
Table 13-a

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

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

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

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

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

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

Bay #13 Local Wall Thickness Evaluation

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

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

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

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

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

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

Remaining Very Local Areas:

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

Conclusion

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

Bay # 13 UT Data

Table 13-b

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

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

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

Summary of Measurements Below 0.736 Inches
Table 13-c

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

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. IA or 2A) were located close to the spots in question and were ground carefully to remove minimum amount of metal but adequate enough for UT.
3. Pit depths are average of four readings taken at 0/45°/90°/135° within 1" distance around ground spot. Taken only where remaining wall showed below 0.736".

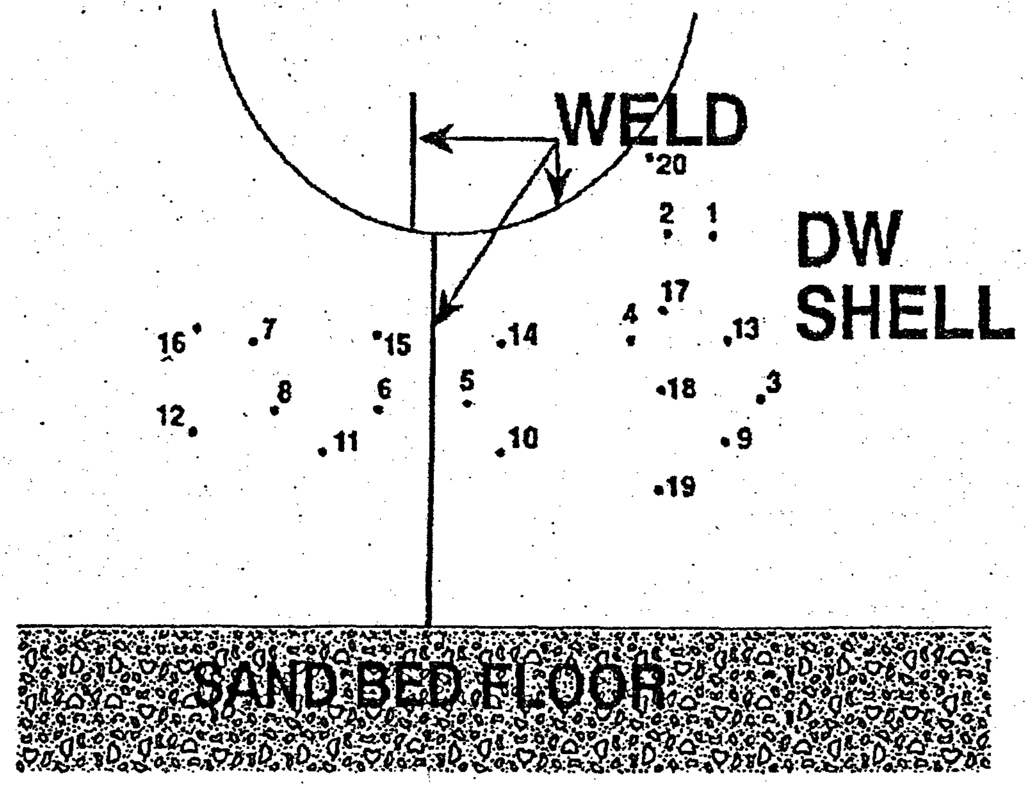

Figure (13)

UT EVALUATION BAY #15:

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

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

Bay #15 General Wall (Sandbed Region) Thickness Evaluation

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

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

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

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

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

Bay # 15 UT Data

Table 15-a

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

Summary of Measurements Below 0.736 Inches
Table 15-b

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

BAY #15 DATA

NOTES:

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

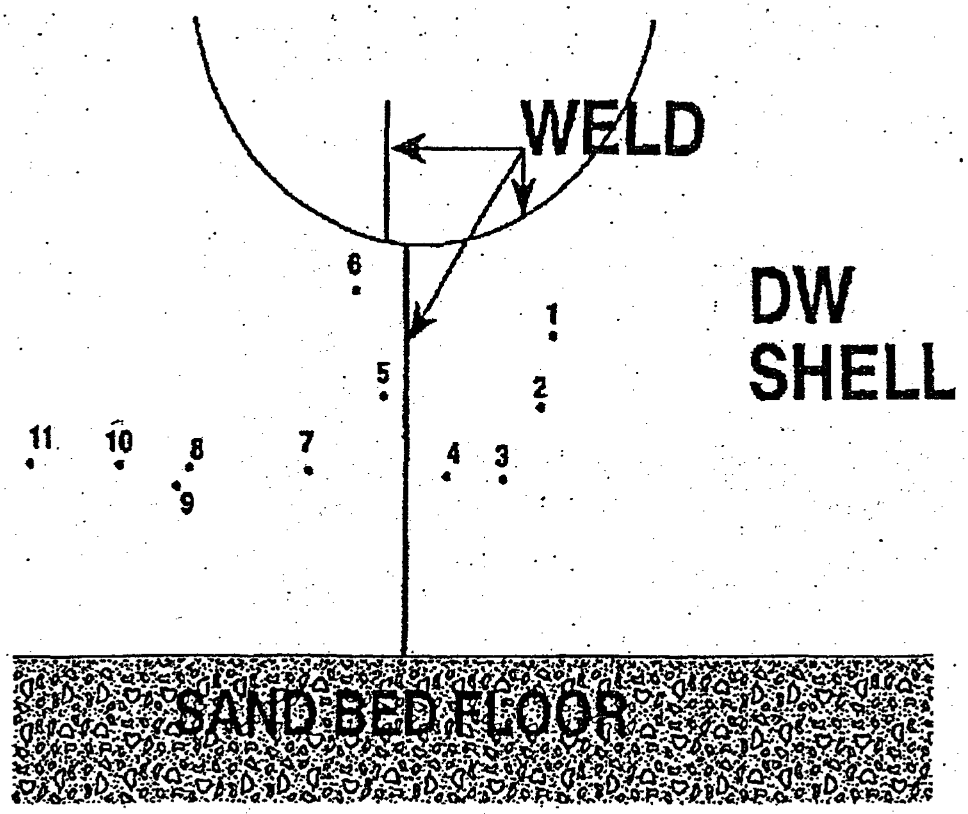

FIGURE (15)

UT EVALUATION BAY #17:

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

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

Bay #17 General Wall (Sandbed Region) Thickness Evaluation

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

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

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

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

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

Bay # 17 UT Data
Table 17-a

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

Summary of Measurements Below 0.736 Inches

Table 17-b

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

BAY #17 DATA

NOTES:

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

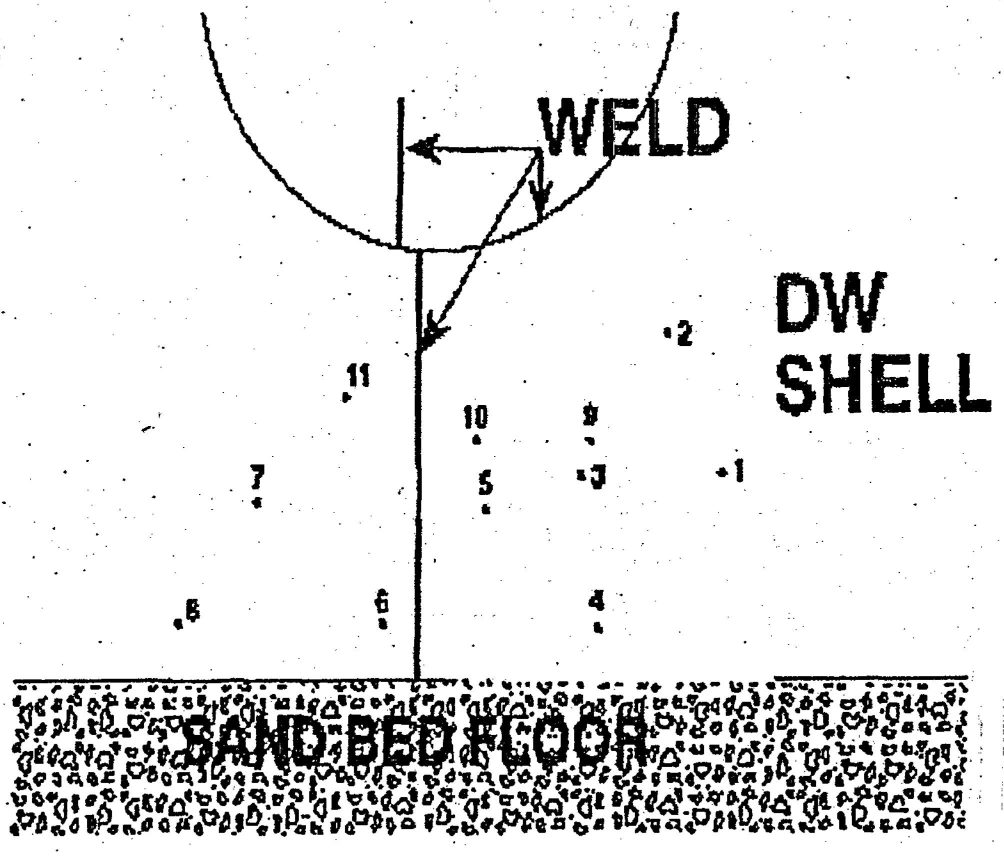

FIGURE (17)

UT EVALUATION BAY #19:

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

Bay #19 General Wall (Sandbed Region) Thickness Evaluation

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

Bay # 19 UT Data
Table 19

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

BAY #19 DATA

NOTES:

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

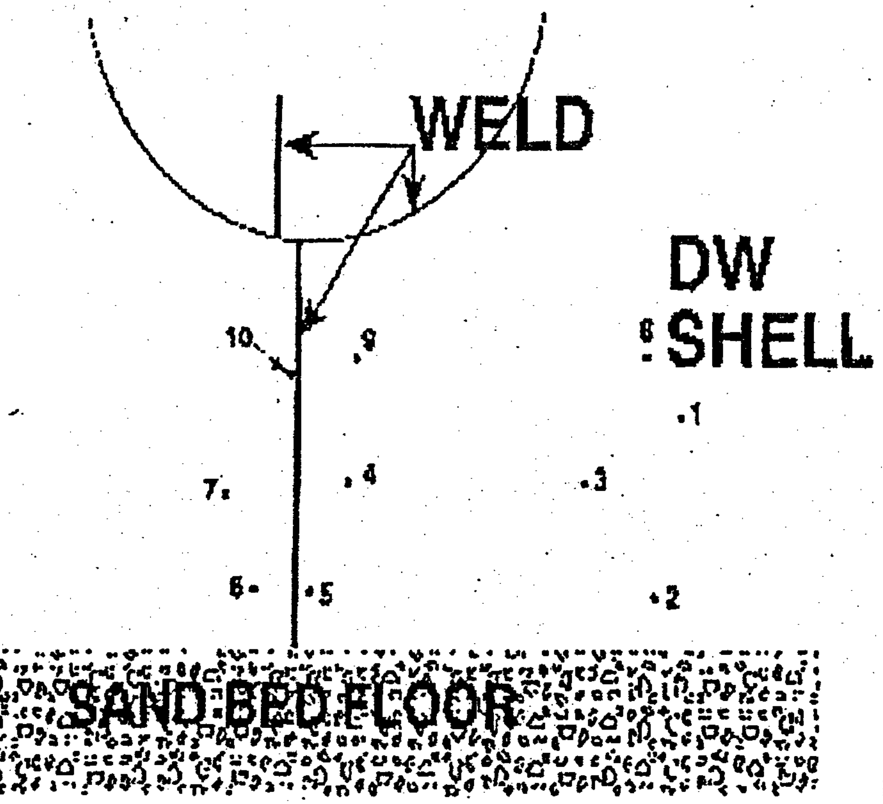

FIGURE (19)

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

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

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

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.

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

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.

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed		**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 53 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli		**Date**

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

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

GPU Nuclear

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

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

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

GPU Nuclear

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

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

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

GPU Nuclear

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

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

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

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

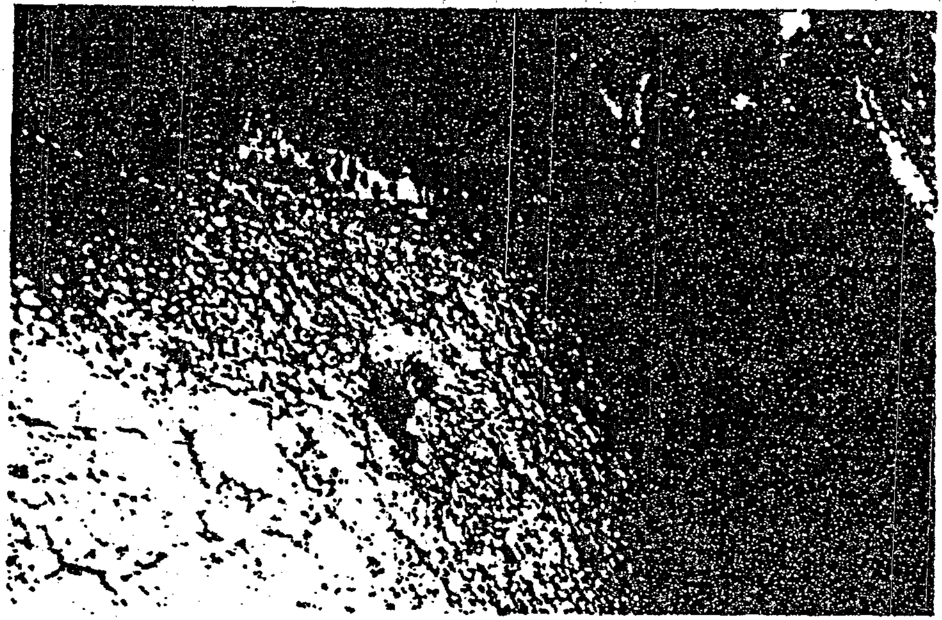
Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	1	58 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli		**Date**

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 20,21,23

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

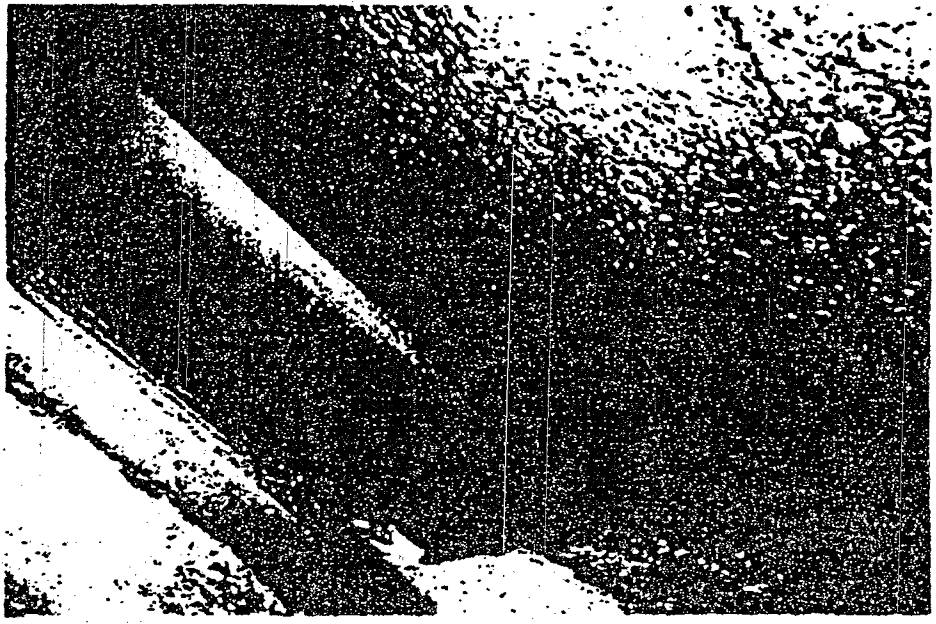
GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	1	61 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli		**Date**

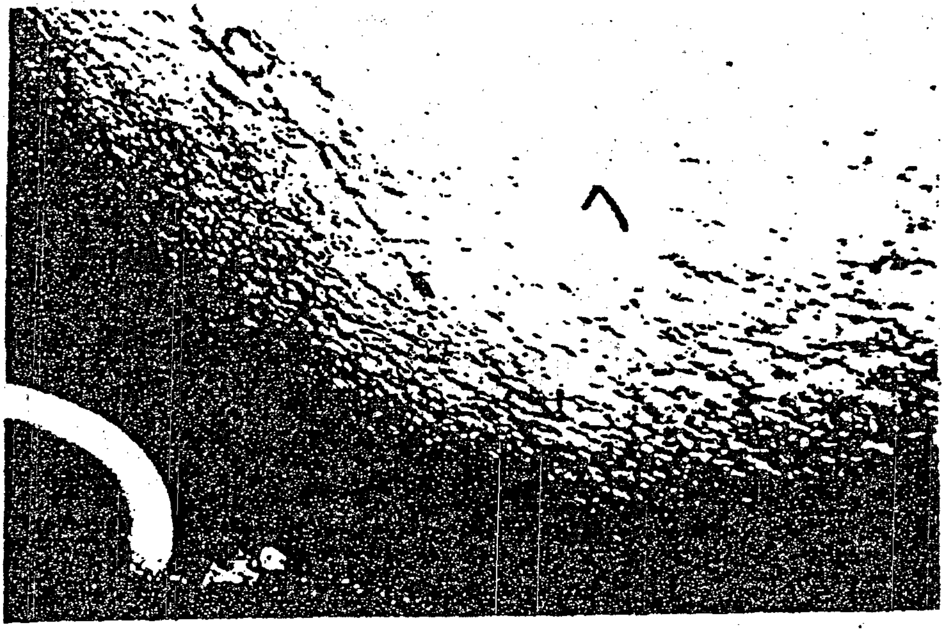
Bay #13 - Looking towards Bay#11 - Upper right corner of D/W shell. Note ① - Grinding depth on UT spot #1 & 2, ② - A part of "Bath Tub Ring" as delineated by marking and ③ locations of UT spots 3,4,13 & 17. The photo on right (although blurred by flash reflection) shows 1/8" projection of plug.

GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	1	62 of 117
Originator	**Date**	**Reviewed by**		**Date**
Mark Yekta	01/12/93	S. C. Tumminelli		



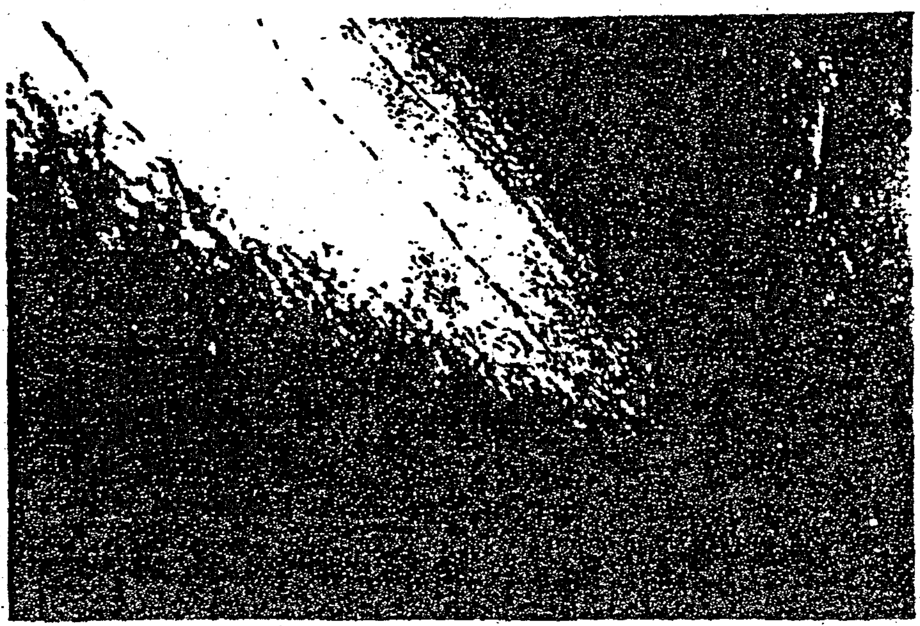
Bay #15 Looking towards Bay#17 which has been closed with foam for coating work in Bay #17. Note the typical surface of the D-W shell and localized corroded spot



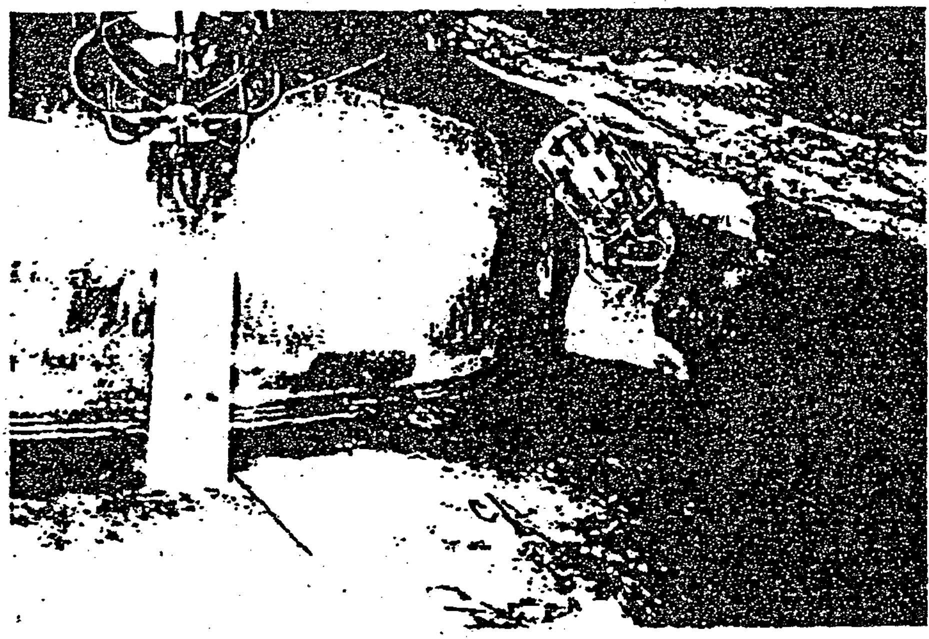
Bay #13 - Looking toward Bay #15 - Lower left corner showing UT spot #7,12 & 16. This close up has captured the peaks and valleys of the corroded shell in vivid detail. Later NDE inspection revealed depth between peaks and valleys in the 0.25" - 0.40"

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed		**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 63 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli		**Date**



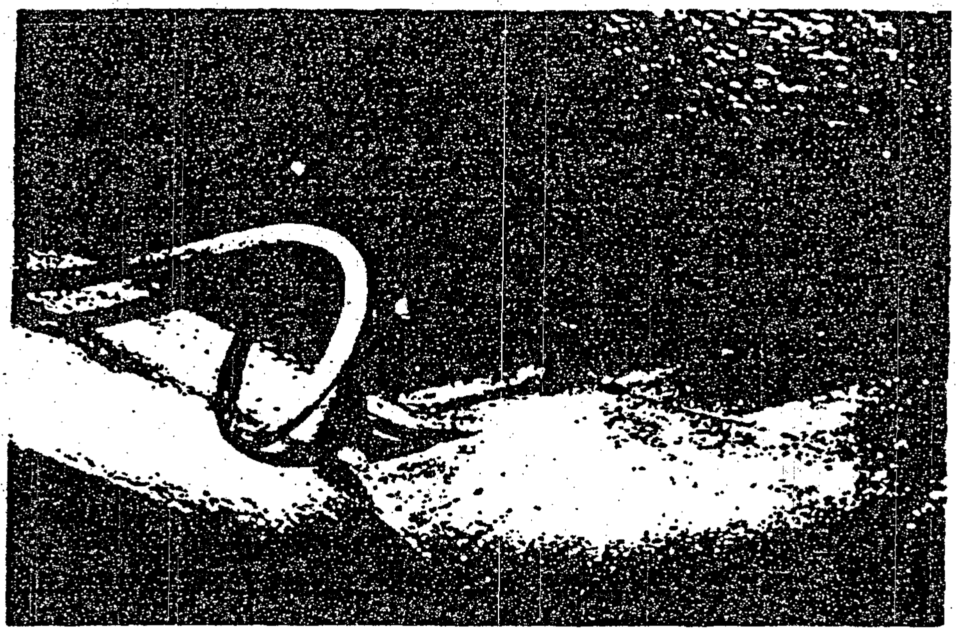
Bay #15 Looking toward Bay #13 showing portions of D/W shell and concrete floor, after removal of loose debris / sand / rust. The concrete floor in this bay is one of the better ones. However - Note (1) no drainage channel and (2) cratered holes near shell corner



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

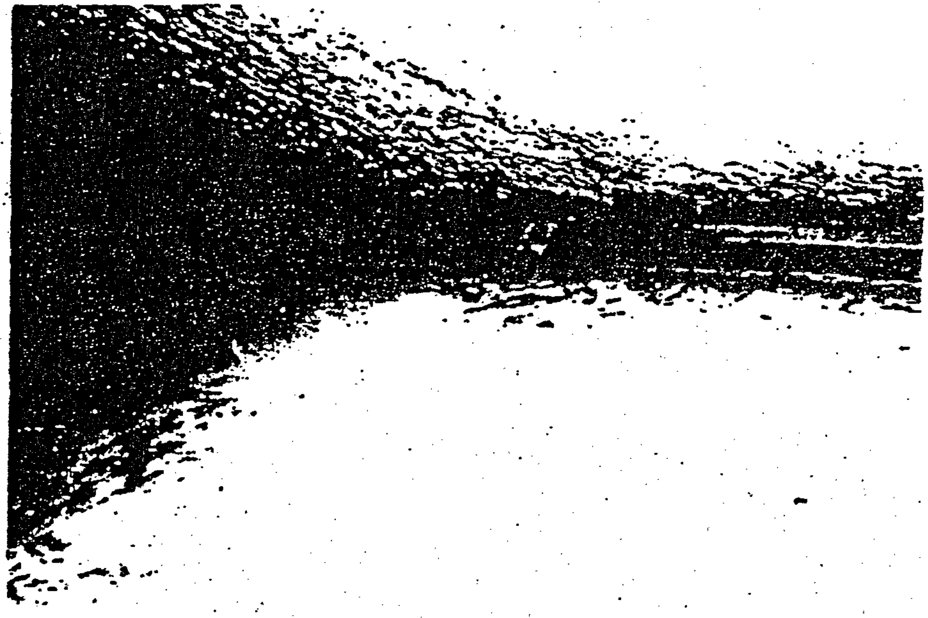
Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	1	64 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli		**Date**

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

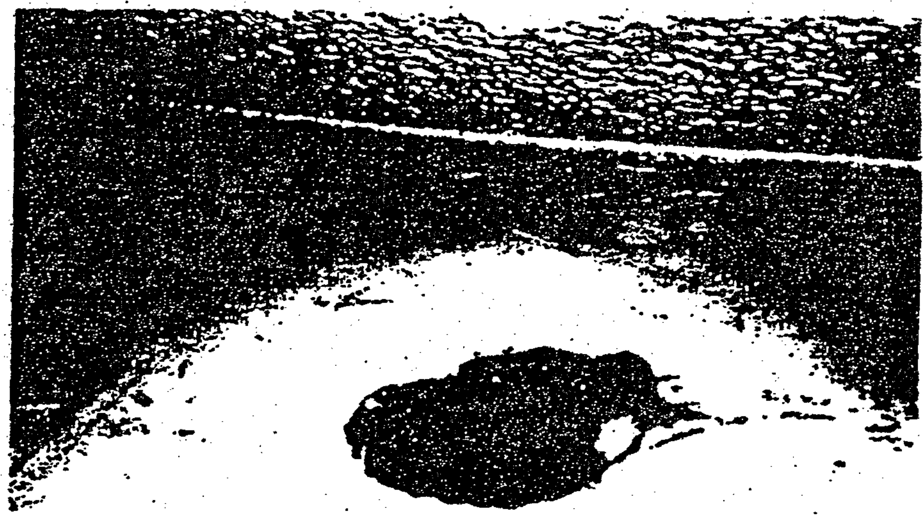


Bay #13 - Looking toward Bay #15 - This photo captures the concrete floor condition and a portion of lower shell corroded surface in very great detail. The floor in this area

Subject O.C. Drywell Ext. UT Evaluation in Sandbed		**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 65 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli		**Date**



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



Drain after floor has been refurbished

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed		**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 66 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli		**Date**

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

GPU Nuclear

NDE Request
Oyster Creek

QC Charge No. 5514-57367

Request No. 92-075

1 To be filled in by Requestor

Job Order No.	Short Form No.	BA No. 322245	Date of Request

Job Description UT THICKNESS OF DW LINER

System:

Job Location SAND BED AREA

Applicable Code/Specification [illegible]

Type of NDE requested:

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

NDE Requested by: J SLITER FOR

Phone No.:

Date 12-5-92

Remarks JOHN FLYNN

2 To be filled in by NDE Coordinator

NDE Coordinator J SLITER

Date

Instructions

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

Remarks

Results ☒ Accept Reject Info Only	MNCR #'s open/close/cond. rel. N/A	Proc. No. Proc. No. Proc. No.
		Job start date / Job stop date
	NDE Coordinator	Date Closed [illegible] / Date to DCC

Yellow - Originator Final Copy
Pink - NDE Field Work Copy
Gold - Originators Initial Copy

N60892 (03-87)

GPU Nuclear

Oyster Creek - QC

NDE/ISI Report Log

Page ____ of ____

NDE Req. #: 92-072

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

System/Location: ________

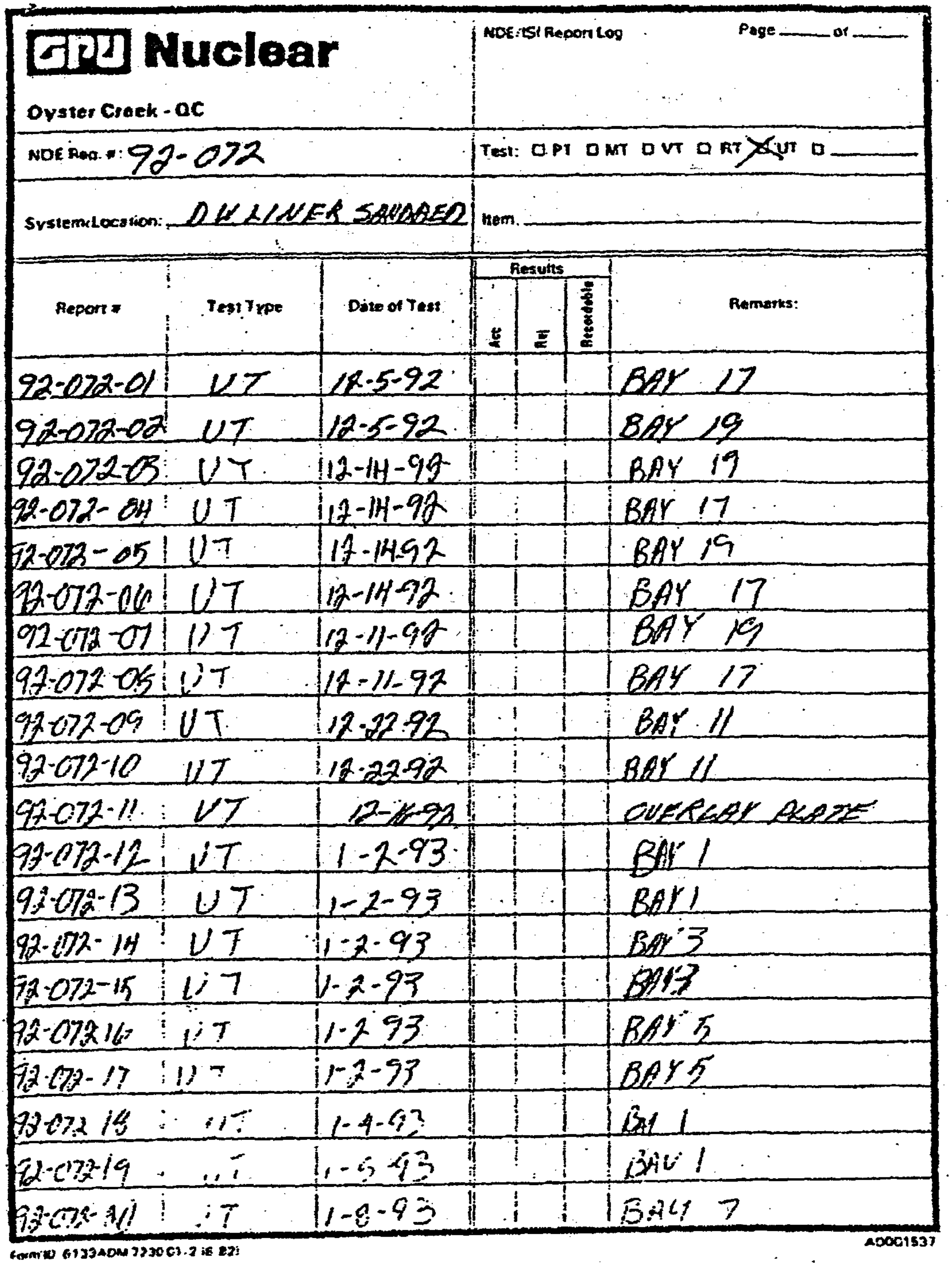
Item: ________

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

Form ID 6133ADM 7230.01-2 (4 82)

A0001537

Subject O.C. Drywell Ext. UT Evaluation in Sandbed		**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 69 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli		**Date**



GPU Nuclear

Oyster Creek - QC

NDE/ISI Report Log

Page ____ of ____

NDE Req. #: 92-072

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

System/Location: DW LINER SANDBED

Item: ______

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

Form ID 6133ADM 7230 01-2 (6 82)

A0001537

Program	* Xducer	Screen	Digital
1	5 mhz 3/4" Single H31900 (SP)	2"	2"
2	2.25 mhz 3/4" Single F28932	2"	2"
3	2 mhz MSEB MC8524	2"	2"
4	5 mhz bubbler water delay	2" delayed	2" delayed
5	5 mhz bubbler water delay	2" SYNC SCREEN	NONE
6	5 mhz bubbler water delay	2" SYNC. SCREEN	2"
7	5 mhz 3/4" single H31900(SP)	1"	1"
8	2 mhz MSEB MOE524	1"	1"
9	5 mhz 1/4" delay GD0504 single	2"	NONE
10	5 mhz 1/4" dual 014252	1"	1"
11	5 mhz 1/4" dual 014252	2"	2"

Jamie for your info.

GPU Nuclear — Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2	Class: N/A	Item: N/A	NDE Request: 92.072	Data Sheet No.: 92072-12
Task Description: UT Thickness			Task No.: N/A	Date: 1/2/93
Comp. Desc.: Drywell Liner	System: 187		Code/Spec.: ENG INFER.	
Procedure/Rev.: 6100-QAP-7209.07 Rev 0		Drawing No./Rev.: 3E-187-29-001 Rev 0		
Test Surface: O.D		Thickness: 1 1/8"	Material: C/S	
Examiner	Sign:	Print: J. VanderLinde	ID No.: 154-48-0319	Level: II
Examiner	Sign: Mark	Print: Mark F Bugnell	ID No.: 553-64-1862	Level: I

Thermometer S/N 88-001 Part Temperature 22 F D-Meter S/N 92-055

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

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

Calibration Readings (inches)

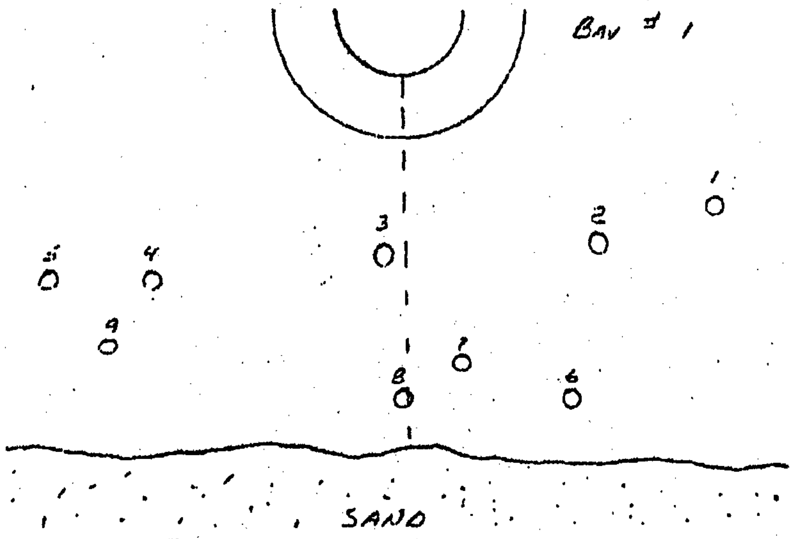
Cal. Blk.	.5	.75	1.0	1.25	1.5	N/A
D-Meter	.5	.75	1.0	1.25	1.5	

Techniques

☐ CRT ☒ D-Meter

Other N/A

Position #/Reading in Inches



Drawing

	AREA		MEASUREMENT
1	0-16"	R30"	.720"
2	0-22"	R17"	.710"
3	0-23"	L3"	.705"
4	0-24"	L33"	.700"
5	0-24"	L45"	.710"
6	0-48"	R16"	.700"
7	0-39"	R5"	.700"
8	0-48"	0"	[illegible]
9	0-36"	L36"	.605"

Reviewed by: Steve McCaulla Level: III Date: 1-3-93 Page 1 of 91

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 72 of 117
Originator Mark Yekta **Date** 01/12/93	**Reviewed by** S. C. Tumminelli		**Date**

GPU Nuclear

Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A

Item: N/A

NDE Request: 92-072

Data Sheet No.: 92-072-13

Task Description: UT Thickness

Task No.: N/A

Date: 1/2/93

Comp. Desc.: Drywell Liner

System: 187

Code/Spec.: Fnl Infor

Procedure/Rev.: 6100-QAP-7209.07 Rev. 0

Drawing No./Rev.: 3E-187-29-001 Rev. 0

Test Surface: O.D.

Thickness: 1 1/8"

Material: C/S

Examiner	Sign:	Print: J. VanderLinde	ID No.: 154-48-0318	Level: II
Examiner	Sign: Mark F. Bagnell	Print: Mark F. Bagnell	ID No.: 353-50-1806	Level: I

Thermometer S/N 86-061 Part Temperature 22 F D-Meter S/N 137-113

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

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

Calibration Readings (Inches)

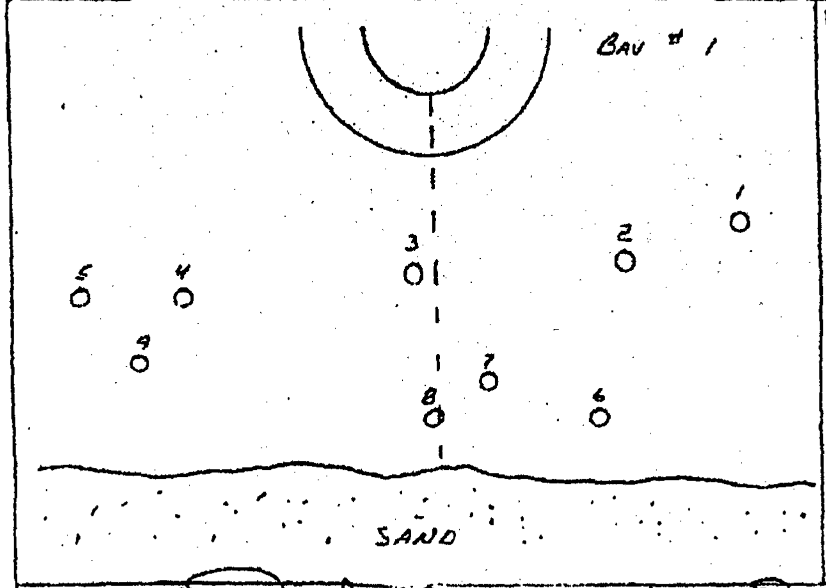
Cal. Blk.	.5	.75	1.0	1.25	1.5	N/A
D-Meter	.5	.75	1.0	1.25	1.5	

Techniques

☒ CRT ☐ D-Meter

Other N/A

Position #/Reading In Inches



Drawing

	AREA		MEASUREMENT
1	0-16°	R 30°	.744"
2	0-22°	R 17°	.710"
3	0-23°	L 3°	.692"*
4	0-24°	L 33°	.750"
5	0-24°	L 45°	.694"*
6	0-48°	R 16°	.766"
7	0-39°	R 5°	.696"*
8	0-45°	0°	.741"
9	0-36°	L 38°	.755"

Reviewed by:

Level: III

Date: 1-3-93

Page 21 of 81

2 Points, under

GPU Nuclear Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A Item: N/A NDE Request: 92-072 Data Sheet No. 92-072-18

Task Description: UT THICKNESS Task No.: N/A Date: 1 4 93

Comp. Desc.: DRYWELL LINER Bay 1 System: 187 Code/Spec.: ENG. INFO.

Procedure/Rev.: 6100-QAP-7209 07 REV. 0 Drawing No./Rev.: 3E-187-29-001

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

Examiner Sign: Print: Joel Mandelcorn ID No.: 153-48-0336 Level: II

Examiner Sign: Mark F. Print: Mark F. Bagnell ID No.: 553-61-1662 Level: I

Thermometer S/N 92-068 Part Temperature 76° F D-Meter S/N 92-036

Cal. Blk. S/N INV 219 Cal. In: N/A AM 23:11 PM

Cal. Blk. Temp. 76° F Cal. Out: N/A AM 23:24 PM

Calibration Readings (Inches)

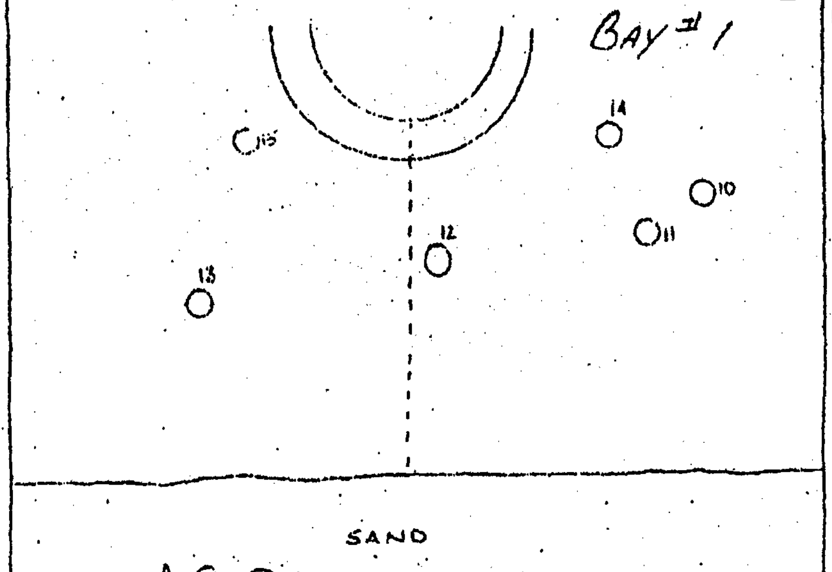
Cal. Blk.	.5	.75	1.0	1.25	1.5	N/A
D-Meter	.5	.75	1.0	1.25	1.5	

Techniques

☐ CRT ☒ D-Meter

Other N/A

Position #/Reading in Inches



Drawing

	AREA		MEASUREMENT
10	D 14"	R 23"	.653"
11	D 23"	R 12"	.711"
12	D 24"	L 5"	.724"
13	D 24"	L 40"	.792"
14	D 2"	R 30"	1.147"
15	D 8"	L 51"	1.156"

NOTE ADDITIONAL READINGS TAKEN FOR CONFORMATION OF PREVIOUS INSPECTION

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

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 74 of 117
Originator Mark Yekta **Date** 01/12/93	**Reviewed by** S. C. Tumminelli		**Date**

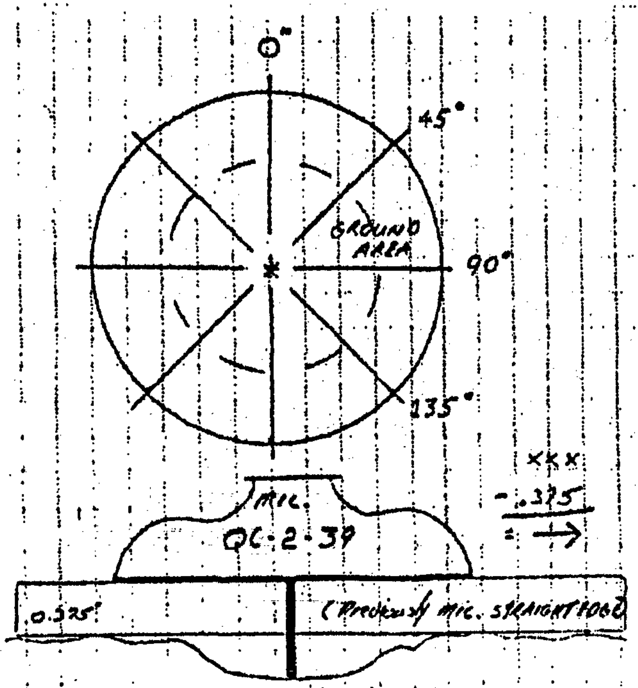
GPU Nuclear

☒ OC ☐ TMI ☐ OTHER ____________

Sketch Form (with grid)

Component: DRYWELL liner SANDBED AREA	Data Sheet No.: 92-072-28		
Location: BAY # 1	Drawing No.: N/A	Rev.: N/A	

Drawing



Technique utilized for The pit depth MEASUREMENTS

AZIMUTH

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

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

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

one part under

GPU Nuclear — Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A	Item: N/A	NDE Request: 92-072	Data Sheet No.: 92-072-F1
Task Description: UT THICKNESS		Task No.: N/A	Date: 1-5-93
Comp. Desc.: DRYWELL LINER Bay 1	System: 187		Code/Spec.: ENG. INFO.
Procedure/Rev.: 6000 QAP 7209.07 REV. 0		Drawing No./Rev.: 3E-187-26-001 REV. 0	
Test Surface: O.D.		Thickness: 1 1/8"	Material: C. S.
Examiner Sign:	Print: Toni Marchese	ID No.: 154-40-6399	Level: II
Examiner Sign: Mark	Print: Mark C. Bagnell	ID No.: 553-61-1812	Level: I

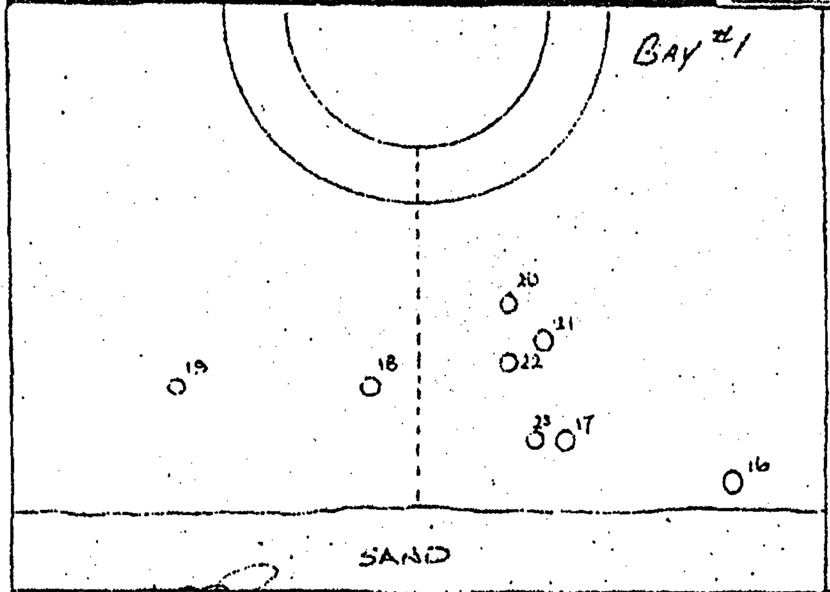
Thermometer S/N 86-081 Part Temperature 72° F D-Meter S/N 90-050
Cal. Blk. S/N INV 214 Cal. In: N/A AM 12:42 PM
Cal. Blk. Temp. 72° F Cal. Out: N/A AM 12:55 PM

Calibration Readings (Inches)

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

Techniques
☐ CRT ☒ D-Meter
Other N/A

Position #/Reading in Inches



Drawing

	AREA		MEASUREMENT
16	D 50"	R 40"	.796"
17	D 48"	R 16"	.860"
18	D 38"	L 2"	.917"
19	D 38"	L 24"	.896"
20	D 18"	R 13"	.965"
21	D 24"	R 15"	.726" *
22	D 52"	R 13"	.852"
23	D 48"	R 15"	.850"

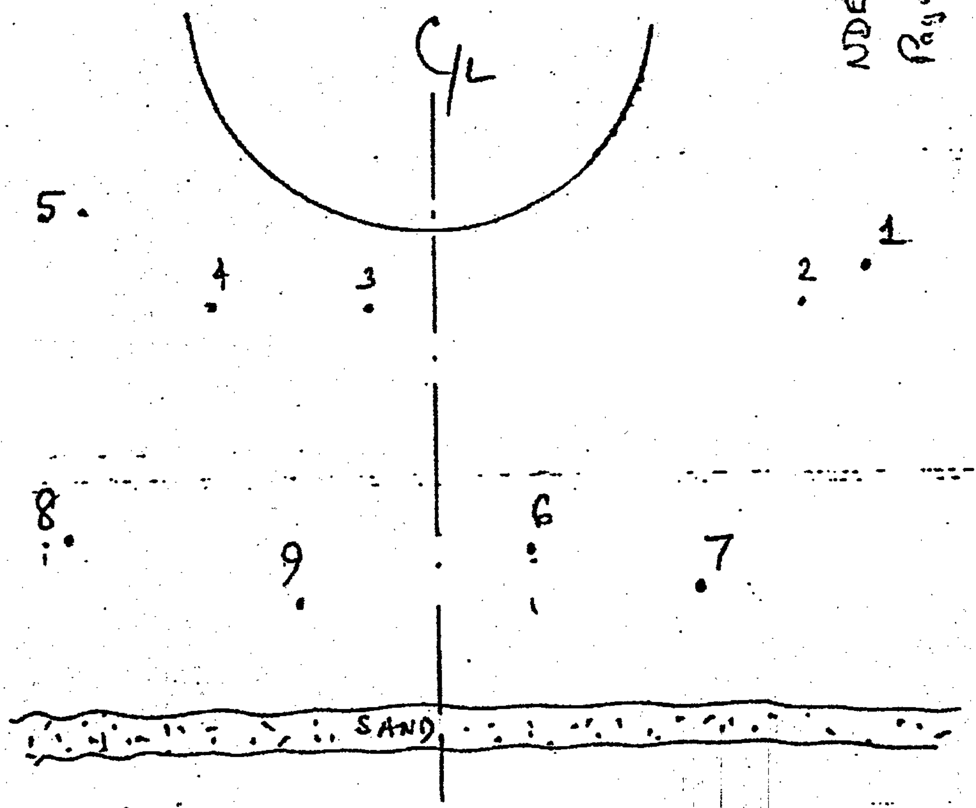
Reviewed by: | Level: II | Date: 1-6-93 | Page 1 of 1

N5488 (05-89)

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	Calc No. C-1302-187-5320-024	Rev. No. 1	Sheet No. 76 of 117
Originator Mark Yekta — Date 01/12/93	Reviewed by S. C. Tumminelli		Date

NDE REQ 92.072
Page 3 of 9



INSPECTION SPOTS FOR UT
BAY #1

NOTE:

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

GPU Nuclear

Subject	Date	Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	1	77 of 117
Originator Mark Yekta	01/12/93	**Reviewed by** S. C. Tumminelli		**Date**

GPU Nuclear

Ultrasonic Thickness Data Sheet

☑ OC ☐ TMI-1 ☐ TMI-2	Class: N/A	Item: N/A	NDE Request: 92-072	Data Sheet No.: 92-072-14
Task Description: UT Thickness			Task No.: 010	Date: 1/2/93
Comp. Desc.: Drywell Liner	System: 187		Code/Spec.: FIN. INFO.	
Procedure/Rev.: 6100-QAP 7209.02 Rev. 0		Drawing No./Rev.: 3E-187-24-001 Rev 0		
Test Surface: O.D.		Thickness: 1 1/8"	Material: C/S	
Examiner	Sign:	Print: J. Malcolm Linde	ID No.: 177-48-0319	Level: II
Examiner	Sign: Mark	Print: Mark F. Bagnell	ID No.: 553-61-1662	Level: I

Thermometer S/N 65-061 Part Temperature 72 F D.Meter S/N 92-0325

Cal. Blk. S/N 214 Cal. In: N/A AM 21:15 PM

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

Calibration Readings (Inches)

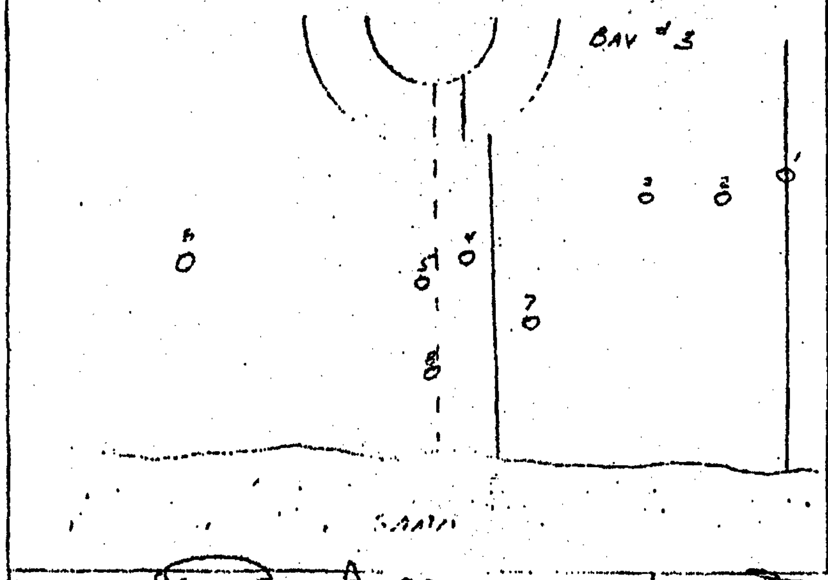
Cal. Blk.	.5	.75"	1.0	1.25"	1.5"	N/A
D-Meter	.5"	.75"	1.0	1.25"	1.5"	

Techniques

☐ CRT ☒ D-Meter

Other N/A

Position #, Reading In Inches



Drawing

	AREA			Measurement
1	0-5"	R	63	.795"
2	0-9"	R	50	1.00"
3	0-9"	R	33	.857"
4	0-13"	L	5	.898"
5	0-15"	L	8	.823"
6	0-15"	L	56	.966"
7	0-17"	R		.826"
8	0-24"	L		.780"

Reviewed by: Stan McCauley Level: III Date: 1-3-93 Page 4 of 21

GPU Nuclear

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

RB 4005

GPU Nuclear

Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A	Item: N/A	NDE Request: 92-072	Data Sheet No. 92-072-15
Task Description: UT Thickness		Task No.: N/A	Date: 1/2/93
Comp. Desc.: Drywell Liner	System: 187		Code/Spec.: Eng. Info. R.
Procedure/Rev.: 6100-QAP-7209.02 Rev. 0		Drawing No./Rev.: 3E-187-29-001 Rev. 0	
Test Surface: O.D.		Thickness: 1 1/8"	Material: C/S
Examiner Sign:	Print: J. VanDer Linde	ID No.: 157-48-0218	Level: II
Examiner Sign: Mark R	Print: Mark T. Bagnell	ID No.: 555-51-1862	Level: II

Thermometer S/N 83-001 Part Temperature 72 F D-Meter S/N 137-115

Cal. Blk. S/N 214 Cal. In: N/A AM 11:18 PM

Cal. Blk. Temp. 72 F Cal. Out: N/A AM 11:45 PM

Calibration Readings (Inches)

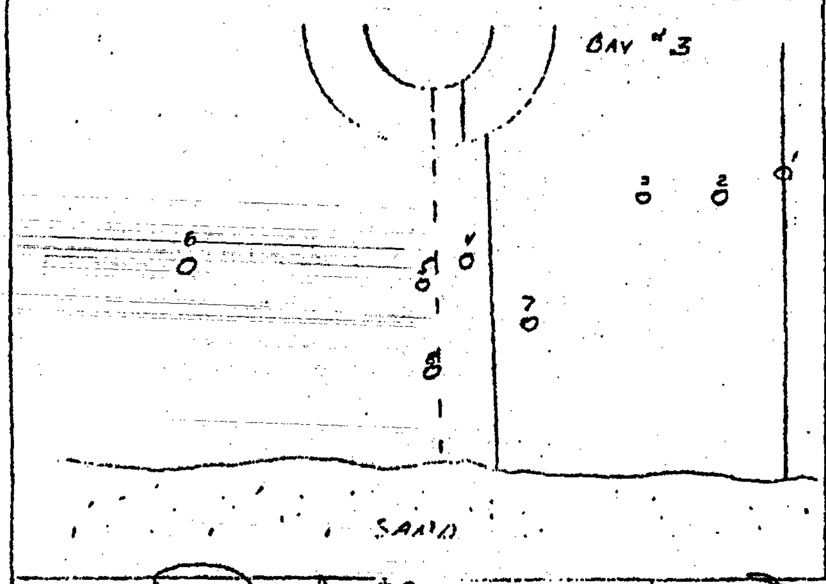
Cal. Blk.	.5"	.75"	1.0	1.25"	1.5"	N/A
D-Meter	.5"	.75"	1.0	1.25	1.5"	

Techniques

☒ CRT ☐ D Meter

Other N/A

Position # Reading In Inches



Drawing

	AREA	Measurement
1	0-5" R-63	.850"
2	0-9" R-50	[illegible]"
3	0-9" R-33	.800"
4	0-13" L-5	.900"
5	0-15" L-8	.840"
6	0-15" L-56	[illegible]"
7	0-17" R	.840"
8	0-24" L	.790"

Reviewed By: A. M

Level: III

Date: 1-3-93

Page 61 of 91

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	Calc No. C-1302-187-5320-024	Rev. No. 1	Sheet No. 79 of 117
Originator Mark Yekta	Date 01/12/93	Reviewed by S. C. Tumminelli	Date

GPU Nuclear

Ultrasonic Thickness Data Sheet

☑ OC ☐ TMI-1 ☐ TMI-2 Class: N/A	Item: N/A	NDE Request: 92-072	Data Sheet No. 92-012-15
Task Description: UT Thickness		Task No.: N/A	Date: 1/2/93
Comp. Desc.: Drywell Liner	System: 187		Code/Spec.: Eng. Inform
Procedure/Rev.: 6100-QAP 7209.02 Rev. 0		Drawing No./Rev.: 3E-187-29-001 Rev. 0	
Test Surface: O.D.		Thickness: 1 1/8"	Material: C/S
Examiner Sign:	Print: J. VanDeLinde	ID No.: 154-48-0318	Level: II
Examiner Sign: Mark	Print: Mark C. Bagnell	ID No.: 353-60-1862	Level: I

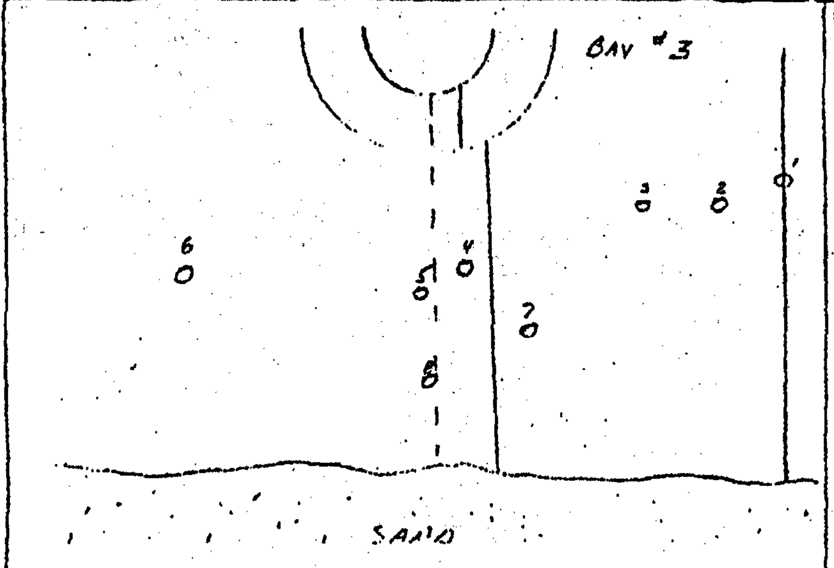
Thermometer S/N 83 001 Part Temperature 72 F D-Meter S/N 127-113
Cal. Blk. S/N 2-4 Cal. In: N/A AM 11:18 PM
Cal. Blk. Temp. 72 F Cal. Out: N/A AM 11:45 PM

Calibration Readings (inches)

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

Techniques
☒ CRT ☐ D Meter
Other N/A

Position # Reading in Inches



Drawing

	AREA		MEASUREMENT
1	0-5"	R-63	[illegible]"
2	0-9"	R-50	.660"
3	0-9"	R-33	.860"
4	0-13"	L-5	.900"
5	0-15"	L-8	.840"
6	0-15"	L-56	.660"
7	0-17"	R-	.840"
8	0-24"	L-	.790"

Reviewed By: [illegible] Level: III Date: 1-3-93 Page 61 of 71

GPU Nuclear Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A Item: N/A NDE Request: 92-072 Data Sheet No.: 92-072-16

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

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

Procedure/Rev.: 6100-QAP-7209.03 Rev. 0 Drawing No./Rev.: 3E-187-20-001 Rev. 0

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

Examiner Sign: Print: J. Chuck Linde ID No.: 157-48-0319 Level: II

Examiner Sign: Mark F. Print: Mark F. Brunell ID No.: 553-61-1862 Level: I

Thermometer S/N 88-081 Part Temperature 72 F D-Meter S/N 91-035

Cal. Blk. S/N 214 Cal. In: N/A AM 12:35 PM

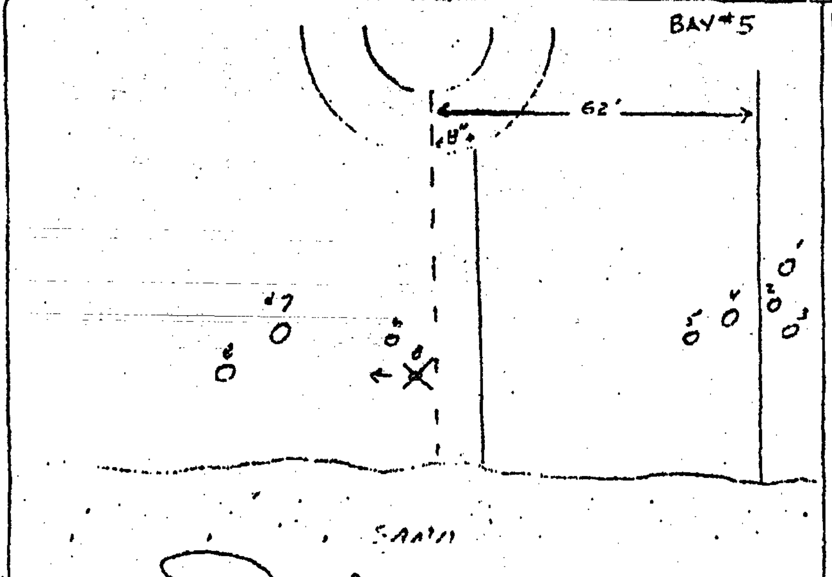
Cal. Blk. Temp. 72 F Cal. Out: N/A AM 12:35 PM

Calibration Readings (inches)

Cal. Blk.	.5	.75"	1.0	1.25"	1.5"	
D-Meter	.5"	.75"	1.0	1.25"	1.5"	

Techniques ☐ CRT ☒ D-Meter Other N/A

Position # Reading In Inches



Drawing

	Area		Measurement
1	0-40"	*R-13"	.970"
2	0-42"	*R-8"	1.440"
3	0-44"	*R-10"	1.020"
4	0-44"	*R-7"	.910"
5	0-46"	*R-11"	.850"
6	0-44"	L-4"	1.000"
7	0-48"	L-24"	.990"
8	0-46"	L-28"	1.010"

* from weld

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

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 81 of 117
Originator Mark Yekta — **Date** 01/12/93	**Reviewed by** S. C. Tumminelli		**Date**

all good

GPU Nuclear — **Ultrasonic Thickness Data Sheet**

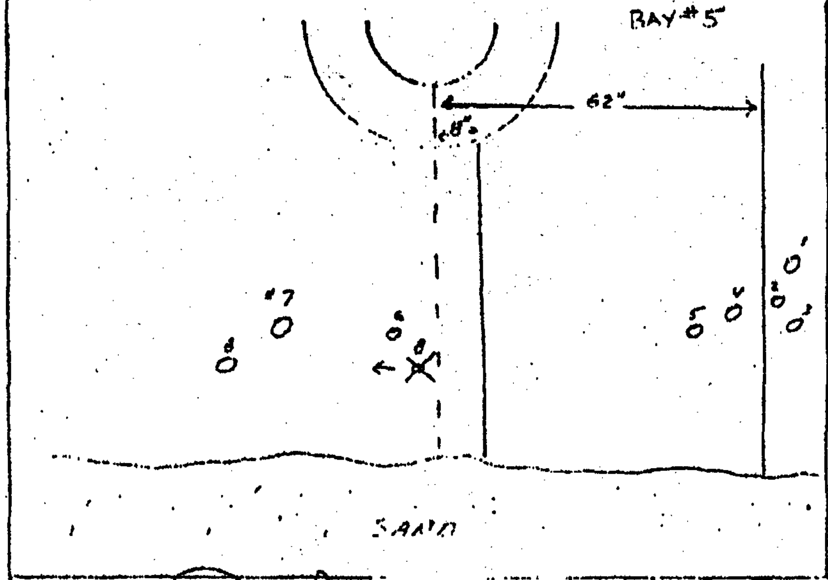
☑ OC ☐ TMI-1 ☐ TMI-2
Class: N/A
Item: N/A
NDE Request: 92-072
Data Sheet No.: 92-072-11
Task Description: UT Thickness
Task No.: N/A
Date: 1/12/93
Comp. Desc.: Drywell Liner
System: 187
Code/Spec.: SWS T.J.F.C.2
Procedure/Rev.: 6100-QAP 7209.07 Rev. 0
Drawing No./Rev.: 3E-187-29-001 Rev. 0
Test Surface: O.D.
Thickness: 1 1/8"
Material: C/S
Examiner — Sign: — Print: J. Van de Linde — ID No.: 154-48-0318 — Level: II
Examiner — Sign: Mark F. Bugnell — Print: Mark F. Bugnell — ID No.: 553-81-1862 — Level: I
Thermometer S/N 88-001 Part Temperature 22 F D-Meter S/N 37-113
Cal. Blk. S/N 224 Cal. In: N/A AM 22:23 PM
Cal. Blk. Temp. 22 F Cal. Out: N/A AM 22:56 PM

Calibration Readings (Inches)

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

Techniques
☒ CRT ☐ D Meter
Other N/A

Position # Reading In Inches



Drawing

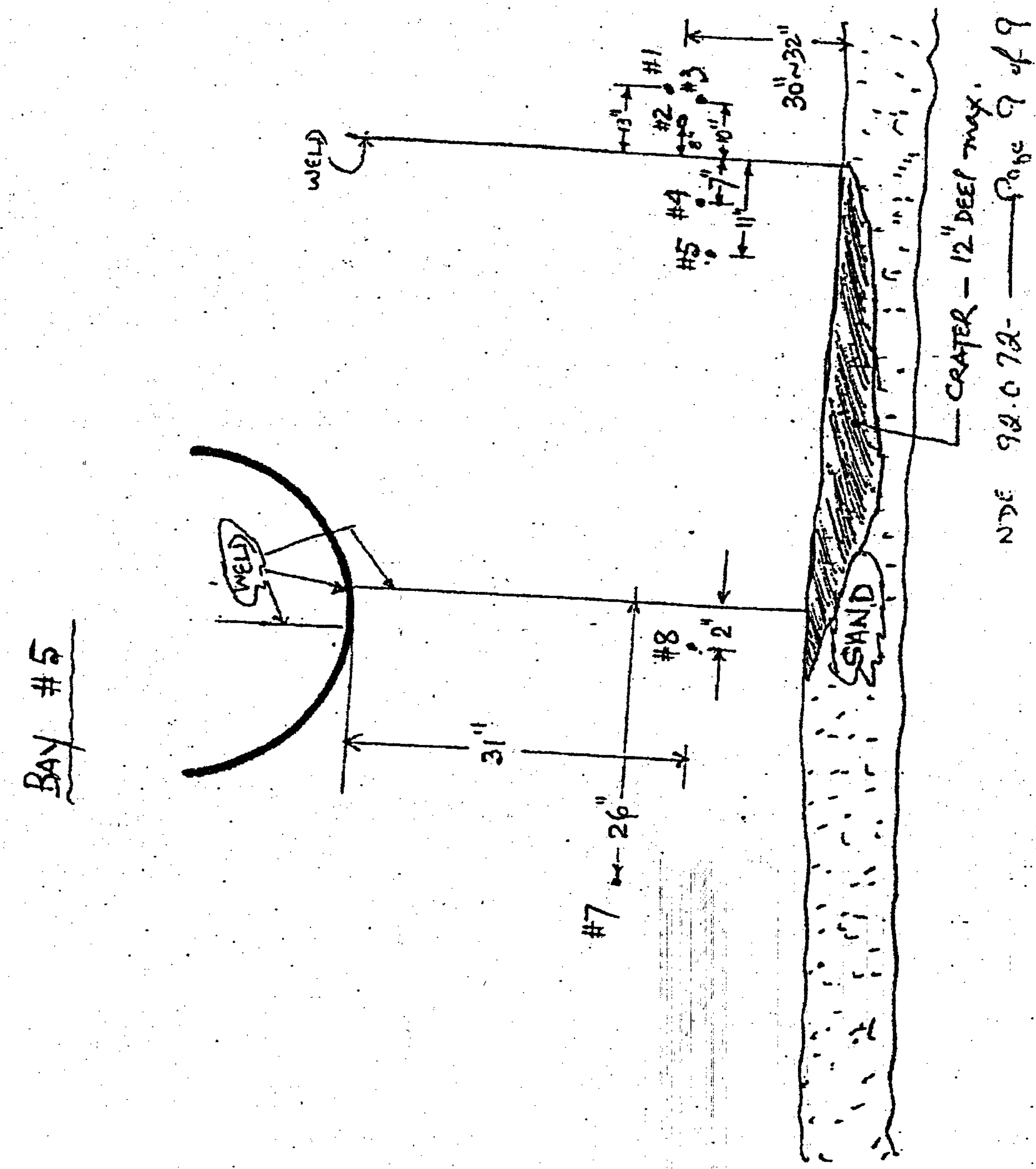
	AREA		Measurement
1	@-40"	*R-13"	.910"
2	@-42"	*R-8"	1.020"
3	@-44"	*R-10"	1.040"
4	@-44"	*R-7"	.960"
5	@-46"	*R-11"	.850"
6	@-44"	L-4"	1.060"
7	@-48"	L-24"	1.000"
8	@-46"	L-28"	1.020"

* FROM weld

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

GPU Nuclear

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



GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 83 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli	**Date**

HOC ITMI

GPU Nuclear

Calibration Sheet

Cal Sheet# 14K-103

System 187	Component Drywell Liner	Procedure 6100-QAP-7209.07			Rev 0
Examiner: Signature: J VanderLinde		Print: J VanderLinde	Initial: JV	ID# 154-48-0208	Level II
Examiner: Signature: Mark F. Exegnell		Print: Mark F. Exegnell	Initial: MFE	ID# 155-61-1662	Level I

Instrument Settings
ID# 122-113
Model/Manuf Sonic 137 Staveley

Gain
Coarse 6.5
Fine N/A
Uncal N/A

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

Operation
[✓ T&R] Normal
Frequency: 2.25 MHZ
Reject: ☒Off ☐On %
Filter: ☐Off ☒On 1 %
Damping: ☐Off ☒On 100 %

Rep Rate: 1000 Hz

Cal Standard
ID# 214
Size N/A Sch. N/A
Thickness .5" & 1.5"
S/S [✓ CS]
Temp 72 °F

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

Date 1-2-93

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

Cal Direction
☐Axial ☐Both
☐Circ. ☒Normal

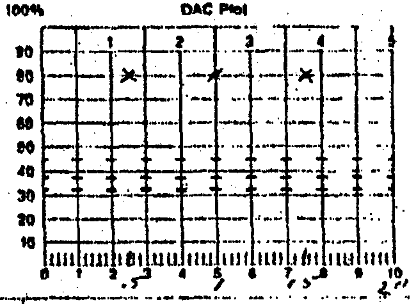
Time 1900

Reflector	Amplitude % of FSH	Screen Reading in Inches
.5	20	.5
1.5	80	1.5

Search Unit Cable
Type BNC to Lemo Length 2x6'

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

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



Time/Date	2118 1-2-93		2151 1-2-93		2223 1-2-93	
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5	80	.5	80	.5	80	.5
1.5	80	1.5	80	1.5	80	1.5
Initials	JV		JV		JV	

Remarks: Drywell liner thickness measurements Digital utilized

Components Examined: Bays # 1, 3 & 5

ANI Review

Technical Review
Reviewed By
Level III Date 1-3-93

NDE Request#: 92-072

N0927 (05-90)

'all good

GPU Nuclear

Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A Item: n/A NDE Request: 92-072 Data Sheet No.: 92-072-20

Task Description: UT THICKNESS Task No.: N/A Date: 1-8-93

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

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

Test Surface: OD Thickness: 1 1/8" Material: c/s

Examiner Sign: Print: Jon VanderLinde ID No.: 157-42-0245 Level: II

Examiner Sign: Print: Luis Valenzuela ID No.: 111-44-2524 Level: II

Thermometer S/N 92-045 Part Temperature 70 F D-Meter S/N 92-035

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

Cal. Blk. Temp. 70 F Cal. Out: 0205 AM ____ PM

Calibration Readings (inches)

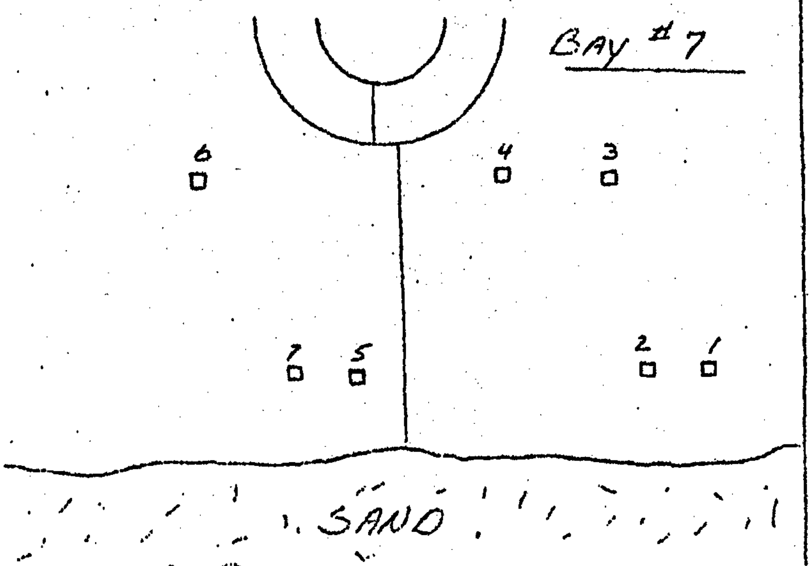
Cal. Blk.	.5	1.0	1.5"			
D-Meter	.5"	1.0	1.5"			

Techniques

☐ CRT ☒ D-Meter

Other ________

Position #/Reading in inches



Drawing

	AREA		MEASUREMENT
1	0 + 21"	R - 29"	0.92"
2	0 + 21"	R - 32"	1.016"
3	0 + 10"	R - 20"	0.984"
4	0 + 10"	R - 10"	1.04"
5	0 + 21"	L - 6"	1.03"
6	0 + 10"	L - 23"	1.045"
7	0 + 21"	L - 12"	1.0"

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

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 85 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli	**Date**

All good.

GPU Nuclear Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2

Class: N/A

Item: N/A

NDE Request: 92-072

Data Sheet No.: 92-072-3

Task Description: UT Thickness

Task No.: N/A

Date: 1-7-93

Comp. Desc.: Drywell Liner

System: 187

Code/Spec.: Eng. Info.

Procedure/Rev.: 6100-QAP-7209.07 Rev. C

Drawing No./Rev.: 3E-187-29-001 Rev. C

Test Surface: O.D. Bay #9

Thickness: 1 1/8"

Material: c/s

Examiner Sign: Print: J. Vanche Lindt ID No.: 154-48-0318 Level: II

Examiner Sign: Print: Luis Valenzuela ID No.: 11n-44-2514 Level: II

Thermometer S/N 92-068 Part Temperature 22 F D-Meter S/N 92-009

Cal. Blk. S/N 219 Cal. In: 0202 AM 0208 PM

Cal. Blk. Temp. 22 F Cal. Out: 0415 AM 0415 PM

Calibration Readings (Inches)

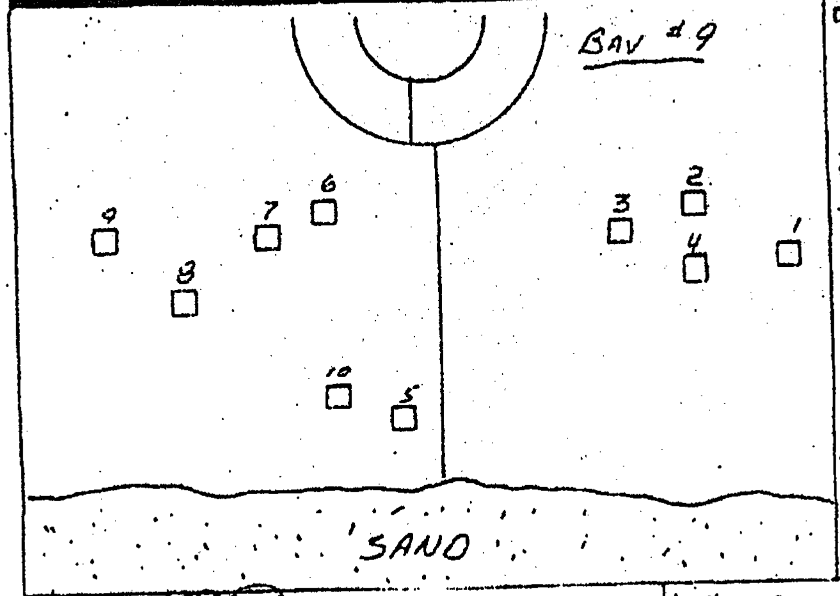
Cal. Blk.	.5	.10	1.5			
D-Meter	.5	1.0	1.5			

Techniques

☐ CRT ☒ D-Meter

Other

Position #/Reading In Inches



Drawing

	AREA	MEASUREMENT
1	0 21 R 32	.960
2	0 12 R 17	.94
3	0 18 R 8	.994
4	0 21 R 12	1.020
5	0 36 L 4	.935
6	0 ~~34~~ 16 L 30	.62
7	0 18 L	.625
8	0 27 L	.791
9	0 ~~58~~ 10 L 55	.632
10	0 32 L 6	.980

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

One Point

GPU Nuclear

Ultrasonic Thickness Data Sheet

☑ OC ☐ TMI-1 ☐ TMI-2 Class: N/A	Item: N/A	NDE Request: 92-072	Data Sheet No.: 92-072-09
Task Description: UT thickness		Task No.: N/A	Date: 12/22/92
Comp. Desc.: Drywell Shell Bay 11	System: 187		Code/Spec.: ASME XI
Procedure/Rev.: 6100 QAP 7209.003 Rev 0		Drawing No./Rev.: 3E-187-29-001 Rev 0	
Test Surface: O.D.		Thickness: 1 1/8"	Material: c/s
Examiner Sign:	Print: J. [illegible]	ID No.: [illegible]	Level: II
Examiner Sign: Mark F. Bagnell	Print: Mark F. Bagnell	ID No.: 553-[illegible]	Level: I

Thermometer S/N 92-[illegible] Part Temperature 65 °F D-Meter S/N 137 113

Cal. Blk. S/N 92

Cal. Blk. Temp. 65 F

Cal. In: n/a AM 2:00 PM

Cal. Out: n/a AM 3:10 PM

Calibration Readings (Inches)

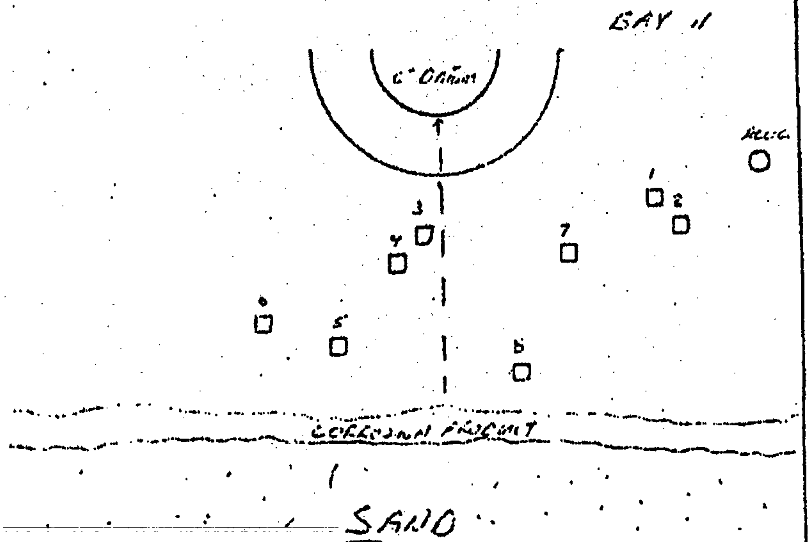
Cal. Blk.	.5"	.75"	1.0			
D-Meter	.5"	.75"	1.0			

Techniques

☑ CRT ☐ D-Meter

Other ______

Position #/Reading in Inches



Drawing

Elev. 15' [illegible] 41" right

AREA		Thickness
1	C-20" R-27"	0.71"
2	C-25" R-32"	0.70"
3	C-41" L-4"	0.83"
4	C-24" L-6"	0.78"
5	C-32" L-14"	0.84"
6	C-27" L-20"	0.81"
7	C-31" R-20"	0.83"
8	C-40" R-13"	0.87"

Reviewed by: Level: III Date: 12-22-92 Page 1 of 1

N5455 (05-90)

GPU Nuclear

Ultrasonic Thickness Data Sheet

☑ OC ☐ TMI-1 ☐ TMI-2 Class: N/A	Item: N/A	NDE Request: 92-072	Data Sheet No.: 92-072-10
Task Description: [illegible]		Task No.: N/A	Date: 12/[illegible]/92
Comp. Desc.: Drywell [illegible] Bay 11	System: 187		Code/Spec.: [illegible] XI
Procedure/Rev.: [illegible]		Drawing No./Rev.: 3E-187-25-001 R00	
Test Surface: [illegible]		Thickness: 1 1/8"	Material: c/s
Examiner Sign:	Print: [illegible]	ID No.: [illegible]	Level: II
Examiner Sign: Mark	Print: Mark F. Bagnell	ID No.: 553-[illegible]	Level: II

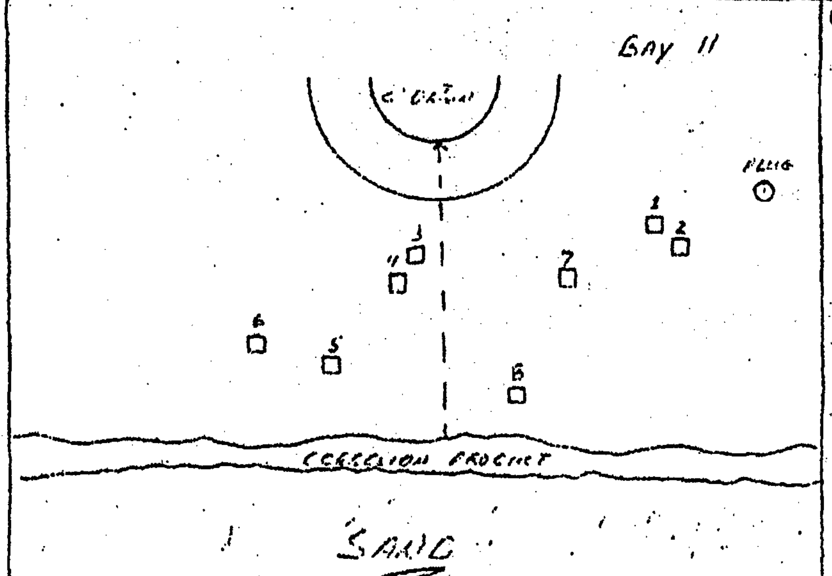
Thermometer S/N 92-[illegible] Part Temperature 65 F D-Meter S/N 92-[illegible]
Cal. Blk. S/N 72 Cal. In: n/a AM 2:40 PM
Cal. Blk. Temp. 65 F Cal. Out: n/a AM 3:02 PM

Calibration Readings (Inches)

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

Techniques
☐ CRT ☑ D-Meter
Other ______

Position #/Reading in Inches



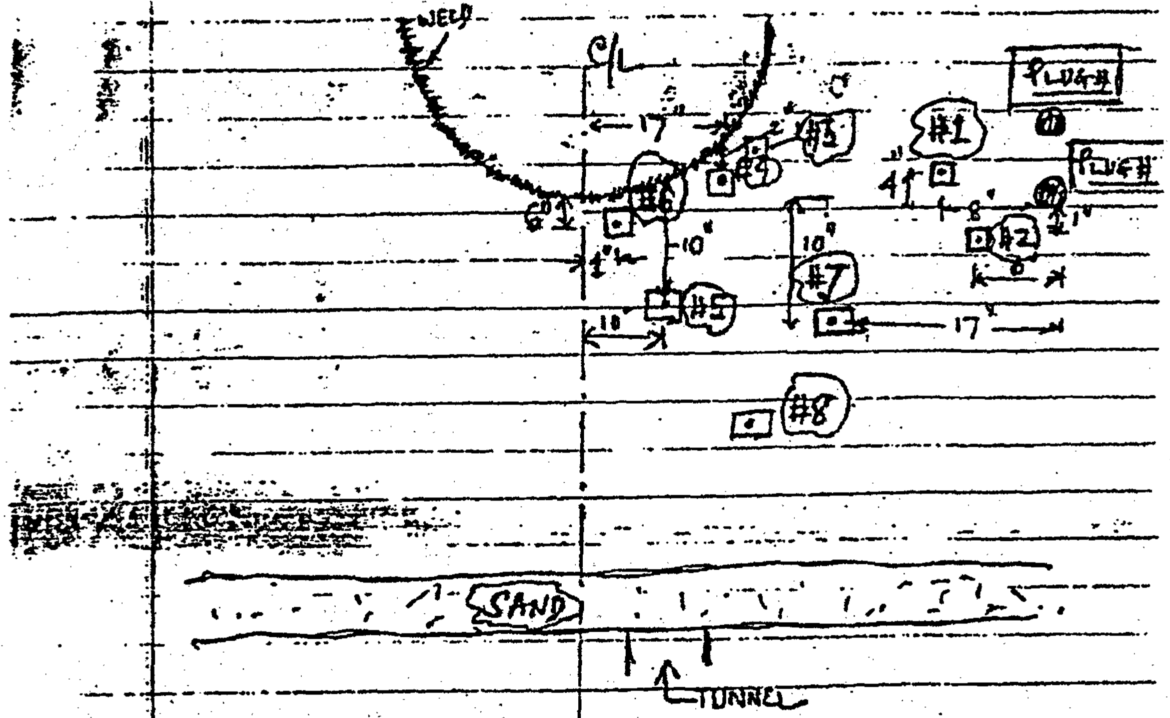
Drawing

[illegible]

	Area	Thickness
1	0-26" [illegible]	0.7[illegible]"
2	0-25" 8-35"	0.720"
3	0-21" 4-4"	0.834"
4	0-24" 4-6"	0.7[illegible]"
5	0-32" 4-14"	0.83[illegible]
6	0-27" 4-22"	0.86
7	0-31" 8-20"	0.831"
8	0-40" 8-13"	0.8[illegible]

Reviewed by: Level: III Date: 12-22-92 Page 1 of 1

NS453 (05-90)

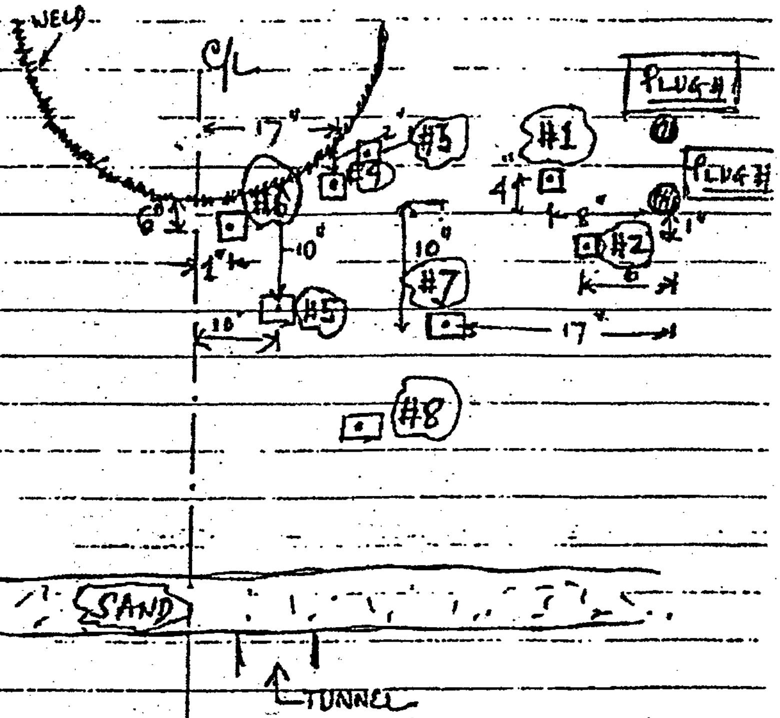


BAY-11 — U.T. SPOTS FOR GRINDING

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

GPU Nuclear

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



BAY—11 — U.T. SPOTS FOR GRINDING

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

GPU Nuclear

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

GPU Nuclear

Calibration Sheet

1-OC 1 ITMI

Cal Sheet# 14K-069

System 187	Component Drywell [illegible] Bay 11	Procedure 6100-QAP-7209.03	Rev 0
Examiner:	Signature:	Print: J [illegible]	Initial: [illegible] — ID# [illegible] — Level II
Examiner:	Signature: Mark	Print: Mark F Bagnell	Initial: MFB — ID# [illegible] — Level I

Instrument Settings
ID# 237-113
Model/Manuf Sonic 137 Staveley

Gain
Coarse 22.0
Fine N/A
Uncal off

Sweep Circuit
Coarse .1 (Range)
Fine [illegible]
Delay 1
Screen Depth 2"

Operation [✓ T&R] Normal
Frequency: 2.25 MHZ
Reject: ☒ Off ☐ On %
Filter: ☐ Off ☒ On 1 %
Damping: ☐ Off ☒ On 250 %

Rep Rate: Normal

Cal Standard
ID# 95
Size 3.1" Sch. NA
Thickness .5"-2.0"
S/S [✓ CS]
Temp 65 °F

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

Date 12/12/92

Search Unit
ID# MC5224
Type MSEB
Freq 5 MHZ
Size 1/4"
Angle 0 Mode Long

Cal Direction
☐ Axial ☐ Both
☐ Circ. ☒ Normal

Time 15:05

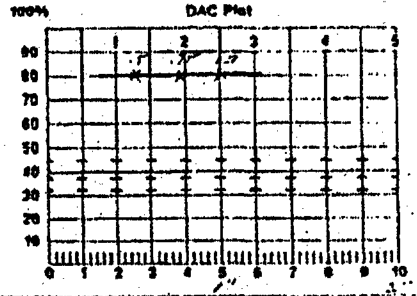
Reflector	Amplitude % of FSH	Screen Reading in Inches
.5	80	.5
.75	80	.75
1.0	80	1.0

Search Unit Cable
Type Dual Lemo Length 2x6'

Couplant
Make [illegible] Batch# [illegible]

Thermometer
S/N: 92-075 Cal Due 5/23/93

DAC Plot



Time/Date	15:30 12/12/92		/		/	
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5"	80	.5				
.75"	80	.75				
1.0"	80	1.0				
Initials	[illegible]					

Remarks:

Components Examined:
BAY 11

ANI Review

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

NDE Request#: 92-072

N0927 (05-90)

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 91 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli	**Date**

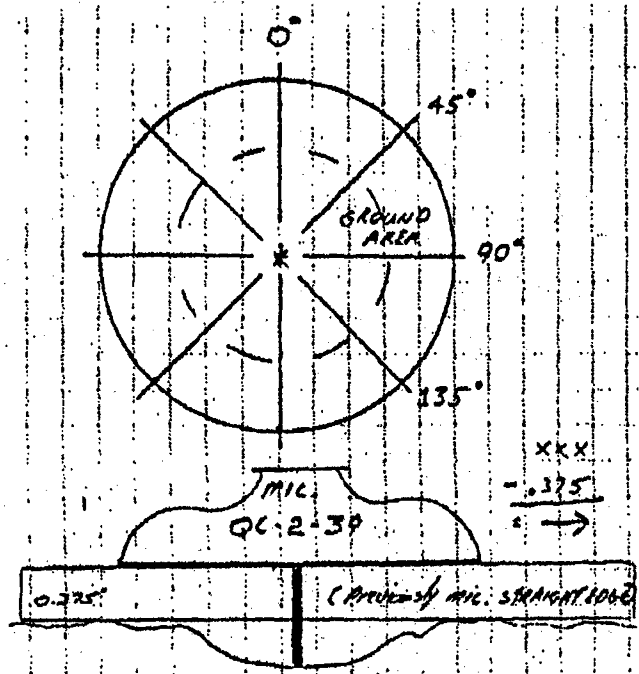
GPU Nuclear

☒ OC ☐ TMI ☐ OTHER ______

Sketch Form (with grid)

Component: DRYWELL liner SANdbed AREA		Data Sheet No.: 92-072-31	
Location: BAY # 11		Drawing No.: N/A	Rev.: N/A

Drawing



Technique utilized for The pit depth MEASUREMENTS

AZIMUTH

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

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

GPU Nuclear

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

four Points under

GPU Nuclear Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: NA	Item: NA	NDE Request: 92-012	Data Sheet No.: 92-012-23
Task Description: DRYWELL CORROSION CONTROL (LINER THICKNESS)		Task No.: NA	Date: 1/8/93
Comp. Desc.: DRYWELL LINER BAY 13	System: DRYWELL		Code/Spec.: ENG. INFO.
Procedure/Rev.: 6100-QAP-7209.01 Rev C		Drawing No./Rev.: 3E-187-29-001	
Test Surface: CD		Thickness: 1 1/8"	Material: CS

Examiner	Sign: JJ A Sl[illegible]	Print: N. H. SHERRER	ID No.: 217-56-4132	Level: II
Examiner	Sign: NA	Print: NA	ID No.: NA	Level: NA

Thermometer S/N 92-068 Part Temperature 74° F D-Meter S/N 92-049
Cal. Blk. S/N 219 Cal. In: NA AM 12:20 PM
Cal. Blk. Temp. 69° F Cal. Out: NA AM 2:30 PM

Calibration Readings (inches)

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

Techniques

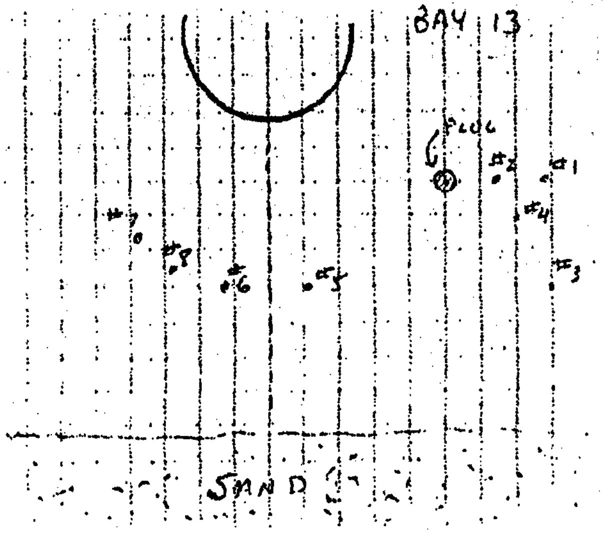
☐ CRT ☒ D-Meter

Other NA

Position #/Reading in Inches

AREA	LOCATION	THK
1	D 6" R 46"	.914"
2	D 6" R 39"	.615"
3	D 26" R 49"	.934"
4	D 12" R 35"	.914"
5	D 26" R 6"	.135"
6	D 24" L 8"	.683"
7	D 17" L 23	.632"
8	D 22" L 20"	.744"

Drawing



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

NR455 (05-90)

GPU Nuclear

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

7 points under

GPU Nuclear Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A	Item: N/A	NDE Request: 92-022	Data Sheet No.: 92-022-21
Task Description: Drywell liner Thk. measurements		Task No.: N/A	Date: 1-11-93
Comp. Desc.: Drywell liner Bay 13	System: 187		Code/Spec.: N/A (Eng. Info.)
Procedure/Rev.: 6100-QAP-7209.07 Rev. 6		Drawing No./Rev.: 3E-187-24 001	
Test Surface: O.D.		Thickness: 1 1/8"	Material: C.S
Examiner Sign:	Print: J. VanderCruyssen	ID No.: 157-48-0324	Level: II
Examiner Sign:	Print: Luis Valenzuela	ID No.: 110-44-2524	Level: II

Thermometer S/N 92-065 Part Temperature 65 F D-Meter S/N 92-035
Cal. Blk. S/N 219 Cal. In: 1/11 AM 2:25 PM
Cal. Blk. Temp. 65 F Cal. Out: 1/11 AM 2:30 PM

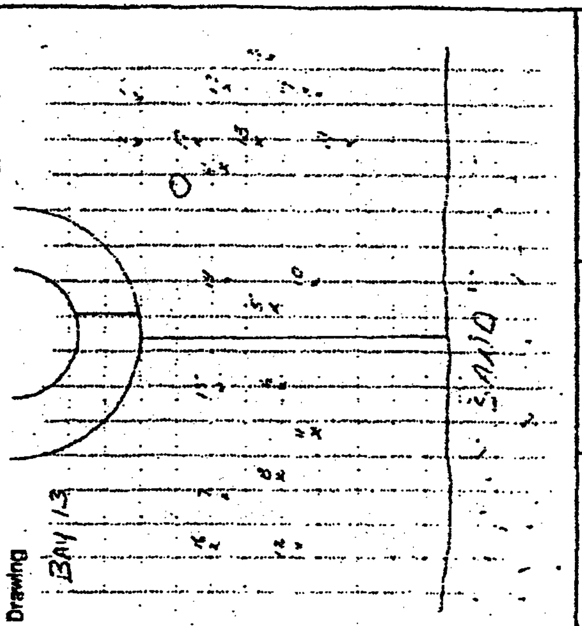
Calibration Readings (Inches)

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

Techniques ☐ CRT ☒ D-Meter Other ______

Position #/Reading in Inches

Drawing



AREA	LOCATION		THK.
1	UP-1"	R-45"	0.672" ***
2	UP-1"	R-38"	0.727"/.723" *
3	0-21"	R-48"	0.941"
4	0-12"	R-36"	0.915"
5	0-21"	R-6"	0.718" ***
6	0-24"	L-8"	0.855" ***
7	0-17"	L-22"	0.816" ***
8	0-24"	L-26"	0.716" ***
9	0-28"	R-41"	0.924"
10	0-28"	R-12"	0.728" *
11	0-28"	L-15"	0.685" *
12	0-28"	L-23"	0.885"
13	0-18"	R-40"	0.922"
14	0-18"	R-8"	0.868"
15	0-20"	L-9"	0.882"
16	0-20"	L-29"	0.839"
17	0-9"	R-32"	0.807"
18	0-22"	R-38"	0.825"
19	0-37"	L-38"	0.912"

20 Inspections [illegible] 1.17" [illegible]
* All The measurement [illegible]
backwall on the CRT

*** [illegible] check of [illegible] readings

Reviewed by: Level: III Date: 1-11-93 Page 1 of 2

N5455 (10-84)

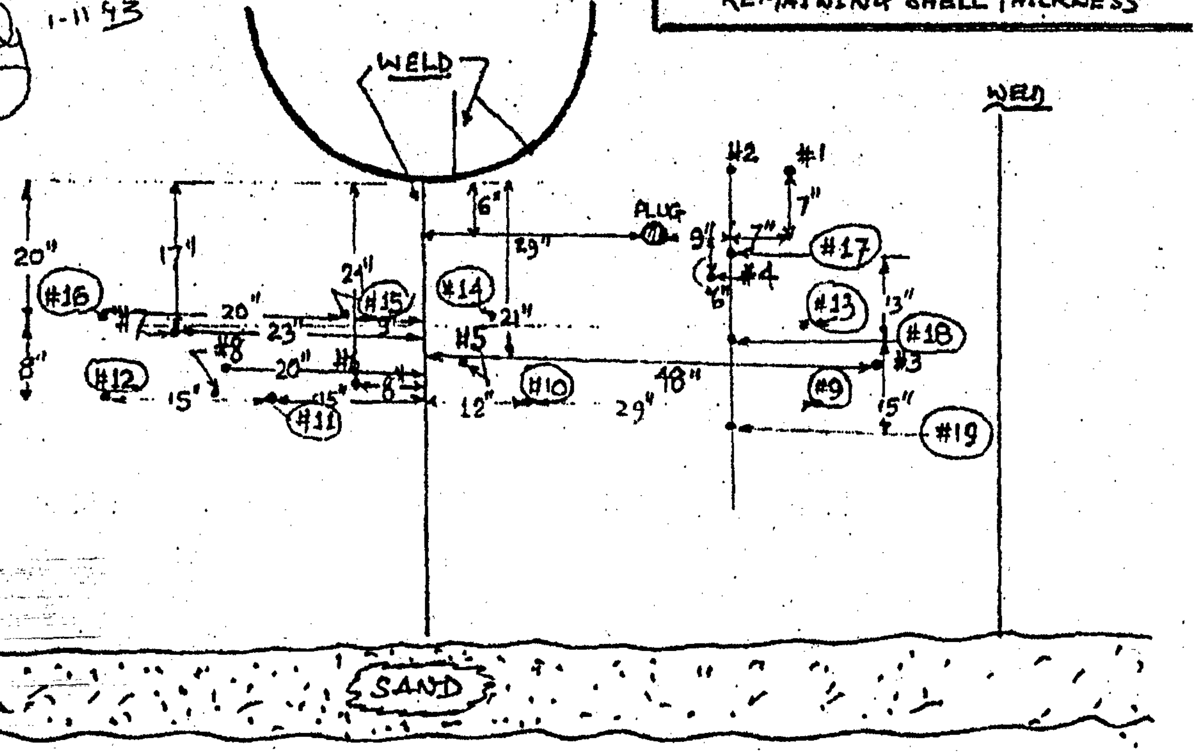
GPU Nuclear

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

BAY # 13

#9.2 6.72 24
Pg 2 of 2
1-11-93

NOTES:
- SPOT #9 THRU 19 MARKED ON 1/10/93. SKD 1/10/93
- GRIND ABOVE SPOTS CAREFULLY AS NOT TO REDUCE SHELL THICKNESS EXCESSIVE
- UT ALL SPOTS (1 THRU 19) FOR REMAINING SHELL THICKNESS



NOTES
- PLUG UNCORRODED – LOCATED IN A DEEP VALLEY.
- "TUB RING" LESS PROMINENT.
- SHELL & FLOOR NEEDS MORE CLEANING.

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 95 of 117
Originator Mark Yekta / **Date** 01/12/93	**Reviewed by** S. C. Tumminelli		**Date**

first under

GPU Nuclear Ultrasonic Thickness Data Sheet

☑ OC ☐ TMI-1 ☐ TMI-2 Class: N/A	Item: N/A	NDE Request: 92-072	Data Sheet No.: 92-072-15
Task Description: Drywell liner Thk. measurements		Task No.: N/A	Date: 1/11/93
Comp. Desc.: Drywell liner Bay 13	System: 187		Code/Spec.: Eng Info
Procedure/Rev.: 6100-QAP-7209.07 Rev 0		Drawing No./Rev.: 3E-187-29-001	
Test Surface: O.D.		Thickness: 1.18"	Material: C/S
Examiner Sign:	Print: J. VanderLinde	ID No.: 154-48-0210	Level: II
Examiner Sign: N/A	Print: N/A	ID No.: N/A	Level: N/A

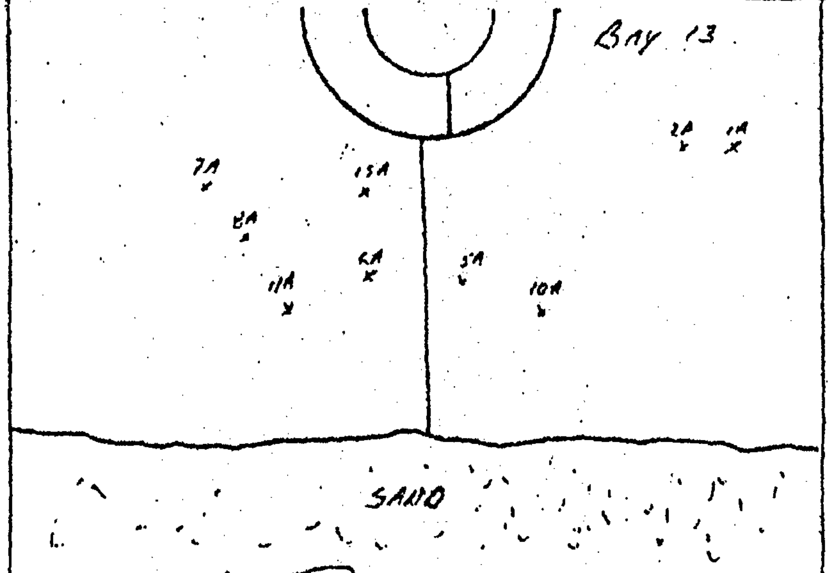
Thermometer S/N 92-062 Part Temperature 70 F D-Meter S/N 92-035
Cal. Blk. S/N 219 Cal. In: N/A AM 1030 PM
Cal. Blk. Temp. 70 F Cal. Out: N/A AM 1045 PM

Calibration Readings (Inches)

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

Techniques: ☐ CRT ☑ D-Meter Other ______

Position #/Reading in Inches



Drawing

AREA	THICKNESS
1A	0.89"
2A	0.943"
5A	0.851"
10A	0.81"
11A	0.854"
8A	0.9"
7A	0.752"
6A	~~[illegible]~~ .776"
15A	~~[illegible]~~ .857"

A minimal grind areas adjacent to previous grindout locations

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

NS455 (05-90)

None under

GPU Nuclear

Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: NA Item: NA NDE Request: 92-072 Data Sheet No.: 92-072-26

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

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

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

Test Surface: O.D. Thickness: 1 1/8" Material: c/s

Examiner Sign: Print: J. Van der Linde ID No.: 154-48-0218 Level: II

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

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

Cal. Blk. S/N 218 Cal. In: N/A AM 10:12 PM

Cal. Blk. Temp. 70 F Cal. Out: N/A AM 11:25 PM

Calibration Readings (inches)

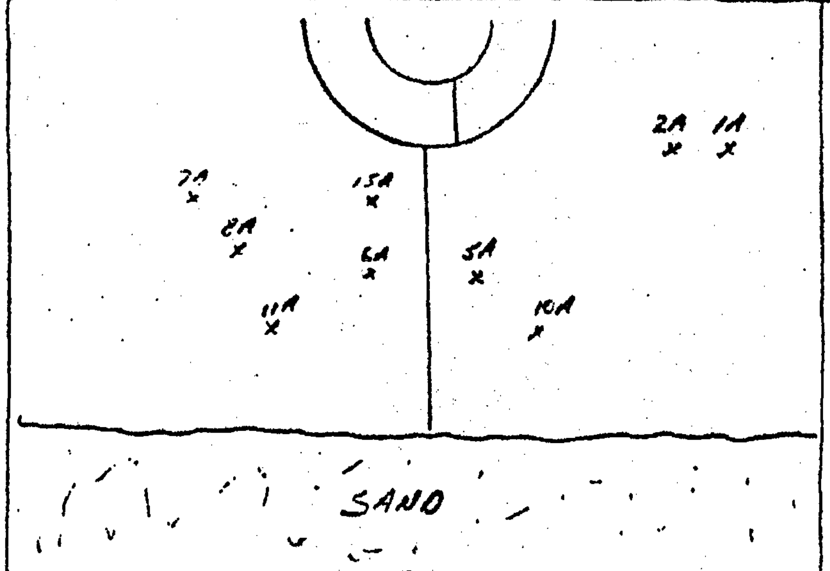
Cal. Blk.	.5	1.0	1.5	N/A		
D-Meter	.5	1.0	1.5			

Techniques

☑ CRT ☑ D-Meter

Other ____

Position & Reading in Inches



Drawing

AREA	Thickness
1A	0.88
2A	0.9
5A	0.83
10A	0.82
11A	0.83
8A	0.87
7A	0.76
6A	0.97
15A	0.85

"A": minimal grind areas adjacent to previous grind/UT location.

Reviewed by: Level: III Date: 1-11-93 Page 1 of 1

GPU Nuclear

Subject		Calc No.	Rev. No.	Sheet No.
O.C. Drywell Ext. UT Evaluation in Sandbed		C-1302-187-5320-024	1	97 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli		**Date**

GPU Nuclear

Calibration Sheet

Cal Sheet# 14R-113

System 187

Component BAY 13 Liner

Procedure 6100-QAP-7209.07 Rev 0

Examiner:	Signature:	Print: J. VanderLinde	Initial: JV	ID# 154-89-0207	Level II
Examiner:	Signature: n/a	Print: n/a	Initial: n/a	ID# n/a	Level N/A

Instrument Settings
ID# 132-113
Model/Manuf SONIC 132 STAVELY

Gain
Coarse 42.6
Fine n/a
Uncal n/a

Sweep Circuit
Coarse 2" (Range)
Fine vel. 0.234
Delay 0.365"
Screen Depth 2"

Operation [✓ T&R] Normal
Frequency: 5 MHZ
Reject: ☐ Off ☐ On %
Filter: ☐ Off ☐ On 1 %
Damping: ☐ Off ☐ On 100 %

Rep Rate: 280 Hz

Cal Standard
ID# 219
Size n/a Sch. n/a
Thickness .5 to 1.5"
S/S [✓ CS]
Temp 70 °F

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

Date 1/11/93

Search Unit
ID# D02264
Type KBA Gamma
Freq 5 MHZ
Size .25"
Angle 0 Mode Long.

Cal Direction
☐ Axial ☐ Both
☐ Circ. ☑ Normal

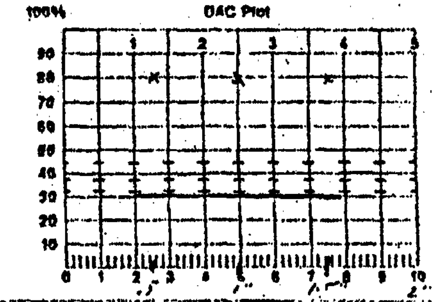
Time 1032 AM

Search Unit Cable
Type Self contained Length 2x6'

Couplant
Make Soundsafe Batch# SIP 87-1105

Thermometer
S/N: 92-058 Cal Due 5/24/93

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



Time/Date	1105AM 1/11/93		/		/	
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5	80	.5"				
1.0	80	1.0				
1.5"	80	1.1				
Initials	JV					

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

Components Examined:
Drywell liner Bay 13

ANI Review

Technical Review
Reviewed By
Level Date 1-11-93

NDE Request#: 92-072

N0927 (05-90)

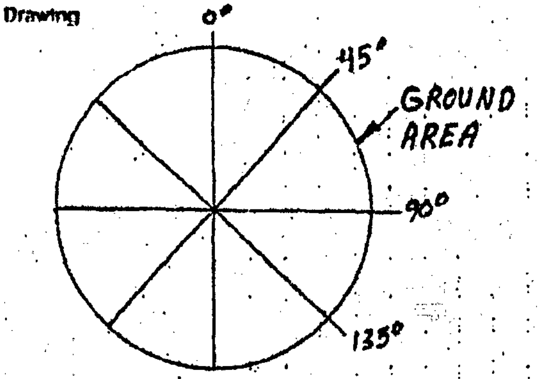
GPU Nuclear

☒ OC ☐ TMI ☐ OTHER ______________

Sketch Form (with grid)

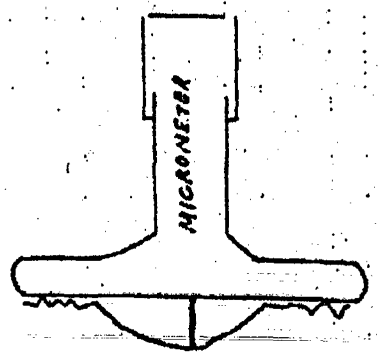
Component: DRY WELL LINEAR	Data Sheet No.: 92-072-~~24~~ 27
Location: BAY 13	Drawing No.: N/A Rev.: N/A

Drawing



UT READING LOCATIONS	0°	45°	90°	135°
1	.330	.382	.346	.346
2	.312	.377	.300	.393
5	.150	.193	.230	.298
6	.327	.339	.290	.247
7	.241	.279	.260	.239
8	.324	.245	.267	.279
10	.186	.173	.255	.229
11	.240	.231	.271	.283
15	.288	.277	.239	.285

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



TECHNIQUE USED TO
DETERMINE DETH OF GROUND AREAS

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

GPU Nu

Subject O.C. Drywel
Originator Mark

[illegible]

GPU Nuclear

Ultrasonic Thickness Data Sheet

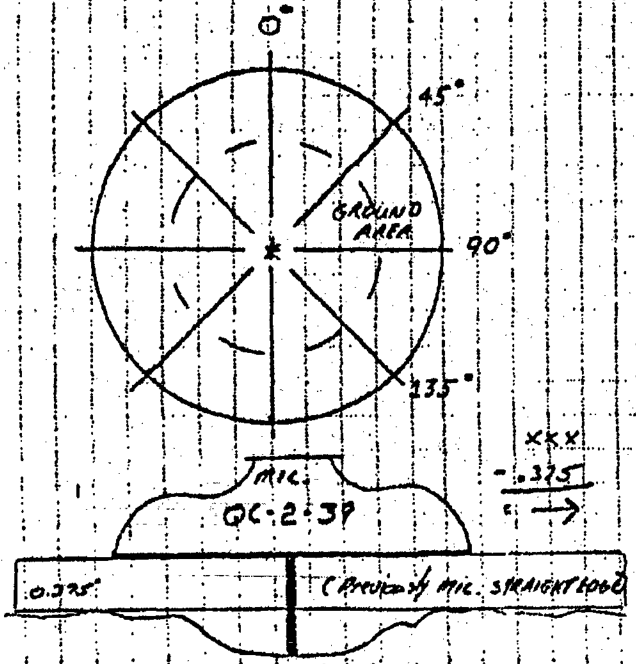
GPU Nuclear

☒ OC ☐ TMI ☐ OTHER ____________

Sketch Form (with grid)

Component: DRYWELL liner SANDBED AREA	Data Sheet No.: 92-072-33
Location: BAY # 15	Drawing No.: N/A Rev.: N/A

Drawing



Technique utilized for The pit depth MEASUREMENTS

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

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

GPU Nuclear

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

All above [illegible]

GPU Nuclear Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: n/a	Item: n/a	NDE Request: 92-072	Data Sheet No.: 92-072-IV
Task Description: UT Thickness Measurements		Task No.: n/a	Date: 12/5/92
Comp. Desc.: Drywell Liner Bay 17	System: 187		Code/Spec.: ASME Sect. VIII
Procedure/Rev.: [illegible]-SAF-7209.07 Rev 0		Drawing No./Rev.: 3E-187-29-001 Rev 0	
Test Surface: O.D.		Thickness: 1 1/8"	Material: C/S
Examiner Sign:	Print: Jonathan VanderLinde	ID No.: 154-48-0310	Level: II
Examiner Sign: Mark	Print: Mark F. Bagnell	ID No.: 553-81-1802	Level: I

Thermometer S/N 92-257 Part Temperature 65 F D-Meter S/N 137-113

Cal. Blk. S/N 218 Cal. In: 9:10 AM n/a PM

Cal. Blk. Temp. 66 F Cal. Out: 9:35 AM n/a PM

Calibration Readings (Inches)

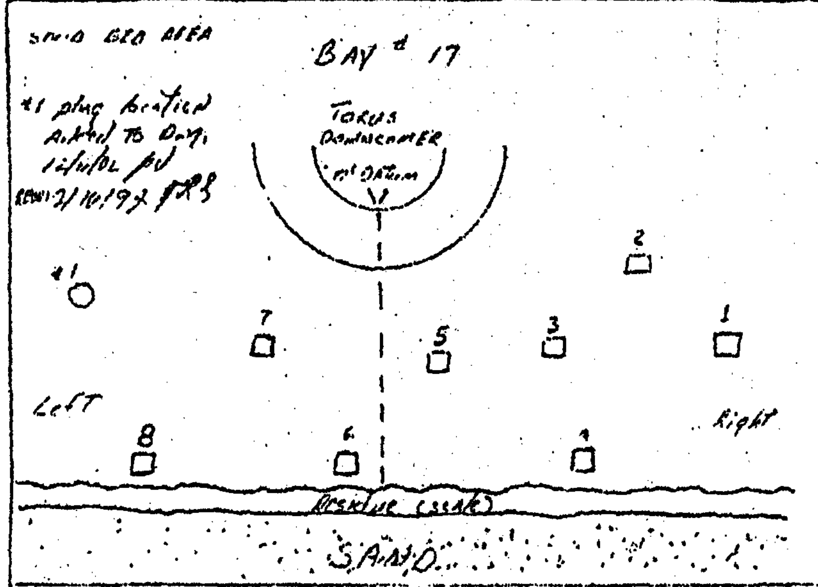
Cal. Blk.	0.5"	0.75"	1.0"	1.25"	1.5"	n/a
D-Meter	0.5"	0.75"	1.0"	1.25"	1.5"	n/a

Techniques

☒ CRT ☒ D-Meter

Other Sonic 137

Position #/Reading in Inches



Drawing

Area	*Position	**UT measurement
1	D-30" R-52"	0.98"
2	D-12" R-42"	1.16"
3	D-22" R-28"	0.92"
4	D-53" R-30"	1.02"
5	D-36" R-13"	0.94"
6	D-52" L-6" position	1.01"
7	D-36" L-26"	0.97"
8	D-52" L-40"	1.03"

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

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

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

N3455 (06-90)

GPU Nuclear **Ultrasonic Thickness Data Sheet**

☒ OC ☐ TMI-1 ☐ TMI-2 | Class: n/a | Item: n/a | NDE Request: 92-072 | Data Sheet No.: 92-072-14

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

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

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

Test Surface: O.D. | Thickness: 1 1/8" | Material: c/s

Examiner | Sign: | Print: Jonathan [illegible] | ID No.: 157-96-[illegible] | Level: II

Examiner | Sign: n/a | Print: n/a | ID No.: n/a | Level: n/a

Thermometer S/N 72-057 Part Temperature 68 F D-Meter S/N 132-117

Cal. Blk. S/N 58

Cal. Blk. Temp. 65 F

Cal. In: n/a AM 1:20 PM

Cal. Out: n/a AM 1:35 PM

Calibration Readings (inches)

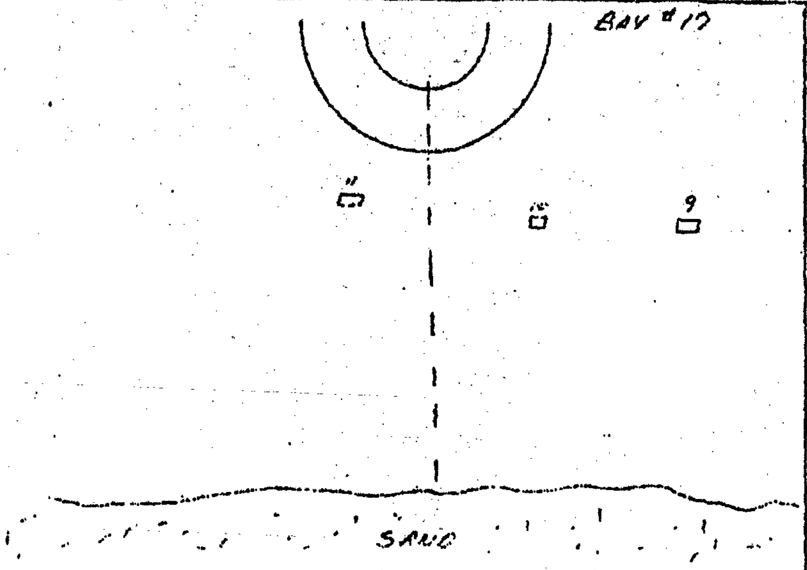
Cal. Blk.	.5	.75	1.0			
D-Meter	.5	.75	1.0			

Techniques

☒ CRT ☒ D-Meter

Other ______

Position #/Reading in Inches



Drawing

Area		Thickness
9	0.22" R-20"	0.72"
10	0.26" R-11"	0.73"
11	0.21" R-12"	0.76"

Performed after additional grinding

Reviewed by: | Level: III | Date: 12-14-92 | Page 1 of 1

NS456 (05-90)

GPU Nuclear

Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: NA	Item: NA	NDE Request: 92-072	Data Sheet No.: 92-072-04
Task Description: UT Thickness		Task No.: NA	Date: 12/14/92
Comp. Desc.: Drywell liner Bay 17	System: 187		Code/Spec.: ASME Sect VIII
Procedure/Rev.: 6100-QAP 7209.07 Rev [illegible]		Drawing No./Rev.: 3E-187-29-001 Rev 0	
Test Surface: O.D.		Thickness: 1 1/8"	Material: C/S
Examiner Sign:	Print: J. Vanderlinde	ID No.: 157-48-0519	Level: II
Examiner Sign: NA	Print: NA	ID No.: NA	Level: NA

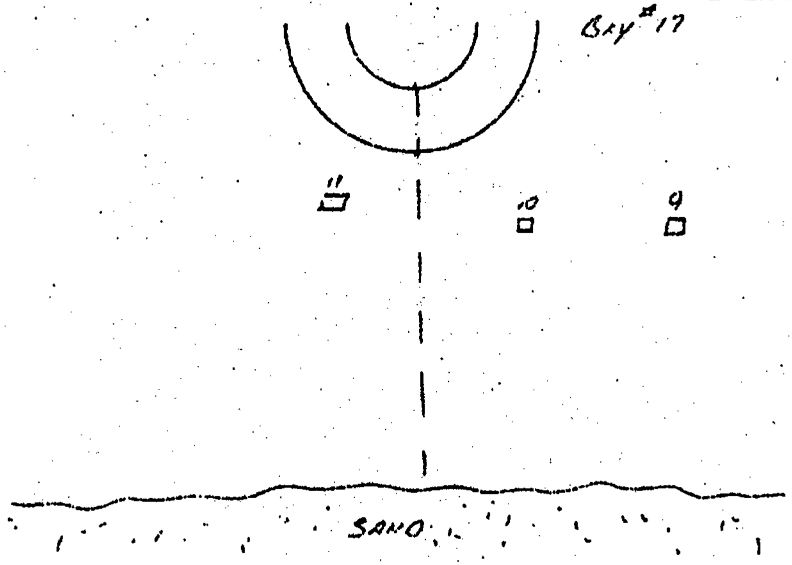
Thermometer S/N 92-057 Part Temperature 68 F ~~D-Meter~~ S/N 92-010
Cal. Blk. S/N 38
Cal. Blk. Temp. 68 F
Cal. In: NA AM 1:05 PM
Cal. Out: NA AM 1:21 PM

Calibration Readings (Inches)

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

Techniques
☒ CRT ☒ D-Meter
Other ______

Position #/Reading In Inches



Drawing

Area		Thickness
9	0.27" R 3"	0.72"
10	0.20" R 11"	0.53"
11	0.21" L 12"	0.77"

Performed after additional grinding near weld area

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

N5455 (05-90)

GPU Nuclear

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

GPU Nuclear — **Ultrasonic Thickness Data Sheet**

☒ OC ☐ TMI-1 ☐ TMI-2	Class: N/A	Item: N/A	NDE Request: 92-072
Task Description: UT Thickness Measurements		Task No.: N/A	Data Sheet No.: 92-072-05
Comp. Desc.: Drywell Liner Bay 1/17	System: 187	Code/Spec.: ASME Sect. VIII	Date: 12/11/92
Procedure/Rev.: 6100-DAP-7209.07 Rev. 0		Drawing No./Rev.: 3E-187-29-001 Rev. 0	
Test Surface: O.D.		Thickness: 1 1/8"	Material: C/S
Examiner Sign:	Print: Jonathan VanderLinde	ID No.: 154-48-0318	Level: II
Examiner Sign:	Print: MARK F. BAGNELL	ID No.: SSN 81-1862	Level: I

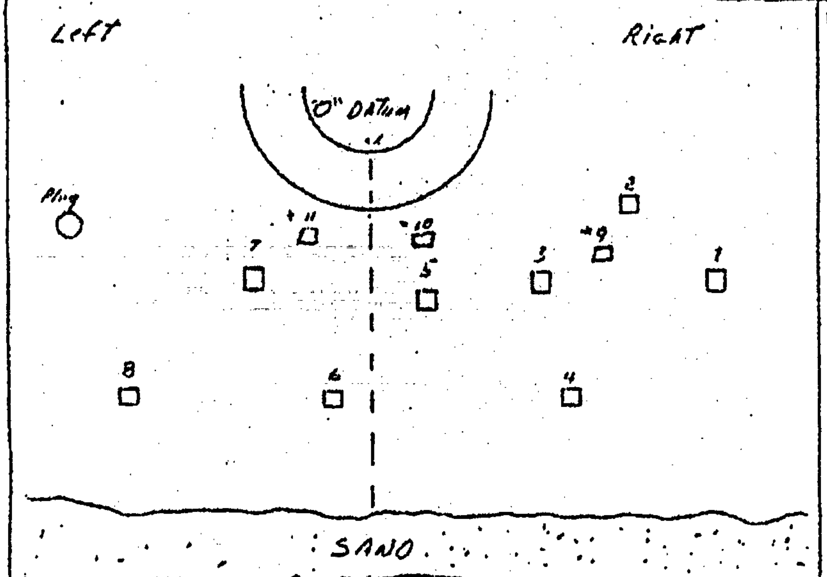
Thermometer S/N 22-013 Part Temperature 72 F D-Meter S/N 92-010
Cal. Blk. S/N 88 Cal. In: 1145 AM n/a PM
Cal. Blk. Temp. 72 F Cal. Out: n/a AM 1225 PM

Calibration Readings (Inches)

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

Techniques
☐ CRT ☒ D-Meter
Other

Position #/Reading in Inches



Drawing

AREA	Position		Thickness
1	D-30"	R-52"	0.916"
2	D-12"	R-42"	1.15"
3	D-32"	R-38"	0.898"
4	D-52"	R-30"	0.951"
5	D-36"	R-14"	0.913"
6	D-52"	L-6"	0.992"
7	D-36"	L-26"	0.97"
8	D-52"	L-40"	0.99"
Plug	D-22"	L-58"	
*9	U-27"	R-30"	0.83"
*10	D-26"	R-11"	0.843"
*11	U-21"	L-12"	0.767"

*AREA's Dished - high noise levels unable to achieve accuracy

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

N5455 (05-90)

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc.No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 105 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli	**Date**

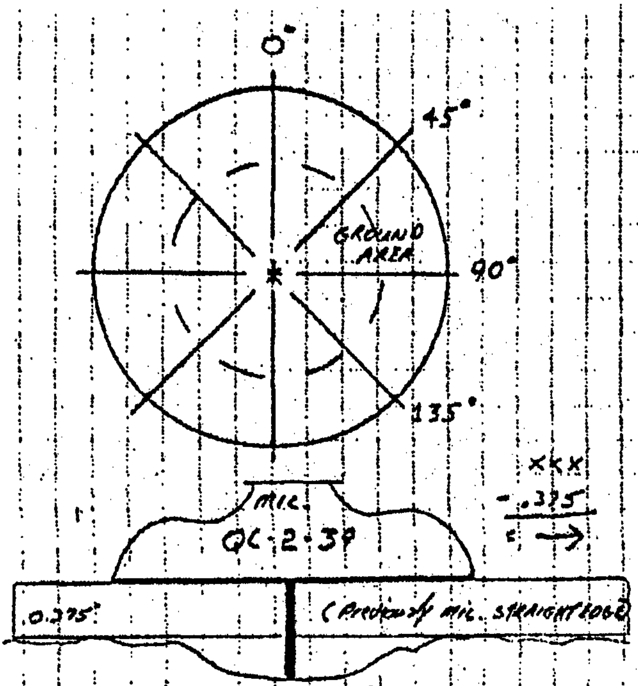
GPU Nuclear

☒ OC ☐ TMI ☐ OTHER ____________

Sketch Form (with grid)

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

Drawing



Technique utilized for The pit depth MEASUREMENTS

AZIMUTH

AREA	0°	45°	90°	135°
9	348	.407	.289	.342

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

GPU Nuclear

Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: nh Item: nh NDE Request: 92-072 Data Sheet No.: 92-072-02

Task Description: UT Thickness Task No.: nh Date: 12/5/92

Comp. Desc.: Drywell Liner Bay 19 System: 187 Code/Spec.: ASME Sect VIII

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

Test Surface: O.D. Thickness: 1 1/8" Material: c/s

Examiner	Sign:	Print: Jonathan VanderLinde	ID No.: 154-48-0319	Level: II
Examiner	Sign: Mark F. B	Print: Mark F. Bagnell	ID No.: 553-81-1802	Level: I

Thermometer S/N 92-057 Part Temperature 68 F D-Meter S/N 132-113

Cal. Blk. S/N 218 Cal. In: 10:20 AM nh PM

Cal. Blk. Temp. 68 F Cal. Out: 10:36 AM nh PM

Calibration Readings (Inches)

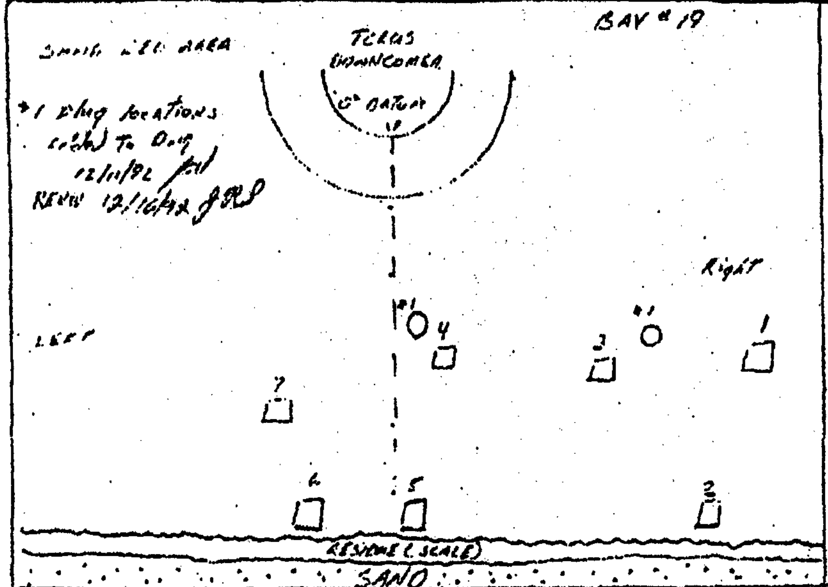
Cal. Blk.	0.5	0.75	1.0	1.25	1.5	
D-Meter	0.5	0.75	1.0	1.25	1.5	

Techniques

☒ CRT ☒ D-Meter

Other Sonic 132

Position #/Reading In Inches



Drawing

AREA	*POSITION		UT Measurement**
1	D-30"	R-70"	0.74"
2	D-52"	R-66"	0.96"
3	D-32"	R-49"	0.78"
4	D-32"	R-11"	0.99"
5	D-53"	R-2"	0.95"
6	D-52"	L-6"	0.86"
7	D-39"	L-12"	0.78"

* Position measurements are approximate

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

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

N9453 (05-91)

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 107 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli	**Date**

GPU Nuclear Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A	Item: N/A	NDE Request: 92-072	Data Sheet No.: 92-072-03
Task Description: UT Thickness		Task No.: N/A	Date: 12/16/92
Comp. Desc.: Drywell Liner Bay #19	System: 187	Code/Spec.: ASME Sect VIII	
Procedure/Rev.: 6100-QAP-7209.03 Rev 0		Drawing No./Rev.: 3E-187-29-001 Rev 0	
Test Surface: O.D.		Thickness: 1 1/8"	Material: C/S
Examiner Sign:	Print: J. Hanczu Luich	ID No.: 154-98-0319	Level: II
Examiner Sign: N/A	Print: N/A	ID No.: N/A	Level: N/A

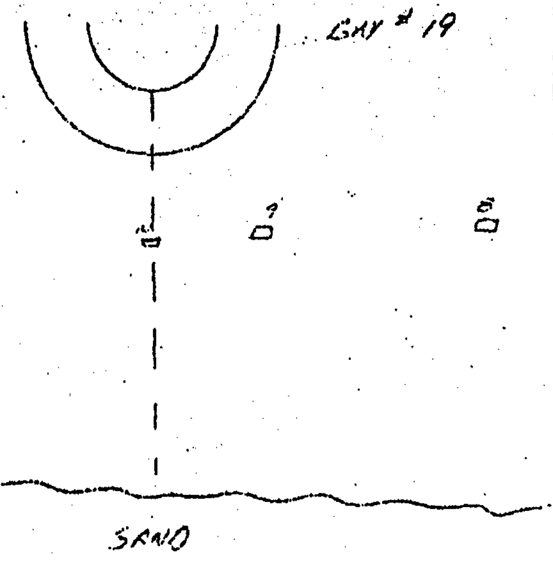
Thermometer S/N 92-007 Part Temperature 65 F D-Meter S/N 132-113
Cal. Blk. S/N 88 Cal. In: N/A AM 1:31 PM
Cal. Blk. Temp. 65 F Cal. Out: N/A AM 2:00 PM

Calibration Readings (Inches)

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

Techniques
☒ CRT ☒ D-Meter
Other ______

Position #/Reading in Inches



Drawing

Point		Thickness
8	0.18' R 63"	0.917
9	0.18' R 12"	0.795
10	0.18' R 0"	0.836

Performed after additional grinding

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

NS455 (05-90)

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 108 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli	**Date**

GPU Nuclear

Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: n/a	Item: n/a	NDE Request: 92-072	Data Sheet No.: 92-072-05
Task Description: UT Thickness		Task No.: n/a	Date: 12/14/92
Comp. Desc.: Drywell liner Bay 19	System: 187		Code/Spec.: ASME Sect VIII
Procedure/Rev.: 6100-QAP-7209.07 Rev. 0		Drawing No./Rev.: 3E-187-21-001 Rev. 0	
Test Surface: O.D.		Thickness: 1 1/8"	Material: C/S
Examiner Sign:	Print: J. Vanickilinck	ID No.: 15448-0319	Level: II
Examiner Sign: n/a	Print: n/a	ID No.: n/a	Level: n/a

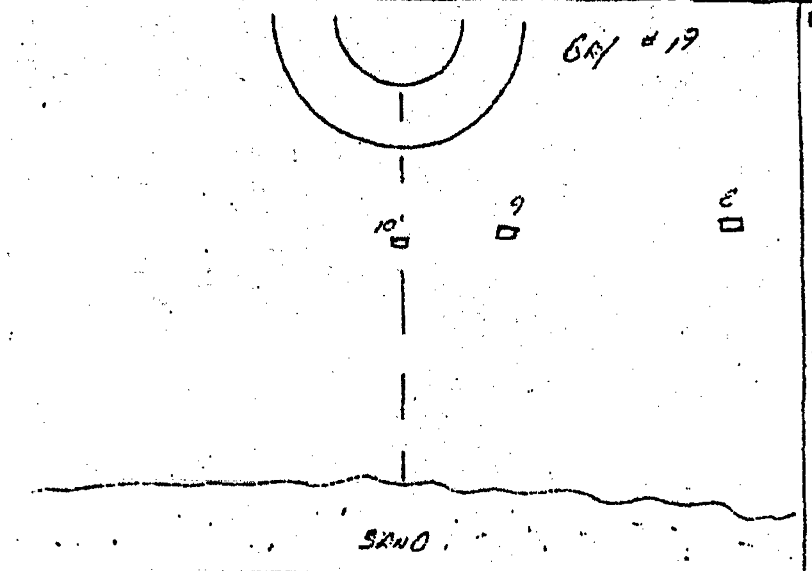
Thermometer S/N 92-017 Part Temperature 65 F D-Meter S/N 92-010
Cal. Blk. S/N 68 Cal. In: n/a AM 1:37 PM
Cal. Blk. Temp. 65 F Cal. Out: n/a AM 2:05 PM

Calibration Readings (inches)

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

Techniques
☒ CRT ☒ D-Meter
Other

Position #/Reading In Inches



Drawing

AREA	THICKNESS
8 D-18" & 63"	0.752
9 D-10" & 12"	0.776
10 D-19" & 0"	0.790

Performed after additional grinding

back with results

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

GPU Nuclear

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

GPU Nuclear

Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A Item: N/A NDE Request: 92-012 Data Sheet No.: 92-072-07

Task Description: UT THICKNESS Task No.: N/A Date: 12 11 92

Comp. Desc.: DRYWELL LINER BAY 19 System: 187 Code/Spec.: ASME SEC VIII

Procedure/Rev.: 6100-QAP 7209 07 REV 0 Drawing No./Rev.: 3E 187-21-001 REV 0

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

Examiner Sign: Print: Jonathan Underclerk ID No.: 157-48-0219 Level: II

Examiner Sign: Mark F B Print: MARK F BAGNELL ID No.: 553-81-1662 Level: I

Thermometer S/N 81-052 Part Temperature 72° F D-Meter S/N 92-010

Cal. Blk. S/N 86 Cal. In: N/A AM 12 45 PM

Cal. Blk. Temp. 72° F Cal. Out: N/A AM 13 15 PM

Calibration Readings (inches)

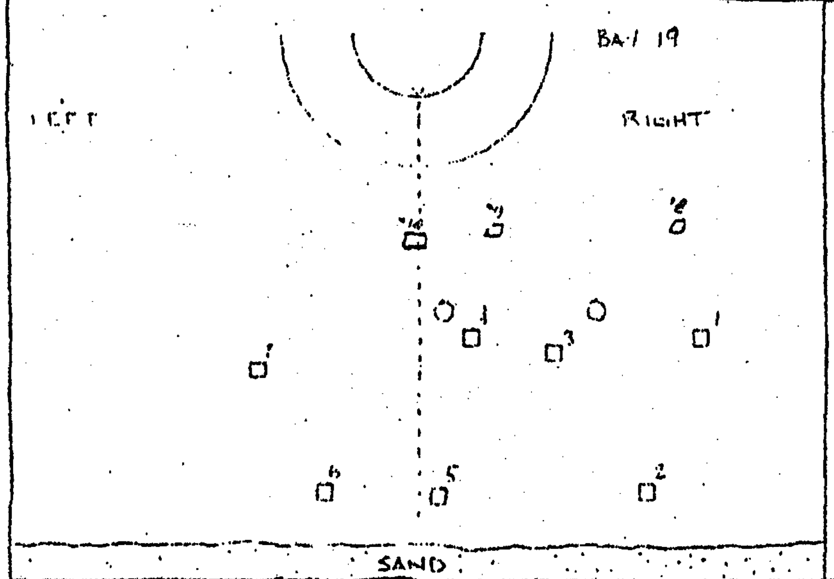
Cal. Blk.	0.5	0.75	1.0	N/A	N/A	N/A
D-Meter	0.5	0.75	1.0	N/A	N/A	N/A

Techniques

☐ CRT ☒ D-Meter

Other N/A

Position #/Reading in Inches



Drawing

AREA	LOCATION		MEASUREMENT
1	D 72	R 70	0.132
2	D 52	R 66	0.129
3	D [illegible]	R 47	0.155
4	D 42	R 11	0.140
5	D 57	R 2	0.156
6	D 52	L 6	0.860
7	D 71	L 12	0.164
* 8	D 16	R 63	0.750
* 9	D 18	R 12	0.703
* 10	D 8	0	0.781
LUG # 1	D 21	R 6	
LUG # 2	D 21	R 55	

[illegible]

* surface chisled unable to achieve accurate measurements

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

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 110 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli	**Date**

GPU Nuclear

Calibration Sheet

MOC ITMI

Cal Sheet# IR-034

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

Examiner: Signature: J V
Print: J Vanderlinde
Initial: JV
ID# 154-48-2319
Level II

Examiner: Signature: Mark B
Print: Mark F. Bagnell
Initial: MB
ID# 553 81-1802
Level I

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

Gain
Coarse 60.0
Fine n/a
Uncal n/a

Sweep Circuit
Coarse 20 Cyl (0.20"/div) (Range)
Fine n/a
Delay 1.0
Screen Depth 2" (sync ID)

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

Rep Rate: 1000 Hz

Cal Standard
ID# 218
Size n/a Sch. n/a
Thickness .5 x 1.5"
S/S [✓ CS]
Temp 68 °F

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

Date 12-5-92

Search Unit
ID# MC2524
Type MSEB
Freq 2 MHZ
Size 1/2"
Angle 0 Mode Long.

Cal Direction
☐Axial ☐Both
☐Circ. ☒Normal

Time 0910

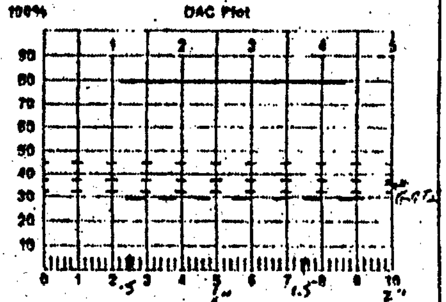
Search Unit Cable
Type RG-174 dual lead Lemo Length 2-6'

Couplant
Make Soundsafe Batch# 55C-89-1-02

Thermometer
S/N: 92-057 Cal Due 5-24-93

Reflector	Amplitude % of FSH	Screen Reading in Inches
.5"	80	.5
.75"	80	.75
1.0	80	1.0
1.25	80	1.25
1.5"	80	1.5

DAC Plot



Time/Date		0936/12-5-92		1029/12-5-92		1036/12-5-92	
Reflector	inches	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5"		80	.5	80	.5	80	.5
.75"		80	}	80	}	80	}
1.0		80		80		80	
1.25"		80		80		80	
1.5"		80	1.5	80	1.5	80	1.5
Initials		JV		JV		JV	

Remarks:
* Reflections adjusted to 80% FSH as required
** Digital calibration independent of CRT
Min .5"
Max 1.5"

Components Examined:
Bay 17 → Bay 19

ANI Review

Technical Review
Reviewed By
Level III Date 12-5-92

NDE Request#: 92-72

N0927 (05-90)

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 111 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli	**Date**

☑OC ☐TMI

GPU Nuclear

Calibration Sheet

Cal Sheet# [illegible]

System 187	Component [illegible]	Procedure [illegible]			Rev [illegible]
Examiner:	Signature:	Print: J VanderLinde	Initial: JV	ID# 157-48-0514	Level II
Examiner:	Signature:	Print: Mark F. Bagnell	Initial: MB	ID# 23-81-1842	Level I

Instrument Settings
ID# [illegible]
Model/Manuf DL 26 Panametrics

Gain
Coarse N/A
Fine N/A
Uncal N/A

Sweep Circuit
Coarse N/A (Range)
Fine N/A
Delay N/A
Screen Depth N/A

Operation [✓ T&R] Normal
Frequency: N/A MHZ
Reject: ☐Off ☐On N/A %
Filter: ☐Off ☐On N/A %
Damping: ☐Off ☐On N/A %

Rep Rate: N/A

Cal Standard
ID# 8F
Size N/A Sch. N/A
Thickness .2 & 1.0"
S/S [✓ CS]
Temp 72 °F

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

Date 12/11/92

Search Unit
ID# 92-038
Type D790 SM
Freq 5 MHZ
Size 0.25
Angle 0 Mode Comp

Cal Direction
☐Axial ☐Both
☐Circ. ☒Normal

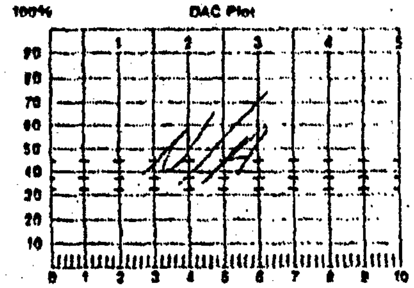
Time 1145

Reflector	Amplitude % of FSH	Screen Reading in Inches
.5	N/A	N/A
.75	N/A	N/A
1.0	N/A	N/A

Search Unit Cable
Type [illegible] Length [illegible]

Couplant
Make Soundsafe Batch# [illegible]

Thermometer
S/N: 87-053 Cal Due 1-9-93



Time/Date	1225 / 12/11/92		1245 / 12/11/92		1315 / 12/11/92	
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5	N/A	.5	N/A	.5	N/A	.5
.75	N/A	.75	N/A	.75	N/A	.75
1.0	N/A	1.0	N/A	1.0	N/A	1.0
Initials	JV		JV		JV	

Remarks:

Components Examined:
Cy 17-19

ANI Review

Technical Review
Reviewed By
Level III Date 12-16-92

NDE Request#: 92-072

N0927 (05-90)

GPU Nuclear

NOC ITMI

Calibration Sheet

Cal Sheet# [illegible]

System 187	Component Drywell liner		Procedure 6100-QAP-7209.07		Rev 0
Examiner:	Signature:	Print: J VanderLinde	Initial: JV	ID# 157-43-0318	Level II
Examiner:	Signature: n/a	Print: n/a	Initial: n/a	ID# n/a	Level n/a

Instrument Settings
ID# 92-010
Model/Manuf DL-26 Panametrics

Gain
Coarse n/a
Fine n/a
Uncal N/

Sweep Circuit
Coarse n/a (Range)
Fine n/a
Delay n/a
Screen Depth n/a

Operation T&R Normal
Frequency: n/a MHZ
Reject: ☐Off ☐On n/a %
Filter: ☐Off ☐On n/a %
Damping: ☐Off ☐On n/a %
Rep Rate: n/a

Cal Standard
ID# 88
Size n/a Sch. n/a
Thickness .5" - 1.0
S/S [✓ CS]
Temp 68 °F

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

Date 12/14/92

Search Unit
ID# 92-[illegible]
Type [illegible]
Freq 5 MHZ
Size 0.[illegible]
Angle 0 Mode [illegible]

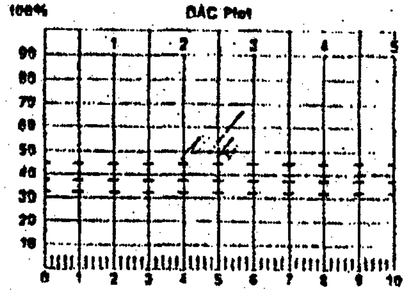
Cal Direction
☐Axial ☐Both
☐Circ. ☒Normal

Time 1305

Search Unit Cable
Type [illegible] Length [illegible]

Couplant
Make [illegible] Batch# [illegible]

Thermometer n/a
S/N: ~~[illegible]~~ 92-057 Cal Due 5-24-93



Reflector	Amplitude % of FSH	Screen Reading in Inches
.5	n/a	n/a
.75	n/a	n/a
1.0	n/a	n/a

Time/Date	1325 / 12/14/92		1337 / 12/14/92		1405 / 12/14/92	
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5	n/a	.5	n/a	.5	n/a	.5
.75	n/a	.75	n/a	.75	n/a	.75
1.0	n/a	1.0	n/a	1.0	n/a	1.0
Initials	JV		JV		JV	

Remarks:

Components Examined:
BAY 17+19

ANI Review

Technical Review
Reviewed By
Level III Date 12-16-92

NDE Request#: 92-077

N0927 (05-90)

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 113 of 117
Originator Mark Yekta / **Date** 01/12/93	**Reviewed by** S. C. Tumminelli		**Date**

GPU Nuclear

MOC 11TMI

Calibration Sheet

Cal Sheet# 12-1-11

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

Examiner:	Signature: for Old A	Print: J. Vander Linde	Initial: JVL	ID# 154-18-0319	Level II
Examiner:	Signature: n/a	Print: n/a	Initial: n/a	ID# n/a	Level n/a

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

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

Sweep Circuit
Coarse 2.0" (vel. 0.231"/μs) (Range)
Fine n/a
Delay 1.0
Screen Depth 2"

Operation
[✓ T&R] Normal
Frequency: 2.25 MHZ
Reject: ☐Off ☐On %
Filter: ☐Off ☐On 1 %
Damping: ☐Off ☐On 200 %

Rep Rate: 1000 Hz

Cal Standard
ID# 68
Size n/a Sch. n/a
Thickness .5-1.0
S/S [✓ CS]
Temp 68 °F

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

Date 12/14/92

Search Unit
ID# A08524
Type MSEB
Freq 2 MHZ
Size ½"
Angle 0 Mode Long

Cal Direction
☐Axial ☐Both
☐Circ. ☒Normal

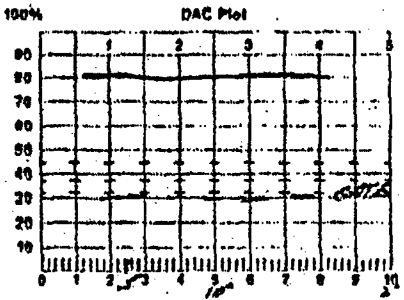
Time 1300

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

Search Unit Cable
Type dual lino Length 2x6'

Couplant
Make Soundsafe Batch# 05E 89-K02

Thermometer
S/N: 92-052 Cal Due 5-24-93



Time/Date	1330 / 12/14/92		1335 / 12/14/92		1400 / 12/14/92	
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5	80	.5	80	.5	80	.5
.75	80	.75	80	.75	80	.75
1.0	80	1.0	80	1.0	80	1.0
Initials	JV		JV		JV	

Remarks:
* backwall maintained at 80% FSH

Components Examined:
Bay 17+19

ANI Review

Technical Review
Reviewed By
Level III Date 12-16-92

NDE Request#: 92-072

N0927 (05-90)

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 114 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli	**Date**

GPU Nuclear Ultrasonic Thickness Data Sheet

☒ OC ☐ TMI-1 ☐ TMI-2 Class: n/a	Item: n/a	NDE Request: 92-072	Data Sheet No.: 92-072-11
Task Description: DRY WALL LINER MOCK-UP		Task No.: n/a	Date: 12-16-92
Comp. Desc.: WELD OVERLAY TEST PLATE	System: 187		Code/Spec.: ASME SECT VIII
Procedure/Rev.: 6100-QAP-7209.07 / 0		Drawing No./Rev.: -NA-	
Test Surface: OD		Thickness: 3/4"	Material: C/S
Examiner Sign:	Print: J. Vander Linde	ID No.: 154-46-0318	Level: II
Examiner Sign:	Print: JAMES PHILLIPPI	ID No.: 462277035	Level: I

Thermometer S/N 92-063 Pan Temperature 68° F D-Meter S/N 92-010

Cal. Blk. S/N 214 Cal. In: N/A AM 1420 PM

Cal. Blk. Temp. 68° F Cal. Out: N/A AM 1440 PM

Calibration Readings (Inches)

Cal. Blk.	.502	.752	1.001	1.251		
D-Meter	.502	.751	1.000	1.250		

Techniques

☐ CRT ☒ D-Meter

Other -NA-

Position #/Reading in Inches

Drawing

	A SCAN	26 DL
BASE METAL	.73	.728
1 PASS	.94	.927
2 PASS	1.12	1.114

Reviewed by: Level: III Date: 12-22-92 Page 1 of 1

N5433 (03-90)

Ultrasonic Thickness Data Sheet

GPU Nuclear

☒ OC ☐ TMI-1 ☐ TMI-2 Class: N/A	Item: N/A	NDE Request: 92-072	Data Sheet No.: 92-072-11
Task Description: DRY WALL LINER MOCK-UP		Task No.: N/A	Date: 12-16-92
Comp. Desc.: WELD OVERLAY TEST PLATE	System: 187		Code/Spec.: ASME SECT VIII
Procedure/Rev.: 6100-QAP-7209.07 / 0		Drawing No./Rev.: -NA-	
Test Surface: OD		Thickness: 3/4"	Material: C/S
Examiner Sign:	Print: J. Vande Linde	ID No.: 154450319	Level: II
Examiner Sign:	Print: JAMES PHILLIPPI	ID No.: 462277035	Level: I

Thermometer S/N 92-063 Part Temperature 68° F D-Meter S/N 92-010

Cal. Blk. S/N 214 Cal. In: N/A AM 1420 PM

Cal. Blk. Temp. 68° F Cal. Out: N/A AM 1440 PM

Calibration Readings (inches)

Cal. Blk.	.502	.752	1.001	1.251		
D-Meter	.502	.751	1.000	1.250		

Techniques

☐ CRT ☒ D-Meter

Other -NA-

Position #/Reading in Inches

Drawing

	A-SCAN	26 DL
BASE METAL	.73	.728
1 PASS	.94	.927
2 PASS	1.12	1.114

Reviewed by: Level: III Date: 12-27-92 Page 1 of 2

GPU Nuclear

Subject O.C. Drywell Ext. UT Evaluation in Sandbed	**Calc No.** C-1302-187-5320-024	**Rev. No.** 1	**Sheet No.** 116 of 117
Originator Mark Yekta	**Date** 01/12/93	**Reviewed by** S. C. Tumminelli	**Date**

GPU Nuclear

☑ OC ☐ TMI

Calibration Sheet

Cal Sheet# 14L-05-2

System 187	Component DRYWELL LINER	Procedure 6100-QAP-7209.07			Rev 0
Examiner:	Signature:	Print: J Vandeclinde	Initial: JV	ID# 5495-0318	Level II
Examiner:	Signature: James Phillippi	Print: JAMES PHILLIPPI	Initial: JP	ID# 462277035	Level I

Instrument Settings
ID# 137-113
Model/Manuf SONIC 137 / STAVELEY

Gain
Coarse 60.2 dB
Fine N/A
Uncal N/A

Sweep Circuit
Coarse 2.0" (VEL .231 in/µs) (Range)
Fine N/A
Delay 1.0
Screen Depth 2"

Operation
T&R Normal
Frequency: 2.25 MHZ
Reject: ☒Off ☐On N/A %
Filter: ☐Off ☒On FILT 1 %
Damping: ☐Off ☒On 200 Ω %

Rep Rate:

Cal Standard
ID# 214
Size NA Sch. NA
Thickness .5-1.25
S/S [✓ CS] NA
Temp 68 °F

System Check
☐Exit Point
☐Angle +/- 2

Search Unit
ID# M08524
Type MSEB
Freq 2.0 MHZ
Size .5"
Angle 0 Mode LONG

Cal Direction
☐Axial ☐Both
☐Circ. ☒Normal

Search Unit Cable
Type DUAL LIMO Length 2 x 6'

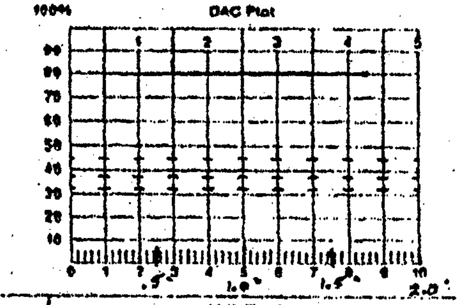
Couplant
Make SOUNDSAFE Batch# SSP-89-1-02

Thermometer
S/N: 92-063 Cal Due 5-24-93

Date 12-16-92 Time 1410

Reflector	Amplitude % of FSH	Screen Reading in Inches
.5	80	.5
.75	80	.75
1.0	80	1.0
1.25	80	1.25

DAC Plot



Time/Date	1415 / 12-16-92		1425 / 12-16-92		/	
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5	80	.5	80	.5		
.75	80	.75	80	.75		
1.0	80	1.0	80	1.0		
1.25	80	1.25	80	1.25		
Initials	JV		JV			

Remarks:

Components Examined:
Drywell Liner weld overlay
Test Plate

ANI Review

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

NDE Request#: 92-072

H0927 (05-90)

GPU Nuclear

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

Examiner: Signature: James Phillippi Print: JAMES PHILLIPPI Initial: JP ID# 462277035 Level I

Instrument Settings
ID# 92-010
Model/Manuf DL-26 PANAMETRICS
Gain
Coarse N/A
Fine N/A
Uncal N/A
Sweep Circuit
Coarse N/A (Range)
Fine N/A
Delay N/A
Screen Depth N/A
Operation
T&R Normal
Frequency: N/A MHZ
Reject: [ ]Off [ ]On N/A %
Filter: [ ]Off [ ]On N/A %
Damping: [ ]Off [ ]On N/A %
Rep Rate: N/A

Cal Standard
ID# 214
Size N/A Sch. N/A
Thickness .5 - 1.5
S/S [✓ CS] N/A
Temp 68 °F

Search Unit
ID# 92-038
Type D790 SM
Freq 5 MHZ
Size .312
Angle 0 Mode LONG.

Search Unit Cable
Type SELF CONTAINED Length 2 × 6'

Couplant
Make SOUNDSAFE Batch# SSP-89-1-02

Thermometer
S/N: 92-063 Cal Due 5-24-93

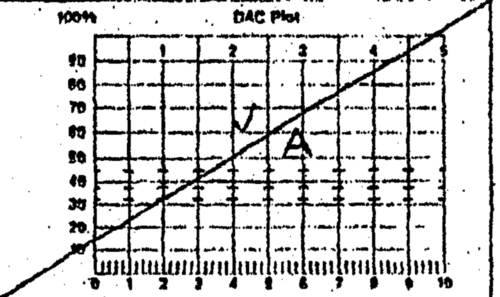
System Check N/A
☐ Exit Point
☐ Angle +/- 2

Cal Direction
☐ Axial ☐ Both
☐ Circ. ☒ Normal

Date 12-16-92 Time 1412

Reflector	Amplitude % of FSH	Screen Reading in Inches
.5	N/A	N/A
.75	N/A	N/A
1.0	N/A	N/A
1.23	N/A	N/A

DAC Plot



Time/Date	1420 12-16-92		1440 12-16-92			
Reflector	% FSH	Inches	% FSH	Inches	% FSH	Inches
.5	N/A	.5	N/A	.5		
.75	N/A	.75	N/A	.75		
1.0	N/A	1.0	N/A	1.0		
1.25	N/A	1.25	N/A	1.25		
Initials	JP		JP			

Remarks:

Components Examined:
Drywell Liner weld overlay
Test plate

ANI Review

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

NDE Request#: 92-072

N0927 (05-90)

APPLICANT'S EXH. 19

Passport 00546049 07
(AR A2152754 E09)

Reason For Evaluation: Water Found in Drywell Trench 5 – UT Data Evaluation

During the 1R21 Refueling Outage, standing water was found in the trench at elevation 10' 3" in Bay 5 of the Drywell. The purpose of this technical evaluation is to develop a conservative approach to address the worst case concerns associated with the as-found water in the drywell concrete. This evaluation will assess the condition through comparisons of the original UT data taken in 1986, and the UT data taken during the 1R21 outage. Note that the sand and water corrosive environment was removed from the sandbed region in 1992. This evaluation will evaluate these UT results as they relate to potential corrosion concerns based on the current plant configuration with water existing in the drywell concrete area. This evaluation will address immediate concerns in the as-found wetted area of the drywell shell to demonstrate adequate design margins exist (in a worst-case scenario) to support startup of the plant and operation of the plant through the next cycle of operation. The complete assessment of all UT data taken in 1R21 and establishing the associated margins to support operating through the period of extended operation of the plant will be addressed separately.

This Tech Eval was developed in accordance with CC-AA-309-101 Revision 7.

The development of this Tech Eval was reviewed with Howie Ray in accordance with HU-AA-1212. The risk rank was assessed as a "2". Therefore a third party review will be performed.

Background:

In 1986 concrete was removed in two locations (one each in Bays 5 and 17) from the interior Drywell floor at elevation 10' 3". Approximately a 1 foot wide by 2 foot long section was removed at each location. These areas have been commonly referenced to as the "trenches". The purpose of the "trenches" was to expose the Drywell Vessel below the concrete inside the Drywell at elevation 10' 3" so that UT readings could be performed on the vessel.

The bottom of trenches in Bay 5 and 17 are located at approximately elevation 8' 9" and 9' 3" respectively, which generally correspond to the elevation of the sandbed floor located outside the Drywell. Therefore the UT readings from the original trench areas correspond to sections of the vessel that are not embedded in outside concrete. The results of these UT inspections were documented in TDR 851 and drawing 3E-SK-S-85. UT readings were taken on 1 inch centers. The results of the 1986 UT inspections show drywell thicknesses which are indicative of the vessel embedded on the inside of the Drywell and exposed to the sand environment on the outside, which was eventually eliminated in 1992 when the sand was removed from the sandbed region.

In 1992, following the removal of the sand from the sandbed region and the removal of corrosion byproducts, the Drywell Vessel was visually inspected from inside the sandbed, which is outside the Drywell Vessel. This inspection identified the thinnest locations in each of the 10 sandbed bays. These thinnest locations were then UT inspected. In some cases the area had to be slightly grinded so that the UT probe could rest flat against the surface of the vessel. The thickness values and the locations of each reading, referenced from existing welds, were recorded on a series of NDE data sheets. At each location one UT reading was performed.

In 2006, UT readings of the interior Drywell shell were again recorded on 1 inch centers in the two trenches. These readings were intended for a comparison with the 1986 readings.

Also in 2006, 106 readings were taken of the external portion of the Drywell Vessel from within the former sandbed region. These locations were located using the 1992 NDE Inspection Data Sheet maps. These readings were intended for a comparison with the 1992 readings.

Additionally, during the 1R21 outage in 2006 more concrete was removed from the bottom of the trench in Bay 5 to expose an additional 6" by 12" section of the drywell vessel. This newly exposed section of the vessel lies below the sandbed floor on the outside of the drywell. Therefore the results of this inspection show drywell thicknesses that are indicative of the vessel that is embedded on both sides by concrete.

Detailed Evaluation:

Assumptions and Clarifications

1) TDR 851 documents that values initially recorded using "D" meter UT instrumentation in the Bay 5 trench in 1986 were much less than nominal.

In order to rule out that these readings did not indicate small or pin-point corrosion cells additional NDE investigations were performed in 1986 by GPUN and EPRI NDE personnel. The investigations revealed that the low readings were due to small inclusions in the steel plate rather than thin steel. This was later confirmed by the removal of a 2" diameter section of the Drywell Vessel, which contained an inclusion. Lab analysis of the inclusion characterized it as an "aluminide stringer" at the mid-wall plane of the plate parallel to the rolling direction (reference TDR 854). The conclusions of this investigation were also reviewed by the NRC in an SER (dated December 29, 1986, Docket No.50-219) and found to be acceptable.

However the actual readings were captured in Drawing 3E-SK-S-85.

Inclusions of this nature and size are acceptable in the manufacturing process of carbon steel plates and do not effect the ultimate strength of the plates,

If Oyster Creek were to perform an inspection of this plate for unacceptable indications then ASME Section III sub-section NB 2532 (2004) would provide acceptance criteria for indications as identified by UT inspection.

Subsection NB 2532 provides acceptance criteria as follows:

1) Any area where one or more imperfection produce continuous total loss of back reflection accompanied by continuous indications on the same plane that cannot be encompassed with a circle whose diameter is 3 inches or one half the plate thicknesses, which ever is greater is unacceptable.
2) In addition two or more imperfections smaller than described in 1 above shall be unacceptable unless separated by a minimum distance equal to the greatest diameter of the largest imperfection, or unless they may be collectively encompassed by the circle described in (1) above

The ultrasonic equipment (Panametrics 37DL) used during 1R21 displays both a "digital thickness readout" and an "A" scan presentation. Small inclusions whether gas or non-metallic that are flattened during the rolling process create perfect sound reflectors in plate. The "A" scan presentation gives the operator the ability to distinguish between non-relevant signals and true thickness readings. It also gives the operator the ability to adjust the appropriate signal (the one representing the full thickness) either by increasing or decreasing the gain to change the signal amplitude or by using a feature called "extended blank" which basically tells the machine not to record readings in a certain area. These adjustments are made so the correct reading can be obtained from the controlled storage module of the instrumentation database.

A review of the 1R21 data taken in the Bay 5 trench shows that the operator made several adjustments to both the gain and the extended blank.

In addition, had any of the inclusions been large enough to block the ultrasonic signal a reading would not have been recorded. No such readings were observed in 1R21. The inspection performed on the Bay 5 Trench during 1R21 was for thickness only, however the fact that we were able to get sound to penetrate through the entire thickness demonstrates that no area contained inclusions larger than the diameter of the transducer (0.438"). This would not have been the case due to the different technology used in 1986. Therefore using the ASME Section III guidance for the 1986 and 2006 inspection led to the following conclusions.

In 2006 all readings located on 1 inches center were successfully obtained and back reflection were achieved on all reading. Therefore based on the size of the UT transducer no imperfections were detected, which approach 0.438 inches in diameter.

UT readings were collected on 1 inch centers with a UT transducer with a head size of 0.438 inches in diameter. Therefore the largest linear distance in the inspection area that would not have been scanned is approximately 0.976 inches, which is diagonal distance between two adjoining inspection points. Therefore any potential laminations approaching 1" in diameter would have been identified by the inspection and were not.

However oblong indications of up to 0.562 inches wide and that exceed 3" in length and are parallel to the grid pattern may not have been observed.

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The existence of unacceptable indications is not considered credible for the following reasons:

1) The 1986 data shows that no three continuous 1 inch grid locations had indications of inclusions.

2) The indication would have to be oblong and parallel to the grid pattern.

3) Any inclusions or indications would have occurred in the manufacturing process randomly with respect to the location on the plate. Therefore, since 1986 and 2006 thickness readings are normally distributed (see attachment 2), it can be concluded with 95% confidence that the true condition of the plate is known in 2006.

Therefore for the purpose of this evaluation, all readings found to be lower than 0.780 inches were discounted from the 1986 readings for the trench in Bay 17. Also the 2006 data showed no similar readings (less than 0.780) in the lower 5 grids. The discounted readings are circled in attachment 1. Note that this treatment of the 1986 data is actually conservative for computing corrosion rate if they were compared to the 2006 data, because the 1986 values (if included) would have reduced the 1986 average thickness.

2) The uncertainties of the 1986, 1992, and 2006 UT readings can be as great as +/- .020 inches based on:

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 the 1986, 1992 and 2006
c) UT Equipment Instrument Uncertainties and
d) The uncertainties in attempting to inspect the exact same location over time

3) Row 7 points 6 and 7 in the Bay 17 trench data for 2006 were discounted because they were much thicker than the previous readings. These points are located on a much thicker weld. These readings were re-verified by NDE to be correct, however these values were discounted to maintain conservative results.

4) The sections of drywell vessel that were exposed by the removal of the concrete in trenches in 1986 continued to corrode from the exterior at elevated rates between 1986 and 1992 prior to the removal of the sand and epoxy coating application. For example inspection in 1992 showed that corrosion rates in Bay 17 could have been as great as 0.0211 inches per year, with 95% confidence (ref. C-1302-187-5300-021). The corrosion rates in the Bay 5 were estimated to be as great as 0.0113 inches per year, at 95% confidence (C1302-187-5300-028). Therefore the material loss measured by the 2006 UT inspection would include the corrosion rates that were known to exist from the sandbed side (exterior) between 1986 and 1992.

5) Direct point to point comparison of the 1986 and 2006 trench UT data cannot be preformed since the precise location of the 1986 readings and grids were not marked.

Acceptance Criteria

Drywell Vessel Thickness criteria has been previously established (reference C-1302-187-5320-024) as follows:

1) General Uniform Thickness - 0.736 inches or greater.

2) If an area is less than 0.736" thick then that area shall be greater than 0.693." thick and shall be no larger then 6" by 6" wide. C-1302-187-5320-024 has previously dispositioned an area of this magnitude in Bay 13.

3) If an area is less than 0.693" thick then that area shall be greater than 0.490" thick and shall be no larger then 2" in diameter. C-1302-187-5320-024 calculated an acceptance criterion of .479 inches however; this evaluation is conservatively using .490 inches, which is the original GE acceptance criterion. Since the UT readings were taken on 1 inch centers and the transducer size is less than 0.5 inch these readings can be characterized as less than 2 inches in diameter.

Comparison of the Bay 5 Trench

The 1986 and 2006 data for the Bay 5 trench is located in attachment 1. A Mathcad spreadsheet that computes the average of each data set is provided in attachment 2. Please note that zero values are automatically discounted from the average and standard deviation computation. These are the values that were concluded to be inclusions in the 1986 data (see assumption 1).

The computation shows that a total of 302 readings were considered for 1986 and that the mean was 1.112 inches with a standard deviation of 0.045 inches and a standard error of .00259 inches. This meets the general acceptance criteria of 0.736 inches with a 95% confidence.

The computation shows that a total of 294 readings were considered for 2006 and that the mean is 1.074 inches with a standard deviation of 0.0456 inches and a standard error of .00266 inches. This meets the general acceptance criteria of 0.736 inches with a 95% confidence.

Assuming the material loss occurred continuously from 1986 to 2006 results in an apparent corrosion rate of 0 .0019 inches per year. However when considering the aggressive corrosive environment that existed from 1986 to 1992 on the outside of the vessel, a corrosion rate of 0.0063 inches per year would be expected during this time frame (1986 to 1992). This rate is well within the range (up to 0.0113 inches per year) measured in bay 5 during this period (see assumption/clarification 4). Therefore, it can be concluded that most of the material loss occurred between 1986 and 1992.

The minimum 2006 reading in this trench was 0.957 inches. This meets the local acceptance criteria of 0.49 inches.

Comparison of the Bay 17 Trench

The 1986 and 2006 data for the Bay 17 trench is located in Attachment 1. A Mathcad spreadsheet that computes the average of each data set is provided in Attachment 3. Note that zero values are automatically discounted from the average and standard deviation computation. These are the 2006 points, which were much thicker than the previous readings (see assumption 3).

The 1986 data consist of five, 7 row by 7 column grids and one additional row. The computation shows that a total of 250 readings were considered for 1986 and that the mean is 1.024 inches, with 95% confidence, a standard deviation of .045 inches, and a standard error of .002847 inches. This meets the general acceptance criteria of 0.736 inches with a 95% confidence.

The 2006 data consist of six 7 row by 7 column grids. The initial 2006 computation of the considered 290 readings resulted in a 0.963 inch mean with a standard deviation of .0713 inches and a standard error of .004184 inches. This meets the general acceptance criteria of 0.736 inches. Statistical review of the data shows that the distribution is skewed and cannot be considered completely normalized. Therefore the calculated mean for these six grids does not have a 95% confidence level. However closer review of the 2006 data shows that the top grid has a mean (0.845 inches) which was significantly less than the mean or the lower 5 grids (0.9852 inches). Statistical review of the 5 lower grids without the top grid shows that the distribution is completely normalized.

The mean of the lower 5 grids (with a total of 243 readings) is 0.9856 inches, a standard deviation of .0412 inches, and a standard error of 0.00266 inches. This meets the general acceptance criteria of 0.736 inches and is consistent with the standard deviation and standard error of 1986 data.

This comparison indicates that it is possible that the lower 5 grids of the six measured in 2006 (with a total of 243 readings) correspond to approximately the same area that 5 grids and 1 row (with 250 reading) measured in 1986. However since the mean of all six 2006 grids (with 290 readings) results in a more conservative rate the 6 grid mean will be used to calculate the maximum potential corrosion rates between 1986 and 1992 and apparent corrosion rates between 1986 and 2006.

Assuming the material loss occurred continuously from 1986 to 2006 results in an apparent corrosion rate of 0.003055 inches per year. However when considering the aggressive corrosive environment that existed from 1986 to 1992 on the outside, a corrosion rate of 0.0102 inches per year would be expected during this time frame (1986 to 1992). This rate is well within the range (up to 0.0211 inches per year) measured in bay 17 during this period (see assumption/clarification 4). Therefore, it is expected that the material loss occurred between 1986 and 1992.

In addition the minimum 2006 individual reading in this trench was 0.702 inches which is estimated to be located in an area no larger than 4" in diameter. This meets the acceptance of criteria 0.693 inches in an area of 6" by 6" or smaller for at least an additional two years.

Comparison of external inspection locations correlating to beneath the interior Drywell floor at elevation 10' 3" but above the wetted area at elevation 9' 2".

The 1992 and 2006 data for 106 external inspections is provided in attachment 4. This attachment includes inspections that were performed above and below the internal concrete floor at elevation 10' 3".

Review of the 106 locations show 18 areas corresponding to elevations of the drywell vessel that are beneath the interior Drywell floor at elevation 10' 3" but above the wetted area at elevation 9' 2" (see attachment 5). The data for the 18 locations is shown in attachment 6. For each of these 18 readings the 2006 value was subtracted from the 1992 value and divided by 14 years (time between 1992 and 2006). Locations with positive rates were re-verified by NDE to be correct during the 2006 inspection. However, since these values would result in positive changes in metal thickness, they were discounted from the computation to maintain conservative results.

The resulting differences in UT readings based on point-to-point comparison in this region vary between 0 and .0065 inches per year. On average the differences for this region, ignoring the described uncertainties, equate to 0.00228 inches per year.

The minimum 2006 reading of all the areas below the concrete floor was 0.669 inches. This meets the local acceptance criteria of 0.49 inches even after deducting the worst case differences including instrument uncertainties.

Comparison of External Inspection Locations correlating to beneath the wetted elevation of 9' 2" (approximate level at which water was discovered in the Bay 5 trench)

The 1992 and 2006 data for 106 external inspections is provided in attachment 4. This attachment includes inspections that were performed above and below the internal concrete floor at elevation 10' 3".

Review of the 106 locations show 22 area corresponding to elevations of the drywell vessel at an elevation below 9' 2"; which is the approximate level that water was discovered in the Bay 5 trench (see attachment 5). The data for the 22 locations is shown in attachment 6. For each of these 22 readings the 2006 value was subtracted from the 1992 value and divided by 14 years (time between 1992 and 2006). Locations with positive rates were re-verified by NDE to be correct during the 2006 inspection.

However, since these values would result in positive changes in metal thickness, they were discounted from the computation to maintain conservative results.

The resulting changes based on point to point comparison varied between 0 and .0061 inches per year. On average the changes for this region would equate to 0.00233 inches per year. These values can be conservatively used to demonstrate that even if the rates are not due to the expected uncertainties, there is sufficient margin existing to account for these uncertainties.

Bounding Worse Case

The maximum worst case point to point difference between 2006 data and 1992 data was found at a single location at an elevation above the wetted region but below the floor at elevation 10' 3". The difference was found at point 5 in Bay 17 from data collected from the external inspection (See attachment 6 sheet 2).

This wall thickness difference was computed be subtracting the 1992 value for this point from the 2006 value without eliminating uncertainties. This point is not located within either of the trench locations. The difference in thickness at this point equates to an apparent rate of 0.0065 inches per year, which is not considered credible given the physical limitations of the UT inspections taken from the exterior surface. These limitations include the roughness of the inspected surfaces, the different UT technologies used between 1992 and 2006, UT Equipment Instrument Uncertainties, and the repeatability due to trying to locate the exact same location over time.

However even when considering this worse case difference which was recorded on a location that is 0.822 inches thick in 2006, and considering it as a loss of wall rate per year at the thinnest location recorded in 2006 for points located below the concrete floor (0.669 inches in Bay 13 point 11), and applying 0.020 inch deduction for instrumentation uncertainty this location would only reduce to 0.636 inches by 2008, which still demonstrates significant margins compared to the acceptance criteria of 0.49 inches. Attachment 6 provides a spreadsheet that illustrates the basis for the above discussion.

Also considering a 0.0065 inches per year rate of change and applying it to the 2006 Bay 17 trench mean value (0.963 inches) and applying .020 inch deduction for instrumentation uncertainty would only reduce this value to 0.930 inches by 2008,

Conclusion:

The UT measurement taken on the plates exposed by the two trenches exhibit signs of material loss. It is concluded that most of the material loss occurred between 1986 and 1992. Assumed corrosion rates for this mechanism between 1986 and 1992 are consistent with as found measured corrosion rates previously established for these bays prior to removing the sand.

Additional concrete was removed from Bay 5 trench and UT readings taken 6 inches below the previous 1986 and 2006 readings. This newly excavated area represents shell thicknesses of the embedded region (on both sides) of the vessel in Bay 5 of sandbed region. The average Drywell shell thickness measured was 1.113 inches and the minimum reading was 1.052 inches. The UT Data Sheet is Attachment 7 to this evaluation. The shell thickness in this area meets the general uniform thickness criteria of 0.736 inches with considerable margin. This area will be used to repeat these UT measurements in 1R22.

Evaluation of the NDE examination results at and below the elevation 10'3" concrete slab concludes that the Drywell shell has sufficient thickness to withstand all design requirements.

Since there is uncertainly associated with the different instrumentation used in 1986 and 1992 and the instrumentation used in 2006, additional inspection of both trenches will be performed during the 2008 refueling outage..

References:

TDR 851, Rev. 0, "Assessment of Oyster Creek Drywell Shell,

TDR 854, Rev. 0, "Drywell Corrosion Assessment"
Drawing 3E-SK-S-85.
C-1302-187-5320-024, "OC Drywell UT Evaluation in Sandbed"

Attachment 1 – 1986 and 2006 Trench Inspection Data – 10 pages
Attachment 2 – Bay 5 Trench Comparison of 1986 and 2006 data – 17 pages
Attachment 3 – Bay 17 Trench Comparison of 1986 and 2006 data – 20 pages
Attachment 4 – 1986 and 2006 Sandbed External Inspection Data – 20 pages
Attachment 5 – Plan and Elevation locations of the External Inspection locations – 8 pages
Attachment 6 – Comparison of 1986 and 2006 External Data – 2 pages
Attachment 7 – UT Data Sheet 1R21LR-032 – 2 pages
Attachment 8 – Third Party Review Documentation - 3 pages
Attachment 9 – MPR Ass. Independent Review Documentation - 2 pages

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Prepared by: Tamburro, P
Pat Tal 11/7/06

This evaluation was Independently Reviewed by Frank Stulb through out its development which took approximately 7 days.

Comment resolution and incorporation of the Independent Third Party Review comments were discussed with Frank Stulb per a telephone conversation on 11/3/06 at 10:12 AM. He provided authorization for documentation and approval of his Independent Review of this document per this telephone conversation.

Independent Reviewer: P. Tamburro for F. Stulb by telecon on 11/7/06
Pat Tal 11/7/06 For F. Stulb per telecon.

Manager Comments:
The preparer and multiple reviewers of this technical evaluation had the appropriate knowledge and experience and are qualified to perform this task. The Independent Third Party Review (ITPR) was performed by MPR who was selected as a subject matter expert based on their expertise and industry experience on this topic. This document has been rigorously challenged and addresses the adequacy of the as-found water conditions and potential impacts to demonstrate the drywell vessel maintains its design and licensing bases requirements to support restart from 1R21.

The ITPR has been completed and comments adequately resolved as documented in Attachment 9.

Manager Approval: F.H. Ray 11/7/2006
F Harris Ray 11/7/06

Presented at Start-Up PORC Meeting No. 06-18

PORC Chairman Approval: 11/7/06

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EXPANDED U.T. AT PT. NO. 5B TRENCH
(5 IN. BY 46 IN. MATRIX)
(DATA SHT. NO. 86-049-47)

1.156	1.166	1.182	1.172	1.225	1.181	[illegible]
1.160	.437	1.184	1.173	1.175	1.171	[illegible]
1.165	1.164	1.151	.657	.419	1.170	[illegible]
1.145	1.151	1.158	1.162	[illegible]	1.159	[illegible]
1.123	1.151	1.148	1.167	.456	1.139	[illegible]
1.128	1.138	1.141	1.137	[illegible]	1.144	[illegible]
1.123	1.149	1.130	.734	.735	N/A	N/A
1.109	1.121	1.144	1.155	1.156	1.149	[illegible]
1.064	1.066	1.068	1.115	1.1	1.109	[illegible]
1.051	1.096	1.041	1.077	1.162	1.078	[illegible]
1.063	1.100	1.110	1.048	1.101	1.110	1.133
1.047	1.109	1.149	1.13	1.176	1.179	1.058
1.125	1.123	1.090	1.117	1.182	1.200	1.182
1.135	1.091	1.107	1.080	1.084	1.125	1.183
1.094	1.064	1.067	1.079	.446	1.169	1.140
1.043	1.079	1.052	1.079	1.119	1.164	.444
1.058	1.055	1.082	1.044	1.071	.475	1.137
1.087	1.049	1.058	1.114	1.083	1.053	1.140
1.180	1.118	1.093	1.043	1.062	1.178	1.156
1.138	1.071	1.109	1.137	1.096	N/A	1.194
1.109	1.082	1.158	1.098	1.166	1.134	1.056
1.141	1.128	1.089	1.154	1.164	1.141	1.122
1.159	.758	.759	1.170	.771	1.151	[illegible]
1.166	1.127	1.105	1.174	1.169	1.105	[illegible]
1.109	1.148	.481	1.166	1.171	1.113	[illegible]
1.089	1.167	.571	[illegible]	1.128	1.133	1.100
1.126	1.092	1.178	.710	1.167	1.124	1.072
1.069	1.054	1.112	1.099	1.146	1.119	1.098
1.076	1.056	1.098	.453	1.139	1.098	1.077
1.118	1.054	1.100	.459	1.060	1.062	1.101
[illegible]67	1.073	1.110	1.205	1.149	1.090	1.113
[illegible]	1.106	1.171	1.193	1.041	1.134	1.093
1.094	1.119	1.115	1.148	1.092	1.118	1.109
1.128	1.134	1.125	N/A	1.147	1.145	1.112
1.065	1.077	1.138	1.168	1.077	1.068	1.073
1.062	1.101	.456	1.088	1.069	1.074	1.047
1.100	1.062	1.141	1.059	1.110	1.076	1.078
1.044	1.052	.445	1.045	1.083	1.081	1.074
1.031	.788	1.057	1.073	1.059	1.109	1.062
1.035	.359	1.076	1.060	1.016	1.074	1.037
1.024	1.103	1.030	1.059	1.061	1.062	[illegible]
.430	1.057	1.021	1.015	1.028	1.089	[illegible]
1.087	1.110	1.027	1.040	1.070	1.079	[illegible]
.773	1.132	1.049	1.096	1.052	1.093	[illegible]
1.168	1.112	1.113	1.101	1.056	1.065	[illegible]
1.271	1.138	1.117	1.103	1.152	1.142	[illegible]
1.211	1.158	1.099	1.133	1.134	1.145	[illegible]

EL11-3"

Note circled values were discounted because thes value indicate inclusions.

TDR-851

From 3E-SK-S-85

Bay 5

Trench 90°

PASSPORT# 00546049 07
AR# A2152754 E09
ATTACHMENT 1
PAGE 1 OF 16

U.T. AT WELD, BAY NO. 5
(DATA SHT NO. 86-049-39)

DOWNCOMER AREA	2.901	2.914
HEAT AFFECTED ZONE AREA	.438	1.206
	1.170	1.175
	.870	.411

EXPANDED U.T. AT PT. NO. 5B
3 IN. ABOVE CURB, 5 IN. FROM WE
(6 IN. BY 6 IN. MATRIX)
(DATA SHT. NO. 86-049-36)

1.173	1.179	.466	.44	.498	1.204
1.184	1.181	1.174	1.255	1.15	1.172
1.177	1.184	.465	1.213	1.212	1.184
1.212	1.178	1.177	1.209	1.177	1.18
1.194	1.181	.465	1.22	1.135	1.172
1.174	1.209	1.163	1.16	1.157	1.166
1.155	1.161	1.163	1.221	1.173	1.185

← WELD

EXPANDED U.T. AT PT. N
11 IN. ABOVE CURB. 30 IN
(6 IN. BY 6 IN. MAT
(DATA SHT. NO. 86-049

EXPANDED U.T. AT PT. NO. 17B TRENCH
(6 IN. BY 39 IN. MATRIX) [illegible] FROM WELD
(DATA SHT. NO. 86-049-[illegible])

EL11'-5'

—EL11'-0"

.939	.932	.963	1.058	.939	.980	[illegible]
1.014	.958	.984	.987	.973	.939	[illegible]
.991	1.005	.951	.968	.939	.945	[illegible]
.995	.975	1.038	1.031	.992	1.003	1.011
1.025	1.019	.928	1.024	1.001	1.002	1.055
1.011	1.036	1.029	1.031	1.084	1.026	1.05[illegible]
1.041	1.055	1.044	1.047	1.043	2.318	[illegible]
1.055	1.009	1.024	1.026	1.008	1.070	[illegible]
.991	1.012	1.041	1.031	1.017	1.078	1.076
1.031	1.101	1.001	1.077	1.040	1.076	1.072
1.003	1.039	1.069	1.057	1.102	1.088	1.047
.998	1.065	1.048	1.004	1.014	1.016	1.016
.964	1.019	.987	1.055	1.048	1.022	1.061
.986	1.040	1.019	.980	1.024	1.010	[illegible]
.984	1.105	1.083	1.011	1.047	1.016	[illegible]
1.063	1.012	1.029	1.047	1.056	.977	[illegible]
1.029	1.097	1.071	1.060	1.033	.919	[illegible]
1.060	1.023	1.066	1.063	1.045	1.039	[illegible]
1.032	1.037	1.044	1.078	1.050	1.034	[illegible]
1.037	1.015	1.028	1.064	1.070	1.056	[illegible]
1.065	1.059	1.026	1.058	1.047	1,067	1.075
1.088	1.046	1.019	1.103	.993	1.086	1.041
1.056	1.045	.995	1.044	1.042	1.026	[illegible]
1.102	1.001	1.044	1.082	1.028	1.004	[illegible]
1.106	1.030	1.002	1.017	1.042	1.034	1.030
.969	.965	.988	1.122	1.034	1.032	[illegible]
1.097	1.028	1.031	.951	1.039	1.015	[illegible]
1.132	1.022	1.076	1.058	.952	.981	[illegible]
1.028	1.049	.987	1.085	1.048	1.072	[illegible]
1.100	1.017	.958	1.044	.991	1.036	[illegible]
1.053	1.030	1.025	.987	1.031	1.039	1.003
1.008	1.049	1.006	1.058	1.058	1.014	[illegible]
.972	.985	1.012	1.009	1.067	1.017	.975
.983	.979	.974	.961	1.017	1.000	.983
.999	.987	1.021	.958	.954	1.064	.942
.923	.981	.976	.978	.964	.998	1.004

WELD

LEG

LD=

LV=

From
3E-SK-S-15
Bay 17
Trench.

PASSPORT# 00546049 07
AR# A2152754 E09
ATTACHMENT L
PAGE 2 OF 13

EXPANDED U.T. AT PT. NO. 17B
14 IN. ABOVE CURB 59"± FROM WELD
(6 IN. BY 6 IN. MATRIX)
(DATA SHT. NO. 86-049-049)

EL12'-2

N/A	1.139	1.139	1.141	1.142	1.141	[illegible]
1.141	1.141	1.142	1.144	1.145	1.143	[illegible]
1.140	1.141	1.140	1.142	1.144	1.143	[illegible]
1.139	1.140	1.140	1.145	1.142	1.143	[illegible]
1.139	1.140	1.141	1.142	1.142	[illegible]	[illegible]
1.140	1.141	1.129	1.139	1.140	1.139	[illegible]
1.134	1.125	1.126	1.131	1.142	N/A	N/A

WELD

56
63
57
57
53
33
67
DA)

— EL 12'-2"

EL

NUM
1
2
3
4
5
7

General Electric		Report Number:	1R21LR-
Oyster Creek	**Ultrasonic Thickness Measurement Data Sheet**	Date:	10/21/2006
Refueling Outage -	1R21	UT Procedure:	ER-AA-335-004
Page 1 of	2	Specification:	IS-328227-004

Examiner: Leslie Richter	Level: II	Instrument Type:	Panametrics 37DL Plus
Examiner: Matt Wilson	Level: II	Instrument No:	031125009

Transducer Type: DV 506	Serial #: 072561	Size: 0.438"	Freq: 5 Mhz	Angle: 0°	
Transducer Cable Type: Panametrics Length: 5'	Couplant: Soundsafe	Batch No: 19620			
Calibration Block Type: C/S Step Wedge	Block Number: CAL-STEP-139				

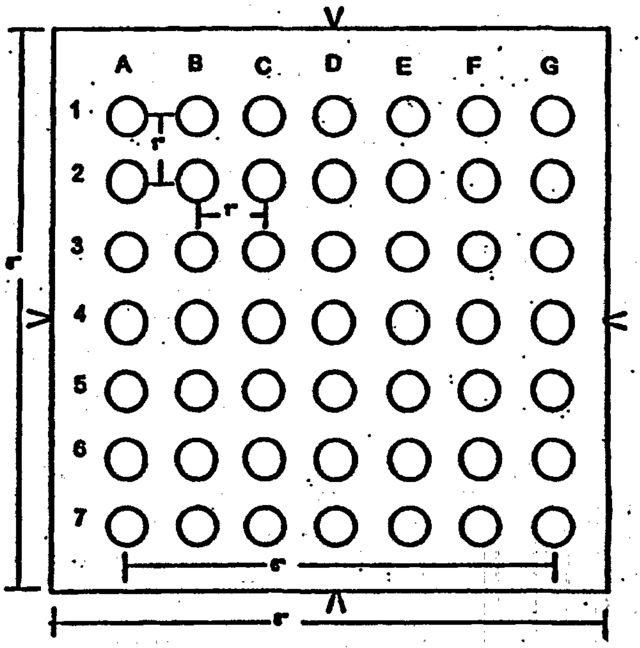
SYSTEM CALIBRATION

INSTRUMENT SETTINGS		Initial Cal. Time	Calibration Checks		Final Cal. Time
Coarse Range:	2.0"	11:01	11:32	12:05	12:38
Coarse Delay:	N/A	Calibrated Sweep Range = 0.500" inches to 1.500" Inches			
Delay Calib:	N/A	Thermometer: 246647	Comp. Temp: 71°	Block Temp: 68°	
Range Calib:	N/A	W/O Number:	C2013479		
Instrument Freq.	N/A	Total Crew Dose 96 mr	Drywell Containment Vessel Thickness Examination. Internal UT Inspections.		
Gain:	63 db				
Damping:	N/A	Trench 1 Bay 5			
Reject:	N/A				
Filter:	N/A				

Thickness readings taken at holes located in template.

The UT transducer was positioned in the same orientation at each grid point.

PASSPORT# 00546049 07
AR# A2152754 E09
ATTACHMENT 1
PAGE 3 OF 10



COMMENTS:

Template was placed at the bottom of the trench and forty-nine (49) points were recorded, then template was relocated above previous location with the centerline of the bottom row 1" +/- 1/16" from previous grid top row.
A "V" was stamped next to each side of each template location and above and below top and bottom.
A total of 294 reading were taken.

1R21LR-025 Pg 2 of 4

General Electric	**Ultrasonic Thickness Measurement Data Sheet**	File Name:	1R21LR- 25
Oyster Creek		Date:	10/18/2006
Refueling Outage - 1R21		UT Procedure:	ER-AA-335-004
Page 2 of 2		Grid Procedure:	IS-328227-004

Bottom of Trench

Location ID		Trench 2		Bay	17	Elev.	10' 3"
	A	B	C	D	E	F	G
1	0.937	0.970	0.927	0.946	0.932	0.918	0.942
2	0.924	1.059	0.934	0.941	0.968	0.924	0.916
3	0.948	0.948	0.963	0.941	0.932	0.937	0.967
4	0.977	0.983	1.032	0.982	0.983	0.997	0.953
5	0.972	0.932	0.977	0.973	1.005	0.959	1.028
6	1.026	1.002	0.968	0.972	0.953	0.964	0.990
7	0.981	1.006	0.967	0.945	0.968	0.943	0.978
8	1.026	0.958	0.958	1.026	0.982	0.988	0.967
9	1.026	0.906	0.915	0.991	1.006	0.984	0.962
10	0.979	0.933	1.027	0.934	0.969	0.958	1.042
11	0.963	1.003	1.016	1.062	0.969	0.987	1.030
12	1.027	0.977	1.039	0.999	0.998	1.027	1.039
13	1.023	1.001	0.959	0.997	0.974	1.003	1.090
14	0.986	1.004	1.009	0.946	1.016	1.023	0.995
15	0.966	1.069	1.014	1.055	0.995	1.002	1.029
16	0.987	0.983	0.942	0.941	1.010	1.023	1.016
17	1.034	1.008	0.971	1.064	0.985	1.022	1.032
18	0.972	1.021	0.985	0.992	1.003	0.997	1.008
19	0.975	0.951	0.985	1.059	1.047	0.935	0.980
20	0.940	0.967	0.895	1.020	1.044	1.075	0.980
21	0.918	0.897	0.934	1.036	1.058	0.998	1.009
22	0.973	0.954	1.004	1.013	1.011	1.043	0.948
23	0.998	0.952	1.007	1.000	0.963	1.006	0.951
24	OBST.	0.978	0.979	0.935	1.014	0.981	1.015
25	1.017	1.074	0.968	0.963	0.966	1.014	1.030
26	1.038	1.053	1.026	1.008	0.983	0.979	1.039
27	0.968	1.028	0.998	1.017	1.004	1.030	1.046
28	1.028	0.950	1.047	1.000	0.977	1.002	1.010
29	0.997	1.023	1.060	1.015	0.964	0.995	0.997
30	1.061	0.958	1.022	1.044	0.991	0.990	1.001
31	1.008	1.021	1.010	1.010	1.003	0.959	0.963
32	0.988	0.991	0.961	0.940	1.029	0.979	0.929
33	1.005	1.014	1.003	0.896	0.944	1.013	0.885
34	0.990	0.976	0.962	0.909	0.905	0.863	0.923
35	0.954	0.954	OBST.	0.885	0.887	0.877	0.930
36	0.963	0.972	0.877	0.835	0.891	0.831	0.894
37	0.897	0.937	0.903	0.893	0.838	0.781	0.841
38	0.855	0.884	0.853	0.850	0.840	0.814	0.788
39	0.802	0.891	0.838	0.790	1.082	OBST.	0.809
40	0.746	0.795	0.776	0.822	0.757	1.042	0.794
41	0.702	0.779	0.811	0.835	0.723	0.738	0.837
42	0.726	0.825	0.878	0.868	OBST.	0.864	0.954
			Top				

Tscr.	AVG.
0.660	0.963
Min Reading	Max. Reading
0.702	1.090

PASSPORT# 00546049 07
AR# A2152754 E09
ATTACHMENT 1
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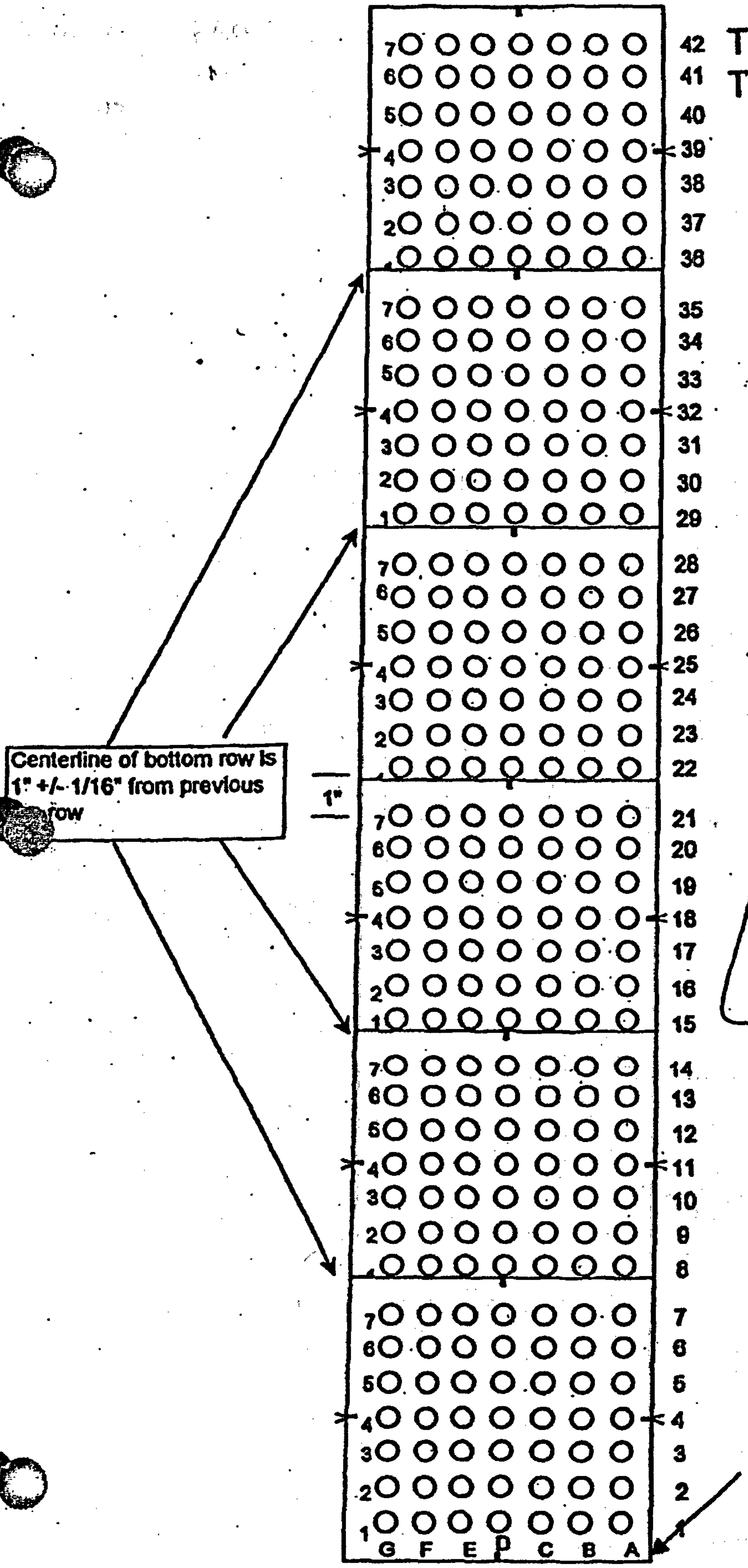
Posey

Examined by Jeremy Tuttle 10/21/06	Level II	Date	10/21/2006
Examined by N/A	Level N/A	Date	N/A
Reviewed by: Lee Stone	Level II	Date	10/21/2006

Template layout for Trench UT data.

1R21LR-025 Pg 3 of 4
~~Pg 3~~
MMc 10-23-06
L III



Centerline of bottom row is 1" +/- 1/16" from previous row

Template placed at Bottom of Trench

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AR# A2152754 E09
ATTACHMENT 1
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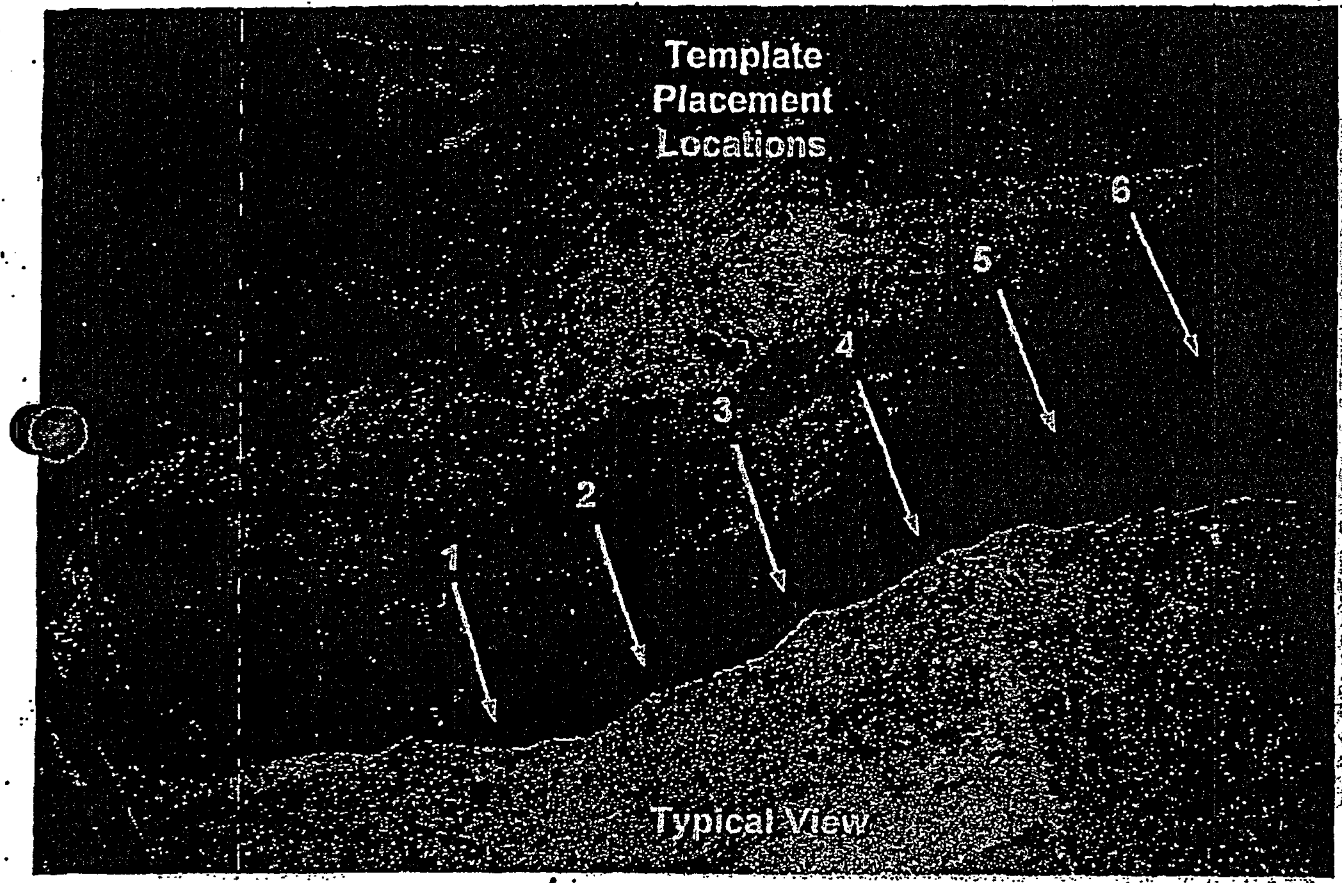
Page 5

1R21CR-025 Pg 4 of 4
MM' C III
10-23-06



Template Placement Locations

Typical View

PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT 1
PAGE 6 OF 10

1R21LR-025 Pg 1 of 4

General Electric	**Ultrasonic Thickness Measurement Data Sheet**	File Name:	1R21LR- 25
Oyster Creek		Date:	10/21/2006
Refueling Outage - 1R21		UT Procedure:	ER-AA-335-004
Page 1 of 2		Specification:	IS-328227-004

Examiner: Jeremy Tuttle	Jeremy Tuttle 10/21/06	Level:	II	Instrument Type:	Panametrics 37DL Plus
Examiner: N/A		Level:	N/A	Instrument No:	031125009

Transducer Type: DV 506	Serial #: 072362	Size: 0.438"	Freq: 5 Mhz	Angle: 0"
Transducer Cable Type: Panametrics Length: 5'		Couplant: Soundsafe		Batch No: 19620
Calibration Block Type: C/S Step Wedge	Block Number: CAL-STEP-139			

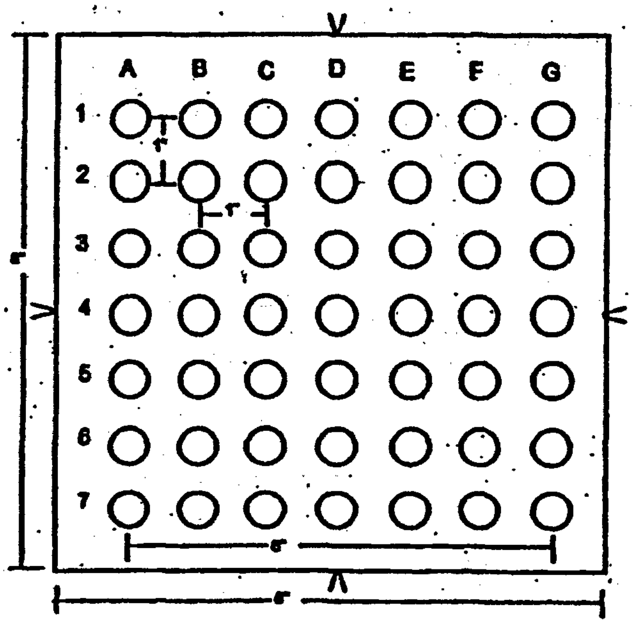
SYSTEM CALIBRATION

INSTRUMENT SETTINGS		Initial Cal. Time	Calibration Checks		Final Cal. Time	
Coarse Range:	2.0"	7:17	8:22	N/A	9:05	
Coarse Delay:	N/A	Calibrated Sweep Range = 0.500" Inches to 1.500" Inches				
Delay Calib:	N/A	Thermometer: 246672		Comp. Temp: 73°	Block Temp: 68°	
Range Calib:	N/A	W/O Number: C2013479				
Instrument Freq.	N/A	Total Crew Dose 223 mr	Drywell Containment Vessel Thickness Examination. Internal UT Inspections.			
Gain:	51 db					
Damping:	N/A	**Trench 2 Bay 17**				
Reject:	N/A					
Filter:	N/A					

Thickness readings taken at holes located in template.

The UT transducer was positioned in the same orientation at each grid point.

PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT 1
PAGE 7 OF 16



COMMENTS:
Grid Template aligned with V-stamps.
Template was placed at the bottom of the trench and forty-nine (49) points were recorded, then template was relocated above previous location with the centerline of the bottom row 1" +/- 1/16" from previous grid top row.
A total of 290 readings were taken.

All obstructions due to rough surface conditions. Some readings taken as best effort readings due to rough surface conditions.

Reviewed by: Lee Stone Lee Stone Level II Date 10/21/2006

1R21LR-024 Pg 2 of 4

General Electric		File Name:	1R21LR- 24
Oyster Creek		Date:	10/21/2006
Refueling Outage -	1R21	UT Procedure:	ER-AA-335-004
Page 2 of	2	Grid Procedure:	IS-328227-004

Ultrasonic Thickness Measurement Data Sheet

L III
10-23-06

Bottom of Trench							
Location ID,		Trench 1		Bay.	5	Elev.	10' 3"
	A	B	C	D	E	F	G
1	1.059	1.034	1.036	1.106	1.074	1.131	1.078
2	1.061	1.021	1.008	1.051	1.047	1.049	1.024
3	1.062	1.026	1.047	1.026	0.968	1.049	1.032
4	1.016	1.055	1.026	0.959	1.013	1.061	0.987
5	1.027	1.046	1.001	0.993	1.064	1.070	0.993
6	1.035	1.021	1.004	0.985	1.013	1.150	0.957
7	1.032	1.054	1.023	1.033	0.962	0.962	0.991
8	1.065	1.023	1.069	1.043	1.092	1.028	1.030
9	1.111	1.037	1.086	1.071	1.044	0.996	0.976
10	1.061	1.034	1.009	1.099	1.036	0.988	1.105
11	1.014	1.022	1.028	1.142	1.064	1.040	1.041
12	1.125	1.146	1.145	1.125	1.079	1.087	1.089
13	1.101	1.157	1.127	1.155	1.072	1.130	1.043
14	1.116	1.077	1.108	1.094	1.087	1.056	1.051
15	1.127	1.042	1.119	1.126	1.079	1.102	1.075
16	1.109	1.176	1.169	1.112	1.054	1.131	1.113
17	1.106	1.090	1.096	1.079	1.073	1.083	1.030
18	1.094	1.115	1.073	1.068	1.065	1.073	1.091
19	1.045	1.117	1.049	1.114	1.082	1.090	1.095
20	1.111	1.123	1.117	1.086	1.138	1.090	1.091
21	1.151	1.131	1.145	1.091	1.075	1.116	1.114
22	1.126	1.094	1.159	1.058	1.088	1.109	1.134
23	1.129	1.100	1.162	1.023	1.096	1.112	1.070
24	1.089	1.159	1.137	1.109	1.091	1.165	1.124
25	1.135	1.167	1.099	1.075	1.141	1.122	1.050
26	1.054	1.050	1.038	1.074	1.032	1.078	1.070
27	1.134	1.045	1.026	1.082	1.171	1.145	1.178
28	1.069	1.085	1.102	1.142	1.120	1.061	1.116
29	1.020	1.065	1.068	1.021	1.040	1.001	1.068
30	1.085	1.064	1.045	1.033	1.006	1.033	1.056
31	1.047	1.059	0.997	1.083	1.018	1.065	1.030
32	1.084	1.062	1.063	1.105	1.143	1.089	1.048
33	1.107	1.093	1.057	1.050	1.130	1.061	1.064
34	1.099	1.066	1.005	1.027	1.044	1.018	1.073
35	1.059	1.118	1.045	1.023	1.039	1.068	1.087
36	1.067	1.072	1.041	1.035	1.030	1.015	1.047
37	1.093	1.050	1.099	1.039	1.033	0.992	1.033
38	1.142	1.094	1.099	1.086	1.086	1.039	1.048
39	1.151	1.122	1.112	1.074	1.115	1.073	1.049
40	1.132	1.115	1.103	1.106	1.083	1.052	1.047
41	1.137	1.130	1.139	1.119	1.106	1.084	1.087
42	1.113	1.131	1.097	1.122	1.131	1.104	1.063
Top							

Tscr.	AVG.
0.660	1.074
Min Reading	Max. Reading
0.957	1.178

PASSPORT# 00546049 07
AR# A2152754 E09
ATTACHMENT 1
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Page 8

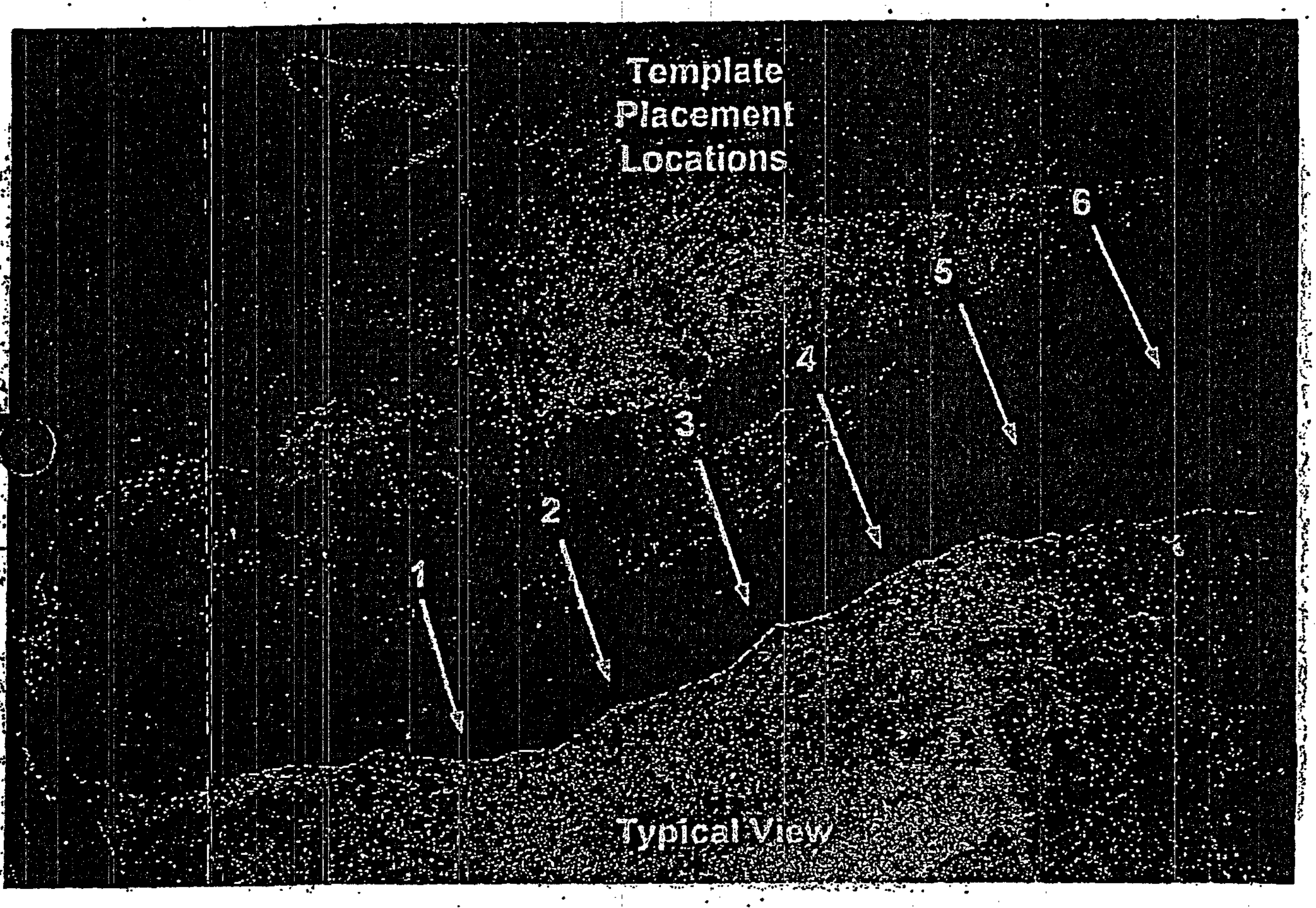
L III
10-23-06

Examined by Leslie Richter	Level II	Date	10/21/2006
Examined by Matt Wilson Matt Wilson	Level II	Date	10/21/2006
Reviewed by: Lee Stone	Level II	Date	10/21/2006

1R21CR-024 Pg 3 of 4
10-23-06

PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT 1
PAGE 9 OF 10

JT



Template layout for Trench UT data.

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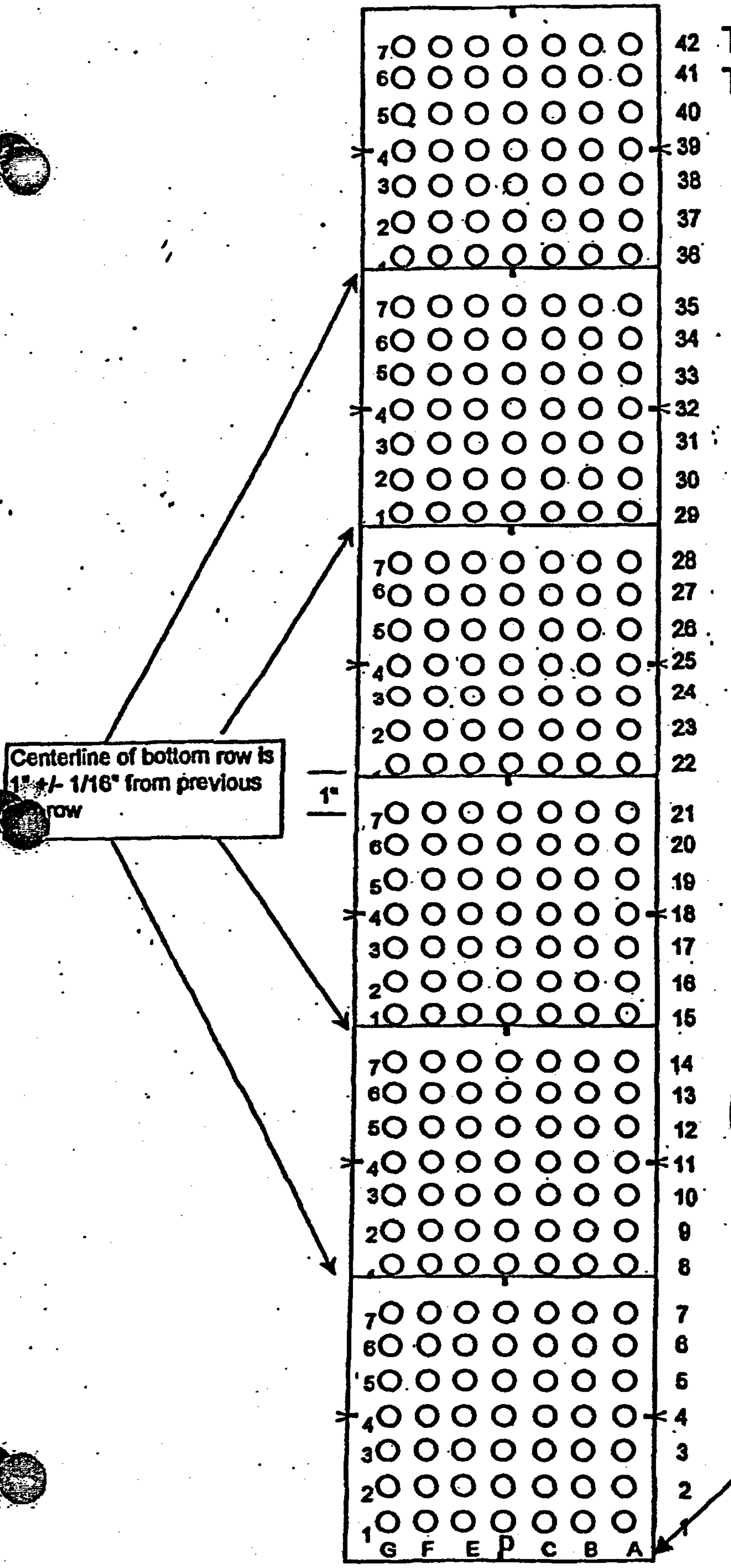

Centerline of bottom row is 1" +/- 1/16" from previous row

Template placed at Bottom of Trench

PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT 1
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Attachment 2 - Bay 5 Trench

1986 Data

The data shown below was collected in 1986 in the trench in Bay 5

page := READPRN("H:\MSOFFICE\Drywell Program data\1986 trenches\Trench5-1.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 1.156 & 1.166 & 1.182 & 1.172 & 1.225 & 1.181 & 1.171 \\ 1.16 & 0 & 1.184 & 1.173 & 1.175 & 1.171 & 1.176 \\ 1.165 & 1.164 & 1.151 & 0 & 0 & 1.17 & 1.17 \\ 1.145 & 1.151 & 1.158 & 1.162 & 1.155 & 1.159 & 1.172 \\ 1.123 & 1.151 & 1.148 & 1.167 & 0 & 1.139 & 1.156 \\ 1.128 & 1.138 & 1.141 & 1.157 & 1.158 & 1.144 & 1.159 \\ 1.123 & 1.149 & 1.13 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$\text{XXXS} := \text{convert}\left(\text{Points}_{49}, 7\right)$

$\text{No}_{\text{DataCells}} := \text{length}(\text{XXXS})$

$\text{XXXS} := \text{deletezero}_{\text{cells}}\left(\text{XXXS}, \text{No}_{\text{DataCells}}\right)$

page := READPRN("H:\MSOFFICE\Drywell Program data\1986 trenches\Trench5-2.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 1.109 & 1.121 & 1.144 & 1.155 & 1.156 & 1.149 & 1.155 \\ 1.064 & 1.066 & 1.068 & 1.115 & 1.1 & 1.109 & 1.124 \\ 1.051 & 1.096 & 1.041 & 1.077 & 1.162 & 1.078 & 0 \\ 1.063 & 1.1 & 1.11 & 1.048 & 1.101 & 1.11 & 1.133 \\ 1.047 & 1.109 & 1.149 & 1.13 & 1.176 & 1.179 & 1.058 \\ 1.125 & 1.123 & 1.09 & 1.117 & 1.182 & 1.2 & 1.182 \\ 1.135 & 1.091 & 1.107 & 1.08 & 1.084 & 1.125 & 1.183 \end{bmatrix}$$

$\text{XXX} := \text{convert}\left(\text{Points}_{49}, 7\right)$

$\text{No}_{\text{DataCells}} := \text{length}(\text{XXX})$

$\text{XXX} := \text{deletezero}_{\text{cells}}\left(\text{XXX}, \text{No}_{\text{DataCells}}\right)$

$\text{Cells}_{86} := \text{stack}(\text{XXX}, \text{XXXS})$

$\text{No}_{\text{DataCells}} := \text{length}\left(\text{Cells}_{86}\right)$

$\text{No}_{\text{DataCells}} = 89$

page := READPRN("H:\MSOFFICE\Drywell Program data\1986 trenches\Trench5-3.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 1.094 & 1.064 & 1.067 & 1.079 & 0 & 1.169 & 1.14 \\ 1.043 & 1.079 & 1.052 & 1.079 & 1.119 & 1.164 & 0 \\ 1.058 & 1.055 & 1.082 & 1.044 & 1.071 & 0 & 1.137 \\ 1.087 & 1.049 & 1.058 & 1.114 & 1.083 & 1.053 & 1.164 \\ 1.18 & 1.118 & 1.093 & 1.043 & 1.062 & 1.178 & 1.156 \\ 1.138 & 1.071 & 1.109 & 1.137 & 1.096 & 0 & 1.194 \\ 1.109 & 1.082 & 1.158 & 1.098 & 1.166 & 1.134 & 1.056 \end{bmatrix}$$

$\text{XXX} := \text{convert}\left(\text{Points}_{49}, 7\right)$

$\text{No}_{\text{DataCells}} := \text{length}(\text{XXX})$

$\text{XXX} := \text{deletezero}_{\text{cells}}\left(\text{XXX}, \text{No}_{\text{DataCells}}\right)$

$\text{Cells}_{86} := \text{stack}\left(\text{Cells}_{86}, \text{XXX}\right)$

$\text{No}_{\text{DataCells}} := \text{length}\left(\text{Cells}_{86}\right)$

$\text{No}_{\text{DataCells}} = 134$

page := READPRN("H:\MSOFFICE\Drywell Program data\1986 trenches\Trench5-4.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 1.141 & 1.128 & 1.089 & 1.154 & 1.164 & 1.141 & 1.122 \\ 1.159 & 0 & 0 & 1.17 & 0 & 1.151 & 1.105 \\ 1.166 & 1.127 & 1.105 & 1.174 & 1.169 & 1.105 & 1.131 \\ 1.109 & 1.148 & 0 & 1.166 & 1.171 & 1.113 & 1.141 \\ 1.089 & 1.167 & 0 & 1.18 & 1.128 & 1.133 & 1.106 \\ 1.126 & 1.092 & 1.178 & 0 & 1.167 & 1.124 & 1.072 \\ 1.069 & 1.054 & 1.112 & 1.089 & 1.146 & 1.119 & 1.098 \end{bmatrix}$$

$\text{XXX} := \text{convert}\left(\text{Points}_{49}, 7\right)$

$\text{No}_{\text{DataCells}} := \text{length}(\text{XXX})$

$\text{XXX} := \text{deletezero}_{\text{cells}}\left(\text{XXX}, \text{No}_{\text{DataCells}}\right)$

$\text{Cells}_{86} := \text{stack}\left(\text{Cells}_{86}, \text{XXX}\right)$

$\text{No}_{\text{DataCells}} := \text{length}\left(\text{Cells}_{86}\right)$

$\text{No}_{\text{DataCells}} = 177$

page := READPRN("H:\MSOFFICE\Drywell Program data\1986 trenches\Trench5-5.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 1.076 & 1.056 & 1.098 & 0 & 1.139 & 1.098 & 1.077 \\ 1.118 & 1.054 & 1.1 & 1.159 & 1.06 & 1.062 & 1.101 \\ 1.067 & 1.073 & 1.11 & 1.205 & 1.149 & 1.09 & 1.113 \\ 1.088 & 1.106 & 1.171 & 1.193 & 1.041 & 1.134 & 1.093 \\ 1.094 & 1.119 & 1.115 & 1.148 & 1.092 & 1.118 & 1.109 \\ 1.128 & 1.134 & 1.125 & 0 & 1.147 & 1.145 & 1.112 \\ 1.065 & 1.077 & 1.179 & 1.168 & 1.077 & 1.068 & 1.073 \end{bmatrix}$$

$\text{XXX} := \text{convert}\left(\text{Points}_{49}, 7\right)$

$\text{No}_{\text{DataCells}} := \text{length}(\text{XXX})$

$\text{XXX} := \text{deletezero}_{\text{cells}}\left(\text{XXX}, \text{No}_{\text{DataCells}}\right)$

$\text{Cells}_{86} := \text{stack}\left(\text{Cells}_{86}, \text{XXX}\right)$ $\text{No}_{\text{DataCells}} := \text{length}\left(\text{Cells}_{86}\right)$ $\text{No}_{\text{DataCells}} = 224$

page := READPRN("H:\MSOFFICE\Drywell Program data\1986 trenches\Trench5-6.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 1.062 & 1.101 & 0 & 1.088 & 1.069 & 1.074 & 1.067 \\ 1.1 & 1.062 & 1.141 & 1.059 & 1.11 & 1.076 & 1.078 \\ 1.044 & 1.052 & 0 & 1.045 & 1.083 & 1.081 & 1.076 \\ 1.031 & 0 & 1.057 & 1.073 & 1.059 & 1.109 & 1.062 \\ 1.035 & 0 & 1.076 & 1.06 & 1.016 & 1.074 & 1.037 \\ 1.024 & 1.103 & 1.03 & 1.059 & 1.061 & 1.062 & 1.076 \\ 0 & 1.057 & 1.021 & 1.015 & 1.028 & 1.089 & 1.08 \end{bmatrix}$$

$\text{XXX} := \text{convert}\left(\text{Points}_{49}, 7\right)$

$\text{No}_{\text{DataCells}} := \text{length}(\text{XXX})$

$\text{XXX} := \text{deletezero}_{\text{cells}}\left(\text{XXX}, \text{No}_{\text{DataCells}}\right)$

$\text{Cells}_{86} := \text{stack}\left(\text{Cells}_{86}, \text{XXX}\right)$

$\text{No}_{\text{DataCells}} := \text{length}\left(\text{Cells}_{86}\right)$

page := READPRN("H:\MSOFFICE\Drywell Program data\1986 trenches\Trench5-7.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\mathrm{Points}_{49} = \begin{bmatrix} 1.087 & 1.11 & 1.027 & 1.04 & 1.07 & 1.079 & 1.081 \\ 0 & 1.132 & 1.049 & 1.096 & 1.052 & 1.093 & 1.092 \\ 1.168 & 1.112 & 1.113 & 1.101 & 1.056 & 1.065 & 1.108 \\ 1.271 & 1.138 & 1.117 & 1.103 & 1.152 & 1.142 & 1.108 \\ 1.211 & 1.158 & 1.099 & 1.133 & 1.134 & 1.145 & 1.108 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$XXX := \mathrm{convert}\left(\mathrm{Points}_{49}, 7\right)$ $\qquad \mathrm{No}_{\mathrm{DataCells}} := \mathrm{length}(XXX)$

$XXX := \mathrm{deletezero}_{\mathrm{cells}}\left(XXX, \mathrm{No}_{\mathrm{DataCells}}\right)$

$\mathrm{Cells}_{86} := \mathrm{stack}\left(\mathrm{Cells}_{86}, XXX\right)$ $\qquad \mathrm{No}_{\mathrm{DataCells}} := \mathrm{length}\left(\mathrm{Cells}_{86}\right)$ $\qquad \mathrm{No}_{\mathrm{DataCells}} = 302$

$\mathrm{No}_{\mathrm{DataCells}} = 302$

The thinnest point at this location is shown below

$\mathrm{minpoint} := \min\left(\mathrm{Cells}_{86}\right)$ $\qquad \mathrm{minpoint} = 1.015 \cdot 10^{3}$

Mean and Standard Deviation

$\mu86_{actual} := \mathrm{mean}(Cells_{86})$ $\mu86_{actual} = 1.1123 \cdot 10^3$ $\sigma86_{actual} := \mathrm{Stdev}(Cells_{86})$

$\sigma86_{actual} = 45.002$

Standard Error

$$Standard_{error} := \frac{\sigma86_{actual}}{\sqrt{No_{DataCells}}}$$

$Standard_{error} = 2.59$

Skewness

$$Skewness := \frac{(No_{DataCells}) \cdot \overrightarrow{\Sigma(Cells_{86} - \mu86_{actual})^3}}{(No_{DataCells} - 1) \cdot (No_{DataCells} - 2) \cdot (\sigma86_{actual})^3}$$

$Skewness = 0.132$

Kurtosis

$$Kurtosis := \frac{No_{DataCells} \cdot (No_{DataCells} + 1) \cdot \overrightarrow{\Sigma(Cells_{86} - \mu86_{actual})^4}}{(No_{DataCells} - 1) \cdot (No_{DataCells} - 2) \cdot (No_{DataCells} - 3) \cdot (\sigma86_{actual})^4} - \frac{3 \cdot (No_{DataCells} - 1)^2}{(No_{DataCells} - 2) \cdot (No_{DataCells} - 3)}$$

$Kurtosis = -0.534$

Normal Probability Plot

In a normal plot, each data value is plotted against what its value would be if it actually came from a normal distribution. The expected normal values, called normal scores, and can be estimated by first calculating the rank scores of the sorted data.

$j := 0..\,\mathrm{last}(Cells_{86})$ $\qquad$ $srt := \mathrm{sort}(Cells_{86})$

Then each data point is ranked. The array rank captures these ranks .

$r_j := j + 1$

$$rank_j := \frac{\overrightarrow{\Sigma\left(\overrightarrow{srt = srt_j}\right)\cdot r}}{\Sigma\overrightarrow{srt = srt_j}}$$

$$p_j := \frac{rank_j}{\mathrm{rows}(Cells_{86}) + 1}$$

The normal scores are the corresponding *p*th percentile points from the standard normal distribution:

$x := 1$ $\qquad$ $N\_Score_j := \mathrm{root}\left[\mathrm{cnorm}(x) - (p_j), x\right]$

Upper and Lower Confidence Values

The Upper and Lower confidence values are calculated based on .05 degree of confidence "α"

$No_{DataCells} := \mathrm{length}(Cells_{86})$

$\alpha := .05$ $\qquad T\alpha := qt\left[\left(1-\frac{\alpha}{2}\right), No_{DataCells}\right]$ $\qquad T\alpha = 1.968$

$Lower_{95\%Con} := \mu 86_{actual} - T\alpha \cdot \frac{\sigma 86_{actual}}{\sqrt{No_{DataCells}}}$ $\qquad Lower_{95\%Con} = 1.107 \cdot 10^{3}$

$Upper_{95\%Con} := \mu 86_{actual} + T\alpha \cdot \frac{\sigma 86_{actual}}{\sqrt{No_{DataCells}}}$ $\qquad Upper_{95\%Con} = 1.117 \cdot 10^{3}$

These values represent a range on the calculated mean in which there is 95% confidence.

Graphical Representation

Distribution of the "Cells" data points are sorted in 1/2 standard deviation increments (bins) within +/- 3 standard deviations

$Bins := Make_{bins}(\mu 86_{actual}, \sigma 86_{actual})$

$Distribution := \mathrm{hist}(Bins, Cells_{86})$

$$Distribution = \begin{pmatrix} 0 \\ 3 \\ 14 \\ 42 \\ 45 \\ 54 \\ 41 \\ 43 \\ 45 \\ 11 \\ 2 \\ 1 \end{pmatrix}$$

The mid points of the Bins are calculated

$k := 0..11$ $\qquad Midpoints_k := \frac{(Bins_k + Bins_{k+1})}{2}$

The Mathcad function pnorm calculates a portion of normal distribution curve based on a given mean and standard deviation

$normal_{curve_0} := \mathrm{pnorm}(Bins_1, \mu 86_{actual}, \sigma 86_{actual})$

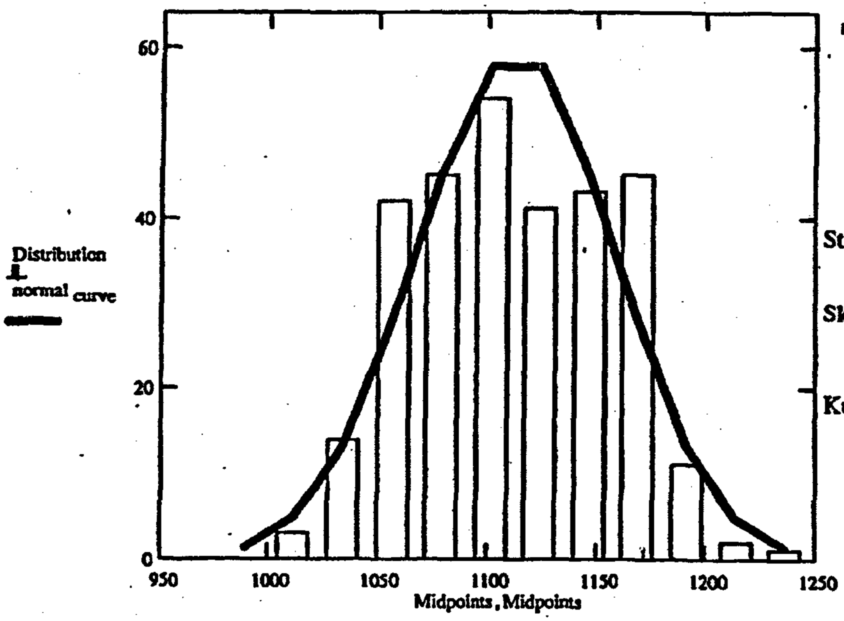
$normal_{curve_k} := \mathrm{pnorm}(Bins_{k+1}, \mu 86_{actual}, \sigma 86_{actual}) - \mathrm{pnorm}(Bins_k, \mu 86_{actual}, \sigma 86_{actual})$

$normal_{curve} := No_{DataCells} \cdot normal_{curve}$

Results For Elevation Sandbed elevation Locatiobn Oct. 2006

The following schematic shows: the the distribution of the samples, the normal curve based on the actual mean and standard deviation, the kurtosis, the skewness, the number of data points, and the the lower and upper 95% confidence values. Below is the Normal Plot for the data.

Data Distribution



minpoint = $1.015 \cdot 10^3$

$\text{Standard}_{\text{error}} = 2.59$

Skewness = 0.132

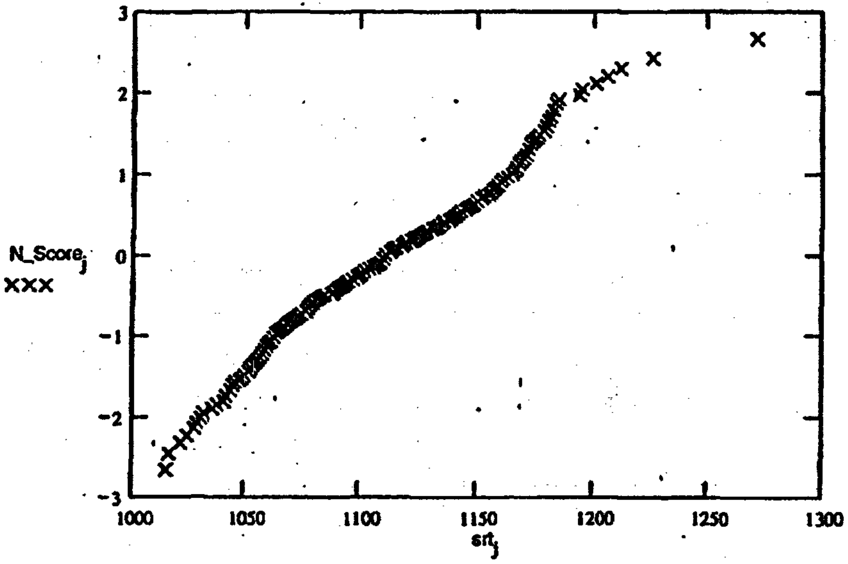
Kurtosis = -0.534

$\text{Lower}_{95\%\text{Con}} = 1.107 \cdot 10^3$ $\text{Upper}_{95\%\text{Con}} = 1.117 \cdot 10^3$

$\mu 86_{\text{actual}} = 1.112 \cdot 10^3$ $\sigma 86_{\text{actual}} = 45.002$ minpoint = $1.015 \cdot 10^3$

A Kurtosis value which is less than +/- 1.0 and approaches 0 is indicative of a normal distrubution

Normal Probability Plot



The Normal Probability Plot and the Kurtosis this data is normally distributed.

A Normal Probability Plot which approaches a straight line is indicative of a normal distrubution

OCT 2006 Data

The data shown below was collected in 2006 in the trench in Bay 5

page := READPRN("H:\MSOFFICE\Drywell Program data\2006 trenchs\Trench5-1.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 1.067 & 1.072 & 1.041 & 1.035 & 1.03 & 1.015 & 1.047 \\ 1.093 & 1.05 & 1.099 & 1.039 & 1.033 & 0.992 & 1.033 \\ 1.142 & 1.094 & 1.099 & 1.086 & 1.086 & 1.039 & 1.048 \\ 1.151 & 1.122 & 1.112 & 1.074 & 1.115 & 1.073 & 1.049 \\ 1.132 & 1.115 & 1.103 & 1.106 & 1.083 & 1.052 & 1.047 \\ 1.137 & 1.13 & 1.139 & 1.119 & 1.106 & 1.084 & 1.087 \\ 1.113 & 1.131 & 1.097 & 1.122 & 1.131 & 1.104 & 1.063 \end{bmatrix}$$

$\text{XXXS} := \text{convert}\left(\text{Points}_{49}, 7\right)$

$\text{No}_{\text{DataCells}} := \text{length}(\text{XXXS})$

$\text{XXXS} := \text{deletezero}_{\text{cells}}\left(\text{XXXS}, \text{No}_{\text{DataCells}}\right)$

page := READPRN("H:\MSOFFICE\Drywell Program data\2006 trenchs\Trench5-2.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 1.02 & 1.065 & 1.068 & 1.021 & 1.04 & 1.001 & 1.066 \\ 1.085 & 1.064 & 1.045 & 1.033 & 1.006 & 1.033 & 1.056 \\ 1.047 & 1.059 & 0.997 & 1.083 & 1.018 & 1.065 & 1.03 \\ 1.084 & 1.062 & 1.063 & 1.105 & 1.143 & 1.089 & 1.048 \\ 1.107 & 1.093 & 1.057 & 1.05 & 1.13 & 1.061 & 1.064 \\ 1.099 & 1.066 & 1.005 & 1.027 & 1.044 & 1.018 & 1.073 \\ 1.059 & 1.118 & 1.045 & 1.023 & 1.039 & 1.068 & 1.087 \end{bmatrix}$$

$\text{XXX} := \text{convert}\left(\text{Points}_{49}, 7\right)$

$\text{No}_{\text{DataCells}} := \text{length}(\text{XXX})$

$\text{XXX} := \text{deletezero}_{\text{cells}}\left(\text{XXX}, \text{No}_{\text{DataCells}}\right)$

$\text{Cells}_{06} := \text{stack}(\text{XXX}, \text{XXXS})$

$\text{No}_{\text{DataCells}} := \text{length}\left(\text{Cells}_{06}\right)$

$\text{No}_{\text{DataCells}} = 98$

page := READPRN("H:\MSOFFICE\Drywell Program data\2006 trenchs\Trench5-3.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 1.126 & 1.094 & 1.159 & 1.058 & 1.088 & 1.109 & 1.134 \\ 1.129 & 1.1 & 1.162 & 1.023 & 1.096 & 1.112 & 1.07 \\ 1.089 & 1.159 & 1.137 & 1.109 & 1.091 & 1.165 & 1.124 \\ 1.135 & 1.167 & 1.099 & 1.075 & 1.141 & 1.122 & 1.05 \end{bmatrix}$$

page := READPRN("H:\MSOFFICE\Drywell Program data\2006 trenchs\Trench5-5.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 1.065 & 1.023 & 1.069 & 1.043 & 1.092 & 1.028 & 1.03 \\ 1.111 & 1.037 & 1.086 & 1.071 & 1.044 & 0.996 & 0.976 \\ 1.061 & 1.034 & 1.009 & 1.099 & 1.036 & 0.988 & 1.105 \\ 1.014 & 1.022 & 1.028 & 1.142 & 1.064 & 1.04 & 1.041 \\ 1.125 & 1.146 & 1.145 & 1.125 & 1.079 & 1.087 & 1.089 \\ 1.101 & 1.157 & 1.127 & 1.155 & 1.072 & 1.13 & 1.043 \\ 1.116 & 1.077 & 1.108 & 1.094 & 1.087 & 1.056 & 1.051 \end{bmatrix}$$

$\text{XXX} := \text{convert}\left(\text{Points}_{49}, 7\right)$ $\qquad$ $\text{No}_{\text{DataCells}} := \text{length}(\text{XXX})$

$\text{XXX} := \text{deletezero}_{\text{cells}}\left(\text{XXX}, \text{No}_{\text{DataCells}}\right)$

$\text{Cells}_{06} := \text{stack}\left(\text{Cells}_{06}, \text{XXX}\right)$ $\qquad$ $\text{No}_{\text{DataCells}} := \text{length}\left(\text{Cells}_{06}\right)$

$\text{No}_{\text{DataCells}} = 245$

page := READPRN("H:\MSOFFICE\Drywell Program data\2006 trenchs\Trench5-6.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 1.059 & 1.034 & 1.036 & 1.106 & 1.074 & 1.131 & 1.078 \\ 1.061 & 1.021 & 1.008 & 1.051 & 1.047 & 1.049 & 1.024 \\ 1.062 & 1.026 & 1.047 & 1.026 & 0.968 & 1.049 & 1.032 \\ 1.016 & 1.055 & 1.026 & 0.959 & 1.013 & 1.061 & 0.987 \\ 1.027 & 1.046 & 1.001 & 0.993 & 1.064 & 1.07 & 0.993 \\ 1.035 & 1.021 & 1.004 & 0.985 & 1.013 & 1.15 & 0.957 \\ 1.032 & 1.054 & 1.023 & 1.033 & 0.962 & 0.962 & 0.991 \end{bmatrix}$$

$\text{XXX} := \text{convert}\left(\text{Points}_{49}, 7\right)$ $\qquad$ $\text{No}_{\text{DataCells}} := \text{length}(\text{XXX})$

$\text{XXX} := \text{deletezero}_{\text{cells}}\left(\text{XXX}, \text{No}_{\text{DataCells}}\right)$

$\text{Cells}_{06} := \text{stack}\left(\text{Cells}_{06}, \text{XXX}\right)$ $\qquad$ $\text{No}_{\text{DataCells}} := \text{length}\left(\text{Cells}_{06}\right)$ $\qquad$ $\text{No}_{\text{DataCells}} = 294$

$\text{minpoint} := \min(\text{XXX})$ $\qquad$ $\text{minpoint} = 957$

The thinnest point at this location is shown below

$\text{minpoint} := \min\left(\text{Cells}_{06}\right)$ $\qquad$ $\text{minpoint} = 957$

Mean and Standard Deviation

$\mu06_{actual} := \mathrm{mean}(Cells_{06})$ $\mu06_{actual} = 1.0743 \cdot 10^3$ $\sigma06_{actual} := \mathrm{Stdev}(Cells_{06})$ $\sigma06_{actual} = 45.628$

Standard Error

$$Standard_{error} := \frac{\sigma06_{actual}}{\sqrt{No_{DataCells}}}$$

$Standard_{error} = 2.661$

Skewness

$$Skewness := \frac{(No_{DataCells}) \cdot \overrightarrow{\Sigma(Cells_{06} - \mu06_{actual})^3}}{(No_{DataCells} - 1) \cdot (No_{DataCells} - 2) \cdot (\sigma06_{actual})^3}$$

$Skewness = -0.071$

Kurtosis

$$Kurtosis := \frac{No_{DataCells} \cdot (No_{DataCells} + 1) \cdot \overrightarrow{\Sigma(Cells_{06} - \mu06_{actual})^4}}{(No_{DataCells} - 1) \cdot (No_{DataCells} - 2) \cdot (No_{DataCells} - 3) \cdot (\sigma06_{actual})^4} - \frac{3 \cdot (No_{DataCells} - 1)^2}{(No_{DataCells} - 2) \cdot (No_{DataCells} - 3)}$$

$Kurtosis = -0.432$

Normal Probability Plot

In a normal plot, each data value is plotted against what its value would be if it actually came from a normal distribution. The expected normal values, called normal scores, and can be estimated by first calculating the rank scores of the sorted data.

$$j := 0 .. \text{last}\left(\text{Cells}_{06}\right) \qquad \text{srt} := \text{sort}\left(\text{Cells}_{06}\right)$$

Then each data point is ranked. The array rank captures these ranks

$$z_j := j + 1$$

$$\text{rank}_j := \frac{\overrightarrow{\Sigma\left(\overrightarrow{\text{srt}=\text{srt}_j}\right)\cdot z}}{\Sigma\overrightarrow{\text{srt}=\text{srt}_j}}$$

$$p_j := \frac{\text{rank}_j}{\text{rows}\left(\text{Cells}_{06}\right)+1}.$$

The normal scores are the corresponding *p*th percentile points from the standard normal distribution:

$$x := 1 \qquad \text{N\_Score}_j := \text{root}\left[\text{cnorm}(x) - \left(p_j\right), x\right]$$

Upper and Lower Confidence Values

The Upper and Lower confidence values are calculated based on .05 degree of confidence "α"

$$No_{DataCells} := \mathrm{length}(Cells_{06})$$

$$\alpha := .05 \qquad T\alpha := qt\left[\left(1 - \frac{\alpha}{2}\right), No_{DataCells}\right] \qquad T\alpha = 1.968$$

$$Lower_{95\%Con} := \mu06_{actual} - T\alpha \cdot \frac{\sigma06_{actual}}{\sqrt{No_{DataCells}}} \qquad Lower_{95\%Con} = 1.069 \cdot 10^{3}$$

$$Upper_{95\%Con} := \mu06_{actual} + T\alpha \cdot \frac{\sigma06_{actual}}{\sqrt{No_{DataCells}}} \qquad Upper_{95\%Con} = 1.08 \cdot 10^{3}$$

These values represent a range on the calculated mean in which there is 95% confidence.

Graphical Representation

Distribution of the "Cells" data points are sorted in 1/2 standard deviation increments (bins) within +/- 3 standard deviations

$$Bins := Make_{bins}(\mu06_{actual}, \sigma06_{actual})$$

$$Distribution := \mathrm{hist}(Bins, Cells_{06})$$

$$Distribution = \begin{pmatrix} 2 \\ 4 \\ 13 \\ 28 \\ 54 \\ 51 \\ 48 \\ 42 \\ 33 \\ 14 \\ 5 \\ 0 \end{pmatrix}$$

The mid points of the Bins are calculated

$$k := 0 .. 11 \qquad Midpoints_{k} := \frac{(Bins_{k} + Bins_{k+1})}{2}$$

The Mathcad function pnorm calculates a portion of normal distribution curve based on a given mean and standard deviation

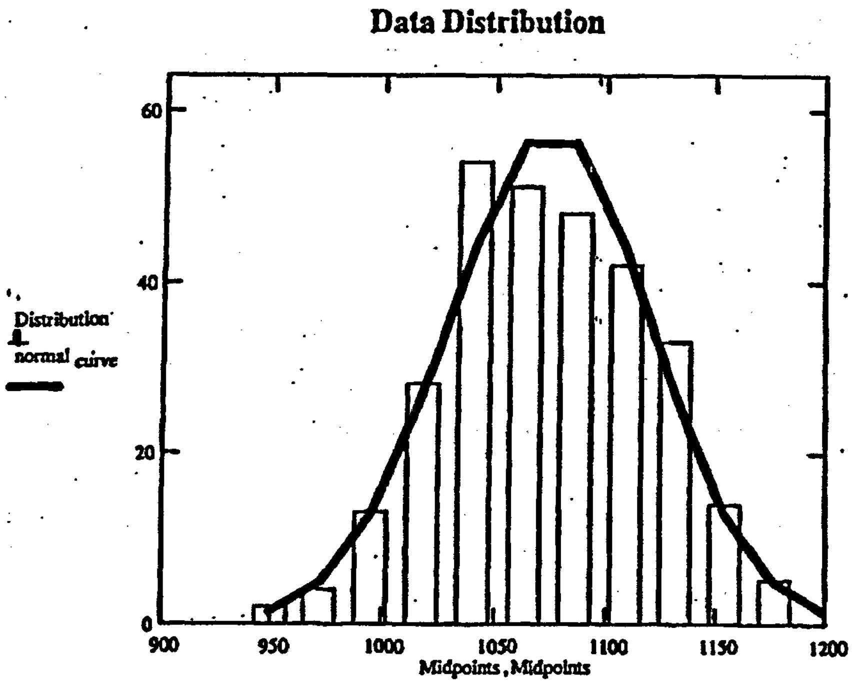
$$normal_{curve_0} := \mathrm{pnorm}(Bins_{1}, \mu06_{actual}, \sigma06_{actual})$$

$$normal_{curve_k} := \mathrm{pnorm}(Bins_{k+1}, \mu06_{actual}, \sigma06_{actual}) - \mathrm{pnorm}(Bins_{k}, \mu06_{actual}, \sigma06_{actual})$$

$$normal_{curve} := No_{DataCells} \cdot normal_{curve}$$

Results For Elevation Sandbed elevation Locatiobn Oct. 2006

The following schematic shows: the the distribution of the samples, the normal curve based on the actual mean and standard deviation, the kurtosis, the skewness, the number of data points, and the the lower and upper 95% confidence values. Below is the Normal Plot for the data.



$minpoint = 957$

$Standard_{error} = 2.661$

$Skewness = -0.071$

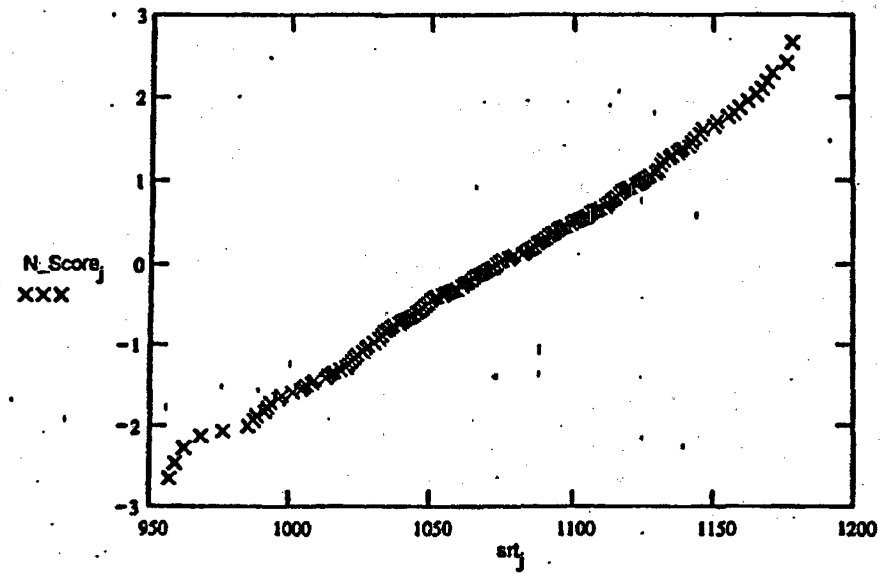
$Kurtosis = -0.432$

$Lower_{95\%Con} = 1.069 \cdot 10^3$ $Upper_{95\%Con} = 1.08 \cdot 10^3$

$\mu06_{actual} = 1.074 \cdot 10^3$ $\sigma06_{actual} = 45.628$ $minpoint = 957$

A Kurtosis value which is less than +/- 1.0 and approaches 0 is indicative of a normal distrubution

Normal Probability Plot



The Normal Probability Plot and the Kurtosis this data is normally distributed.

A Normal Probability Plot which approaches a straight line is indicative of a normal distrubution

Corrosion Rate assuming corrosion occured between 1986 and 2006

$$\frac{(\mu 86_{actual} - \mu 06_{actual})}{2006 - 1986} = 1.9$$

Corrosion Rate assuming corrosion occured between 1986 and 1992

$$\frac{(\mu 86_{actual} - \mu 06_{actual})}{1992 - 1986} = 6.334$$

Attachment 3 Bay 17 Trench

1986 Data

The data shown below was collected in 1986 in the trench in Bay 17

page := READPRN("H:\MSOFFICE\Drywell Program data\1986 trenches\Trench17-1.txt")

$$\mathrm{Points}_{49} := \mathrm{showcells}(\mathrm{page}, 7, 0)$$

$$\mathrm{Points}_{49} = \begin{bmatrix} 0.93 & 0.932 & 0.943 & 0.958 & 0.927 & 0.889 & 0.913 \\ 1.014 & 0.953 & 0.984 & 0.987 & 0.973 & 0.939 & 0.956 \\ 0.991 & 1.005 & 0.951 & 0.968 & 0.939 & 0.945 & 0.956 \\ 0.995 & 0.995 & 1.038 & 1.031 & 0.992 & 1.003 & 1.011 \\ 1.025 & 1.011 & 0.968 & 1.024 & 1.004 & 1.002 & 1.055 \\ 1.017 & 1.036 & 1.029 & 1.031 & 1.084 & 1.026 & 1.05 \\ 1.041 & 1.055 & 1.044 & 1.047 & 1.043 & 0 & 0 \end{bmatrix}$$

$$\mathrm{XXXS} := \mathrm{convert}\left(\mathrm{Points}_{49}, 7\right)$$

$$\mathrm{No}_{\mathrm{DataCells}} := \mathrm{length}(\mathrm{XXXS})$$

$$\mathrm{XXXS} := \mathrm{deletezero}_{\mathrm{cells}}\left(\mathrm{XXXS}, \mathrm{No}_{\mathrm{DataCells}}\right)$$

$$\mathrm{Grid}_{\mathrm{Top1986}} := \mathrm{XXXS}$$

page := READPRN("H:\MSOFFICE\Drywell Program data\1986 trenches\Trench17-2.txt")

$$\mathrm{Points}_{49} := \mathrm{showcells}(\mathrm{page}, 7, 0)$$

$$\mathrm{Points}_{49} = \begin{bmatrix} 1.045 & 1.009 & 1.024 & 1.026 & 1.008 & 1.07 & 1.07 \\ 0.991 & 1.012 & 1.041 & 1.031 & 1.017 & 1.076 & 1.076 \\ 1.031 & 1.101 & 1.081 & 1.077 & 1.04 & 1.076 & 1.072 \\ 1.087 & 1.059 & 1.069 & 1.057 & 1.102 & 1.088 & 1.047 \\ 0.998 & 1.065 & 1.048 & 1.004 & 1.014 & 1.016 & 1.016 \\ 0.964 & 1.019 & 0.987 & 1.055 & 1.045 & 1.022 & 1.061 \\ 0.906 & 1.04 & 1.019 & 0.98 & 1.024 & 1.01 & 1.014 \end{bmatrix}$$

$$\mathrm{XXX} := \mathrm{convert}\left(\mathrm{Points}_{49}, 7\right) \qquad \mathrm{No}_{\mathrm{DataCells}} := \mathrm{length}(\mathrm{XXX})$$

$$\mathrm{XXX} := \mathrm{deletezero}_{\mathrm{cells}}\left(\mathrm{XXX}, \mathrm{No}_{\mathrm{DataCells}}\right)$$

$$\mathrm{Cells}_{86} := \mathrm{stack}(\mathrm{XXX}, \mathrm{XXXS}) \qquad \mathrm{No}_{\mathrm{DataCells}} := \mathrm{length}\left(\mathrm{Cells}_{86}\right) \qquad \mathrm{No}_{\mathrm{DataCells}} = 96$$

page := READPRN("H:\MSOFFICE\Drywell Program data\1986 trenches\Trench17-3.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 0.964 & 1.105 & 1.083 & 1.011 & 1.047 & 1.016 & 1.028 \\ 1.063 & 1.012 & 1.029 & 1.047 & 1.056 & 0.972 & 0.907 \\ 1.021 & 1.097 & 1.071 & 1.068 & 1.033 & 0.911 & 0.952 \\ 1.066 & 1.023 & 1.006 & 1.063 & 1.045 & 1.035 & 0.992 \\ 1.052 & 1.037 & 1.044 & 1.078 & 1.05 & 1.054 & 1.051 \\ 1.037 & 1.015 & 1.026 & 1.064 & 1.07 & 1.056 & 1.044 \\ 1.065 & 1.059 & 1.026 & 1.058 & 1.047 & 1.067 & 1.075 \end{bmatrix}$$

$\text{XXX} := \text{convert}(\text{Points}_{49}, 7)$ $\text{No}_{\text{DataCells}} := \text{length}(\text{XXX})$

$\text{XXX} := \text{deletezero}_{\text{cells}}(\text{XXX}, \text{No}_{\text{DataCells}})$

$\text{Cells}_{86} := \text{stack}(\text{Cells}_{86}, \text{XXX})$ $\text{No}_{\text{DataCells}} := \text{length}(\text{Cells}_{86})$

$\text{No}_{\text{DataCells}} = 145$

page := READPRN("H:\MSOFFICE\Drywell Program data\1986 trenches\Trench17-4.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 1.088 & 1.046 & 1.019 & 1.103 & 0.993 & 1.086 & 1.041 \\ 1.056 & 1.045 & 0.995 & 1.044 & 1.042 & 1.026 & 1.116 \\ 1.102 & 1.001 & 1.044 & 1.082 & 1.028 & 1 & 1.08 \\ 1.106 & 1.05 & 1.002 & 1.017 & 1.042 & 1.034 & 1.037 \\ 1.069 & 0.965 & 0.988 & 1.122 & 1.034 & 1.032 & 1.07 \\ 1.097 & 1.028 & 1.051 & 0.951 & 1.059 & 1.015 & 1.005 \\ 1.135 & 1.022 & 1.076 & 1.058 & 0.952 & 0.981 & 1.023 \end{bmatrix}$$

$\text{XXX} := \text{convert}(\text{Points}_{49}, 7)$ $\text{No}_{\text{DataCells}} := \text{length}(\text{XXX})$

$\text{XXX} := \text{deletezero}_{\text{cells}}(\text{XXX}, \text{No}_{\text{DataCells}})$

$\text{Cells}_{86} := \text{stack}(\text{Cells}_{86}, \text{XXX})$ $\text{No}_{\text{DataCells}} := \text{length}(\text{Cells}_{86})$

$\text{No}_{\text{DataCells}} = 194$

page := READPRN("H:\MSOFFICE\Drywell Program data\1986 trenches\Trench17-5.txt")

$$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$$

$$\text{Points}_{49} = \begin{bmatrix} 1.023 & 1.049 & 0.987 & 1.085 & 1.048 & 1.072 & 0.98 \\ 1.1 & 1.017 & 0.958 & 1.044 & 0.991 & 1.056 & 1.074 \\ 1.053 & 1.03 & 1.025 & 0.987 & 1.031 & 1.059 & 1.087 \\ 1.005 & 1.049 & 1.006 & 1.058 & 1.058 & 1.011 & 0.992 \\ 0.972 & 0.985 & 1.012 & 1.009 & 1.067 & 1.017 & 0.975 \\ 0.985 & 0.979 & 0.974 & 0.961 & 1.017 & 1.008 & 0.982 \\ 0.999 & 0.987 & 1.021 & 0.958 & 0.954 & 1.064 & 0.942 \end{bmatrix}$$

$$XXX := \text{convert}(\text{Points}_{49}, 7) \qquad \text{No}_{\text{DataCells}} := \text{length}(XXX)$$

$$XXX := \text{deletezero}_{\text{cells}}(XXX, \text{No}_{\text{DataCells}})$$

$$\text{Cells}_{86} := \text{stack}(\text{Cells}_{86}, XXX) \qquad \text{No}_{\text{DataCells}} := \text{length}(\text{Cells}_{86}) \qquad \text{No}_{\text{DataCells}} = 243$$

page := READPRN("H:\MSOFFICE\Drywell Program data\1986 trenches\Trench17-6.txt")

$$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$$

$$\text{Points}_{49} = \begin{bmatrix} 0.923 & 0.981 & 0.976 & 0.97 & 0.964 & 0.99 & 1.004 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$XXX := \text{convert}(\text{Points}_{49}, 7) \qquad \text{No}_{\text{DataCells}} := \text{length}(XXX)$$

$$XXX := \text{deletezero}_{\text{cells}}(XXX, \text{No}_{\text{DataCells}})$$

$$\text{Cells}_{86} := \text{stack}(\text{Cells}_{86}, XXX)$$

$$\text{No}_{\text{DataCells}} := \text{length}(\text{Cells}_{86})$$

$$\text{No}_{\text{DataCells}} = 250$$

The thinnest point at this location is shown below

$$\text{minpoint} := \min(\text{Cells}_{86}) \qquad \text{minpoint} = 889$$

Mean and Standard Deviation

$\mu86_{actual} := \mathrm{mean}(Cells_{86})$ $\mu86_{actual} = 1.0239 \cdot 10^{3}$ $\sigma86_{actual} := \mathrm{Stdev}(Cells_{86})$ $\sigma86_{actual} = 45.019$

Standard Error

$$Standard_{error} := \frac{\sigma86_{actual}}{\sqrt{No_{DataCells}}} \qquad Standard_{error} = 2.847$$

Skewness

$$Skewness := \frac{(No_{DataCells}) \cdot \overrightarrow{\Sigma(Cells_{86} - \mu86_{actual})^{3}}}{(No_{DataCells} - 1) \cdot (No_{DataCells} - 2) \cdot (\sigma86_{actual})^{3}} \qquad Skewness = -0.387$$

Kurtosis

$$Kurtosis := \frac{No_{DataCells} \cdot (No_{DataCells} + 1) \cdot \overrightarrow{\Sigma(Cells_{86} - \mu86_{actual})^{4}}}{(No_{DataCells} - 1) \cdot (No_{DataCells} - 2) \cdot (No_{DataCells} - 3) \cdot (\sigma86_{actual})^{4}} \cdots + -\frac{3 \cdot (No_{DataCells} - 1)^{2}}{(No_{DataCells} - 2) \cdot (No_{DataCells} - 3)} \qquad Kurtosis = -0.033$$

Normal Probability Plot

In a normal plot, each data value is plotted against what its value would be if it actually came from a normal distribution. The expected normal values, called normal scores, and can be estimated by first calculating the rank scores of the sorted data.

$$j := 0 .. \text{last}\left(\text{Cells}_{86}\right) \qquad \text{srt} := \text{sort}\left(\text{Cells}_{86}\right)$$

Then each data point is ranked. The array rank captures these ranks

$$r_j := j + 1 \qquad \text{rank}_j := \frac{\overrightarrow{\Sigma\left(\overrightarrow{\text{srt}=\text{srt}_j}\right)\cdot r}}{\Sigma\overrightarrow{\text{srt}=\text{srt}_j}}$$

$$p_j := \frac{\text{rank}_j}{\text{rows}\left(\text{Cells}_{86}\right) + 1}$$

The normal scores are the corresponding *p*th percentile points from the standard normal distribution:

$$x := 1 \qquad \text{N\_Score}_j := \text{root}\left[\text{cnorm}(x) - \left(p_j\right), x\right]$$

Upper and Lower Confidence Values

The Upper and Lower confidence values are calculated based on .05 degree of confidence "α"

$$No_{DataCells} := \mathrm{length}(Cells_{86})$$

$$\alpha := .05 \qquad T\alpha := qt\left[\left(1-\frac{\alpha}{2}\right), No_{DataCells}\right] \qquad T\alpha = 1.969$$

$$Lower_{95\%Con} := \mu86_{actual} - T\alpha \cdot \frac{\sigma86_{actual}}{\sqrt{No_{DataCells}}} \qquad Lower_{95\%Con} = 1.018 \cdot 10^{3}$$

$$Upper_{95\%Con} := \mu86_{actual} + T\alpha \cdot \frac{\sigma86_{actual}}{\sqrt{No_{DataCells}}} \qquad Upper_{95\%Con} = 1.029 \cdot 10^{3}$$

These values represent a range on the calculated mean in which there is 95% confidence.

Graphical Representation

Distribution of the "Cells" data points are sorted in 1/2 standard deviation increments (bins) within +/- 3 standard deviations

$$Bins := Make_{bins}(\mu86_{actual}, \sigma86_{actual})$$

$$Distribution := \mathrm{hist}(Bins, Cells_{86})$$

$$Distribution = \begin{pmatrix} 4 \\ 5 \\ 13 \\ 17 \\ 30 \\ 47 \\ 50 \\ 44 \\ 28 \\ 9 \\ 3 \\ 0 \end{pmatrix}$$

The mid points of the Bins are calculated

$$k := 0..11 \qquad Midpoints_k := \frac{(Bins_k + Bins_{k+1})}{2}$$

The Mathcad function pnorm calculates a portion of normal distribution curve based on a given mean and standard deviation

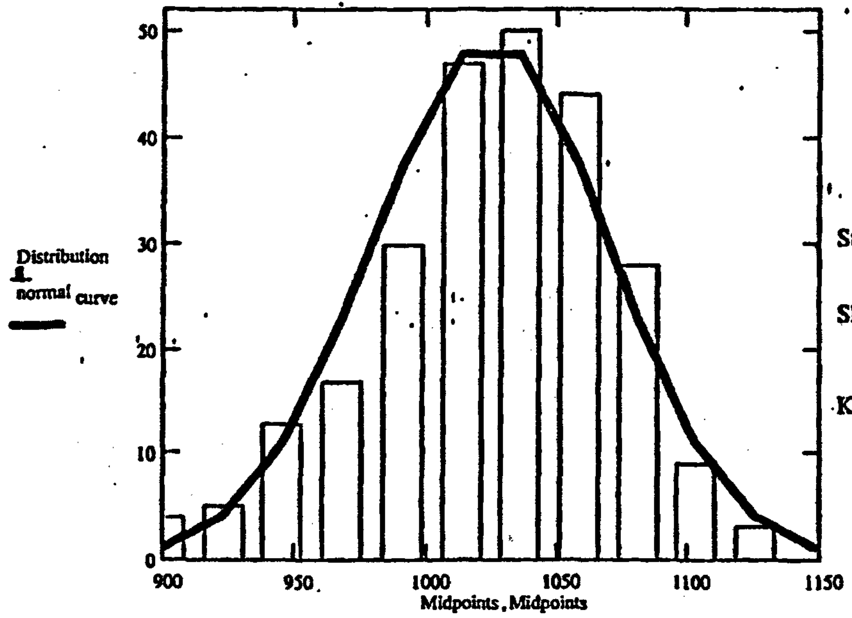
$$normal_{curve_0} := \mathrm{pnorm}(Bins_1, \mu86_{actual}, \sigma86_{actual})$$

$$normal_{curve_k} := \mathrm{pnorm}(Bins_{k+1}, \mu86_{actual}, \sigma86_{actual}) - \mathrm{pnorm}(Bins_k, \mu86_{actual}, \sigma86_{actual})$$

$$normal_{curve} := No_{DataCells} \cdot normal_{curve}$$

Results For Trench 17 1986 Data
The following schematic shows: the the distribution of the samples, the normal curve based on the actual mean and standard deviation, the kurtosis, the skewness, the number of data points, and the the lower and upper 95% confidence values. Below is the Normal Plot for the data.

Data Distribution



minpoint = 889

$\text{Standard}_{\text{error}} = 2.847$

$\text{Skewness} = -0.387$

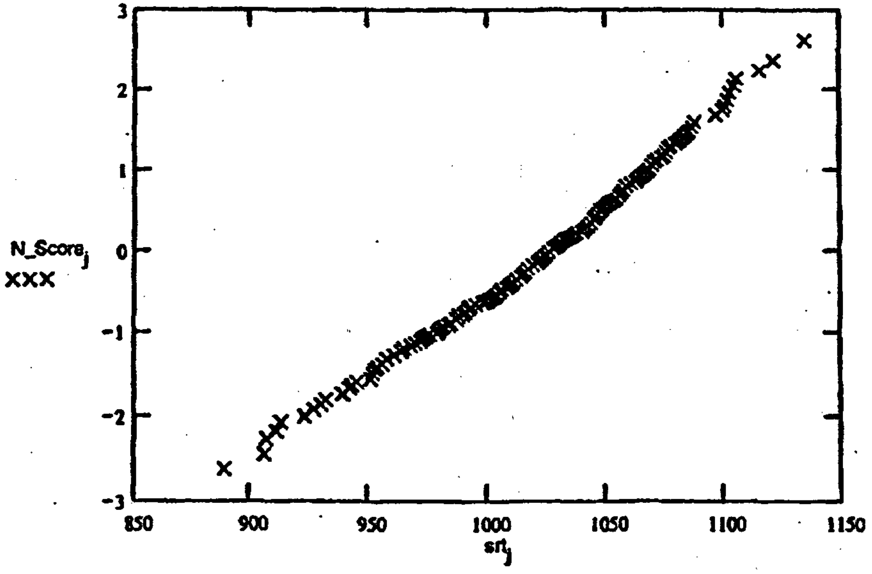
$\text{Kurtosis} = -0.033$

$\text{Lower}_{95\%\text{Con}} = 1.018 \cdot 10^{3}$ $\text{Upper}_{95\%\text{Con}} = 1.029 \cdot 10^{3}$

$\mu 86_{\text{actual}} = 1.024 \cdot 10^{3}$ $\sigma 86_{\text{actual}} = 45.019$ minpoint = 889

A Kurtosis value which is less than +/- 1.0 and approaches 0 is indicative of a normal distrubution

Normal Probability Plot



The Normal Probability Plot and the Kurtosis this data is normally distributed.

A Normal Probability Plot which approaches a straight line is indicative of a normal distrubution. Therefore the 1986 Bay 17 trench data had a normal distribution.

2006 Data

The data shown below was collected in 2006 in the trench in Bay 17

page := READPRN("H:\MSOFFICE\Drywell Program data\2006 trenchs\Trench17-1.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 0.963 & 0.972 & 0.877 & 0.835 & 0.891 & 0.831 & 0.894 \\ 0.897 & 0.937 & 0.903 & 0.893 & 0.838 & 0.781 & 0.841 \\ 0.855 & 0.884 & 0.853 & 0.85 & 0.84 & 0.814 & 0.788 \\ 0.802 & 0.891 & 0.838 & 0.79 & 1.082 & 0 & 0.809 \\ 0.746 & 0.795 & 0.776 & 0.822 & 0.757 & 1.042 & 0.794 \\ 0.702 & 0.779 & 0.811 & 0.835 & 0.723 & 0.738 & 0.837 \\ 0.726 & 0.825 & 0.878 & 0.868 & 0 & 0.864 & 0.954 \end{bmatrix}$$

$\text{XXXS} := \text{convert}\left(\text{Points}_{49}, 7\right)$

$\text{No}_{\text{DataCells}} := \text{length}(\text{XXXS})$

$\text{XXXS} := \text{deletezero}_{\text{cells}}\left(\text{XXXS}, \text{No}_{\text{DataCells}}\right)$

$\text{Grid}_{\text{Top2006}} := \text{XXXS}$

page := READPRN("H:\MSOFFICE\Drywell Program data\2006 trenchs\Trench17-2.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 0.997 & 1.023 & 1.06 & 1.015 & 0.964 & 0.995 & 0.997 \\ 1.061 & 0.958 & 1.022 & 1.044 & 0.991 & 0.99 & 1.001 \\ 1.008 & 1.021 & 1.01 & 1.01 & 1.003 & 0.959 & 0.963 \\ 0.988 & 0.991 & 0.961 & 0.94 & 1.029 & 0.979 & 0.929 \\ 1.005 & 1.014 & 1.003 & 0.896 & 0.944 & 1.013 & 0.885 \\ 0.99 & 0.976 & 0.962 & 0.909 & 0.905 & 0.863 & 0.923 \\ 0.954 & 0.954 & 0 & 0.885 & 0.887 & 0.877 & 0.93 \end{bmatrix}$$

$\text{XXX} := \text{convert}\left(\text{Points}_{49}, 7\right)$

$\text{No}_{\text{DataCells}} := \text{length}(\text{XXX})$

$\text{XXX} := \text{deletezero}_{\text{cells}}\left(\text{XXX}, \text{No}_{\text{DataCells}}\right)$

$\text{Cells}_{06} := \text{stack}(\text{XXX}, \text{XXXS})$

$\text{No}_{\text{DataCells}} := \text{length}\left(\text{Cells}_{06}\right)$

$\text{Grid}_{2} := \text{XXX}$

$\text{No}_{\text{DataCells}} = 95$

page := READPRN("H:\MSOFFICE\Drywell Program data\2006 trenchs\Trench17-3.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 0.973 & 0.954 & 1.004 & 1.013 & 1.011 & 1.043 & 0.948 \\ 0.998 & 0.952 & 1.007 & 1 & 0.963 & 1.006 & 0.951 \\ 0 & 0.978 & 0.979 & 0.935 & 1.014 & 0.981 & 1.015 \\ 1.017 & 1.074 & 0.968 & 0.963 & 0.966 & 1.014 & 1.03 \\ 1.038 & 1.053 & 1.026 & 1.008 & 0.983 & 0.979 & 1.039 \\ 0.968 & 1.028 & 0.998 & 1.017 & 1.004 & 1.03 & 1.046 \\ 1.028 & 0.95 & 1.047 & 1 & 0.977 & 1.002 & 1.01 \end{bmatrix}$$

$\text{XXX} := \text{convert}(\text{Points}_{49}, 7)$

$\text{No}_{\text{DataCells}} := \text{length}(\text{XXX})$

$\text{XXX} := \text{deletezero}_{\text{cells}}(\text{XXX}, \text{No}_{\text{DataCells}})$

$\text{Cells}_{06} := \text{stack}(\text{Cells}_{06}, \text{XXX})$

$\text{Grid}_{3} := \text{XXX}$

$\text{No}_{\text{DataCells}} := \text{length}(\text{Cells}_{06})$

$\text{No}_{\text{DataCells}} = 143$

page := READPRN("H:\MSOFFICE\Drywell Program data\2006 trenchs\Trench17-4.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 0.966 & 1.069 & 1.014 & 1.055 & 0.995 & 1.002 & 1.029 \\ 0.987 & 0.983 & 0.942 & 0.941 & 1.01 & 1.023 & 1.016 \\ 1.034 & 1.008 & 0.971 & 1.064 & 0.985 & 1.022 & 1.032 \\ 0.972 & 1.021 & 0.985 & 0.992 & 1.003 & 0.997 & 1.008 \\ 0.975 & 0.951 & 0.985 & 1.059 & 1.047 & 0.935 & 0.98 \\ 0.94 & 0.967 & 0.895 & 1.02 & 1.044 & 1.075 & 0.98 \\ 0.918 & 0.897 & 0.934 & 1.036 & 1.058 & 0.998 & 1.009 \end{bmatrix}$$

$\text{XXX} := \text{convert}(\text{Points}_{49}, 7)$

$\text{No}_{\text{DataCells}} := \text{length}(\text{XXX})$

$\text{XXX} := \text{deletezero}_{\text{cells}}(\text{XXX}, \text{No}_{\text{DataCells}})$

$\text{Cells}_{06} := \text{stack}(\text{Cells}_{06}, \text{XXX})$

$\text{Grid}_{4} := \text{XXX}$

$\text{No}_{\text{DataCells}} := \text{length}(\text{Cells}_{06})$

$\text{No}_{\text{DataCells}} = 192$

page := READPRN("H:\MSOFFICE\Drywell Program data\2006 trenchs\Trench17-5.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 1.026 & 0.958 & 0.958 & 1.026 & 0.982 & 0.988 & 0.967 \\ 1.026 & 0.906 & 0.915 & 0.991 & 1.006 & 0.984 & 0.962 \\ 0.979 & 0.933 & 1.027 & 0.934 & 0.969 & 0.956 & 1.042 \\ 0.963 & 1.003 & 1.016 & 1.062 & 0.969 & 0.987 & 1.03 \\ 1.027 & 0.977 & 1.039 & 0.999 & 0.998 & 1.027 & 1.039 \\ 1.023 & 1.001 & 0.959 & 0.997 & 0.974 & 1.003 & 1.09 \\ 0.986 & 1.004 & 1.009 & 0.946 & 1.016 & 1.023 & 0.995 \end{bmatrix}$$

$\text{XXX} := \text{convert}\left(\text{Points}_{49}, 7\right)$ $\qquad$ $\text{No}_{\text{DataCells}} := \text{length}(\text{XXX})$

$\text{XXX} := \text{deletezero}_{\text{cells}}\left(\text{XXX}, \text{No}_{\text{DataCells}}\right)$

$\text{Grid}_5 := \text{XXX}$

$\text{Cells}_{06} := \text{stack}\left(\text{Cells}_{06}, \text{XXX}\right)$ $\qquad$ $\text{No}_{\text{DataCells}} := \text{length}\left(\text{Cells}_{06}\right)$

$\text{No}_{\text{DataCells}} = 241$

page := READPRN("H:\MSOFFICE\Drywell Program data\2006 trenchs\Trench17-6.txt")

$\text{Points}_{49} := \text{showcells}(\text{page}, 7, 0)$

$$\text{Points}_{49} = \begin{bmatrix} 0.937 & 0.97 & 0.927 & 0.946 & 0.932 & 0.918 & 0.942 \\ 0.924 & 1.059 & 0.934 & 0.941 & 0.968 & 0.924 & 0.916 \\ 0.948 & 0.948 & 0.963 & 0.941 & 0.932 & 0.937 & 0.967 \\ 0.977 & 0.983 & 1.032 & 0.982 & 0.983 & 0.997 & 0.953 \\ 0.972 & 0.932 & 0.977 & 0.973 & 1.005 & 0.959 & 1.028 \\ 1.026 & 1.002 & 0.968 & 0.972 & 0.953 & 0.964 & 0.99 \\ 0.981 & 1.006 & 0.967 & 0.945 & 0.968 & 0.943 & 0.978 \end{bmatrix}$$

$\text{XXX} := \text{convert}\left(\text{Points}_{49}, 7\right)$ $\qquad$ $\text{No}_{\text{DataCells}} := \text{length}(\text{XXX})$

$\text{XXX} := \text{deletezero}_{\text{cells}}\left(\text{XXX}, \text{No}_{\text{DataCells}}\right)$ $\qquad$ $\text{Grid}_6 := \text{XXX}$

$\text{Cells}_{06} := \text{stack}\left(\text{Cells}_{06}, \text{XXX}\right)$

$\text{No}_{\text{DataCells}} := \text{length}\left(\text{Cells}_{06}\right)$ $\qquad$ $\text{No}_{\text{DataCells}} = 290$

$\text{minpoint} := \min(\text{XXX})$ $\qquad$ $\text{minpoint} = 916$

The thinnest point at this location is shown below

$\text{minpoint} := \min\left(\text{Cells}_{06}\right)$ $\qquad$ $\text{minpoint} = 702$

Mean and Standard Deviation

$\mu06_{actual} := \mathrm{mean}(\mathrm{Cells}_{06})$ $\mu06_{actual} = 962.7897$ $\sigma06_{actual} := \mathrm{Stdev}(\mathrm{Cells}_{06})$ $\sigma06_{actual} = 71.259$

Standard Error

$$\mathrm{Standard}_{error} := \frac{\sigma06_{actual}}{\sqrt{\mathrm{No}_{DataCells}}}$$

$\mathrm{Standard}_{error} = 4.184$

Skewness

$$\mathrm{Skewness} := \frac{(\mathrm{No}_{DataCells})\cdot\sum\overrightarrow{(\mathrm{Cells}_{06} - \mu06_{actual})^3}}{(\mathrm{No}_{DataCells} - 1)\cdot(\mathrm{No}_{DataCells} - 2)\cdot(\sigma06_{actual})^3}$$

$\mathrm{Skewness} = -1.252$

Kurtosis

$$\mathrm{Kurtosis} := \frac{\mathrm{No}_{DataCells}\cdot(\mathrm{No}_{DataCells} + 1)\cdot\sum\overrightarrow{(\mathrm{Cells}_{06} - \mu06_{actual})^4}}{(\mathrm{No}_{DataCells} - 1)\cdot(\mathrm{No}_{DataCells} - 2)\cdot(\mathrm{No}_{DataCells} - 3)\cdot(\sigma06_{actual})^4} \cdots + -\frac{3\cdot(\mathrm{No}_{DataCells} - 1)^2}{(\mathrm{No}_{DataCells} - 2)\cdot(\mathrm{No}_{DataCells} - 3)}$$

$\mathrm{Kurtosis} = 1.587$

Normal Probability Plot

In a normal plot, each data value is plotted against what its value would be if it actually came from a normal distribution. The expected normal values, called normal scores, and can be estimated by first calculating the rank scores of the sorted data.

$j := 0..\ \mathrm{last}(\mathrm{Cells}_{06})$ $\quad$ $\mathrm{srt} := \mathrm{sort}(\mathrm{Cells}_{06})$

Then each data point is ranked. The array rank captures these ranks

$z_j := j + 1$

$$\mathrm{rank}_j := \frac{\overrightarrow{\Sigma\left(\overrightarrow{\mathrm{srt} = \mathrm{srt}_j}\right) \cdot z}}{\Sigma \overrightarrow{\mathrm{srt} = \mathrm{srt}_j}}$$

$$p_j := \frac{\mathrm{rank}_j}{\mathrm{rows}(\mathrm{Cells}_{06}) + 1}$$

The normal scores are the corresponding *p*th percentile points from the standard normal distribution:

$x := 1$ $\qquad$ $\mathrm{N\_Score}_j := \mathrm{root}\left[\mathrm{cnorm}(x) - (p_j), x\right]$

Upper and Lower Confidence Values

The Upper and Lower confidence values are calculated based on .05 degree of confidence "α"

$No_{DataCells} := \mathrm{length}(Cells_{06})$

$\alpha := .05 \qquad T\alpha := \mathrm{qt}\left[\left(1 - \frac{\alpha}{2}\right), No_{DataCells}\right] \qquad T\alpha = 1.968$

$Lower_{95\%Con} := \mu06_{actual} - T\alpha \cdot \frac{\sigma06_{actual}}{\sqrt{No_{DataCells}}} \qquad Lower_{95\%Con} = 954.554$

$Upper_{95\%Con} := \mu06_{actual} + T\alpha \cdot \frac{\sigma06_{actual}}{\sqrt{No_{DataCells}}} \qquad Upper_{95\%Con} = 971.025$

These values represent a range on the calculated mean in which there is 95% confidence.

Graphical Representation

Distribution of the "Cells" data points are sorted in 1/2 standard deviation increments (bins) within +/- 3 standard deviations

$Bins := Make_{bins}(\mu06_{actual}, \sigma06_{actual})$

$Distribution := \mathrm{hist}(Bins, Cells_{06})$

$$Distribution = \begin{pmatrix} 4 \\ 8 \\ 13 \\ 12 \\ 18 \\ 49 \\ 80 \\ 74 \\ 23 \\ 4 \\ 0 \\ 0 \end{pmatrix}$$

The mid points of the Bins are calculated

$k := 0 .. 11 \qquad Midpoints_k := \frac{(Bins_k + Bins_{k+1})}{2}$

The Mathcad function pnorm calculates a portion of normal distribution curve based on a given mean and standard deviation

$normal_{curve_0} := \mathrm{pnorm}(Bins_1, \mu06_{actual}, \sigma06_{actual})$

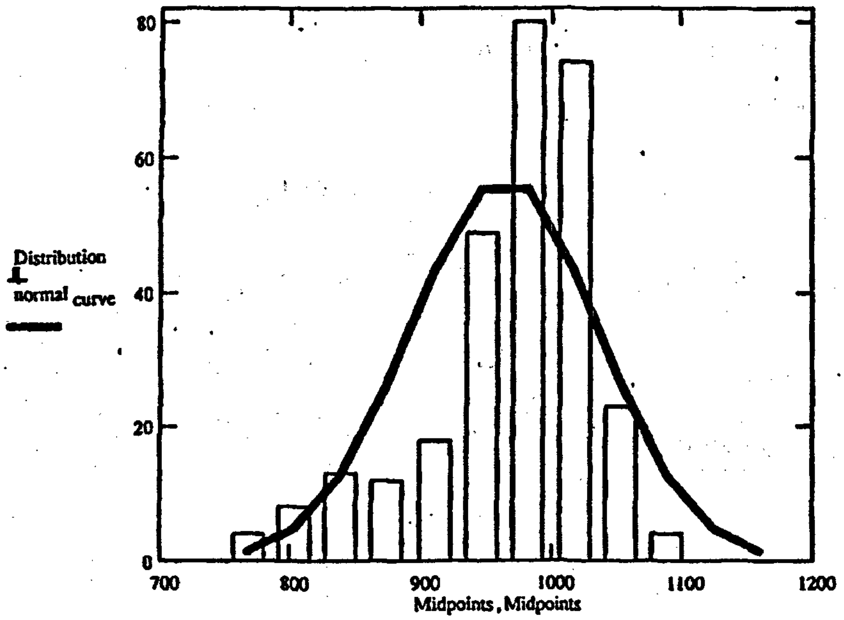
$normal_{curve_k} := \mathrm{pnorm}(Bins_{k+1}, \mu06_{actual}, \sigma06_{actual}) - \mathrm{pnorm}(Bins_k, \mu06_{actual}, \sigma06_{actual})$

$normal_{curve} := No_{DataCells} \cdot normal_{curve}$

Results For Trench 17 2006

The following schematic shows: the the distribution of the samples, the normal curve based on the actual mean and standard deviation, the kurtosis, the skewness, the number of data points, and the the lower and upper 95% confidence values. Below is the Normal Plot for the data.

Data Distribution



minpoint = 702

$\text{Standard}_{\text{error}} = 4.184$

Skewness = -1.252

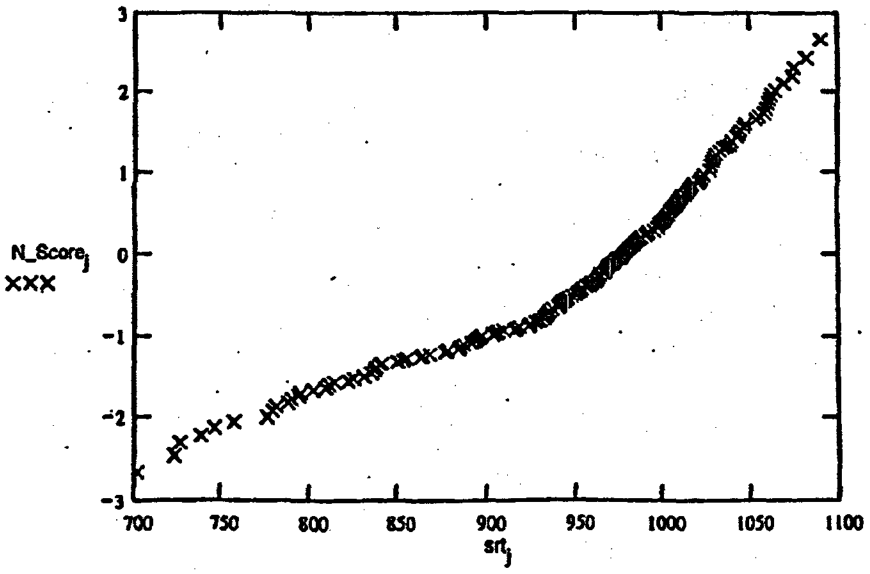
Kurtosis = 1.587

minpoint = 702

$\mu 06_{\text{actual}} = 962.79$ $\text{Lower}_{95\%\text{Con}} = 954.554$ $\sigma 06_{\text{actual}} = 71.259$ $\text{Upper}_{95\%\text{Con}} = 971.025$

A Kurtosis value which is less than +/- 1.0 and approaches 0 is indicative of a normal distrubution. Therefore this distribution may not be completely normal. The data is skewed towards the right.

Normal Probability Plot



A Normal Probability Plot indicates the distrubution of this data is not completely normal

Review of the 2006 data shows that the first 49 point grid located at the top of the trench is much thinner than the remaining five 49 point grids lower in the trenchs

The mean of the top grid is $\mathrm{mean}(\mathrm{Grid}_{\mathrm{Top2006}}) = 845.128$

While the mean of the remaining five grids are:

$\mu06_{\mathrm{grid.actual}_0} := \mathrm{mean}(\mathrm{Grid}_2)$ $\mathrm{mean}(\mathrm{Grid}_2) = 972.583$

$\mu06_{\mathrm{grid.actual}_1} := \mathrm{mean}(\mathrm{Grid}_3)$ $\mathrm{mean}(\mathrm{Grid}_3) = 999.75$

$\mu06_{\mathrm{grid.actual}_2} := \mathrm{mean}(\mathrm{Grid}_4)$ $\mathrm{mean}(\mathrm{Grid}_4) = 996.51$

$\mu06_{\mathrm{grid.actual}_3} := \mathrm{mean}(\mathrm{Grid}_5)$ $\mathrm{mean}(\mathrm{Grid}_5) = 993.816$

$\mu06_{\mathrm{grid.actual}_4} := \mathrm{mean}(\mathrm{Grid}_6)$ $\mathrm{mean}(\mathrm{Grid}_6) = 965.102$

$$\mathrm{mean}(\mu06_{\mathrm{grid.actual}}) = 985.552$$

Therefore the distibuteion of each of these set of data were investigated. The follwoing creates an array of the lower 5 grids

$\mathrm{five}_{\mathrm{Cells}} := \mathrm{stack}(\mathrm{Grid}_3, \mathrm{Grid}_2)$

$\mathrm{five}_{\mathrm{Cells}} := \mathrm{stack}(\mathrm{five}_{\mathrm{Cells}}, \mathrm{Grid}_4)$

$\mathrm{five}_{\mathrm{Cells}} := \mathrm{stack}(\mathrm{five}_{\mathrm{Cells}}, \mathrm{Grid}_5)$

$\mathrm{five}_{\mathrm{Cells}} := \mathrm{stack}(\mathrm{five}_{\mathrm{Cells}}, \mathrm{Grid}_6)$

$\mathrm{No}_{\mathrm{DataCells}} := \mathrm{length}(\mathrm{five}_{\mathrm{Cells}})$ $\mathrm{No}_{\mathrm{DataCells}} = 243$

Mean and Standard Deviation

$\mu_{5grids.actual} := \mathrm{mean}(five_{Cells})$ $\qquad$ $\sigma_{5grids.actual} := \mathrm{Stdev}(five_{Cells})$

$\mu_{5grids.actual} = 985.5473$ $\qquad$ $\sigma_{5grids.actual} = 41.462$

Standard Error

$$Standard_{error} := \frac{\sigma_{5grids.actual}}{\sqrt{No_{DataCells}}}$$

$Standard_{error} = 2.66$

Skewness

$$Skewness := \frac{(No_{DataCells}) \cdot \overrightarrow{\Sigma(five_{Cells} - \mu_{5grids.actual})^3}}{(No_{DataCells} - 1) \cdot (No_{DataCells} - 2) \cdot (\sigma_{5grids.actual})^3}$$

$Skewness = -0.242$

Kurtosis

$$Kurtosis := \frac{No_{DataCells} \cdot (No_{DataCells} + 1) \cdot \overrightarrow{\Sigma(five_{Cells} - \mu_{5grids.actual})^4}}{(No_{DataCells} - 1) \cdot (No_{DataCells} - 2) \cdot (No_{DataCells} - 3) \cdot (\sigma_{5grids.actual})^4} \cdots$$
$$+ -\frac{3 \cdot (No_{DataCells} - 1)^2}{(No_{DataCells} - 2) \cdot (No_{DataCells} - 3)}$$

$Kurtosis = -0.082$

Normal Probability Plot

In a normal plot, each data value is plotted against what its value would be if it actually came from a normal distribution. The expected normal values, called normal scores, and can be estimated by first calculating the rank scores of the sorted data.

$j := 0 .. \text{last}\left(\text{five}_{\text{Cells}}\right)$ $\qquad$ $\text{srt} := \text{sort}\left(\text{five}_{\text{Cells}}\right)$

Then each data point is ranked. The array rank captures these ranks

$zz_j := j + 1$

$$\text{rank}_j := \frac{\Sigma \overrightarrow{\left(\overrightarrow{\text{srt} = \text{srt}_j}\right) \cdot zz}}{\Sigma \overrightarrow{\text{srt} = \text{srt}_j}}$$

$$p_j := \frac{\text{rank}_j}{\text{rows}\left(\text{five}_{\text{Cells}}\right) + 1}$$

The normal scores are the corresponding *p*th percentile points from the standard normal distribution:

$x := 1$ $\qquad$ $\text{N\_Score}_j := \text{root}\left[\text{cnorm}(x) - \left(p_j\right), x\right]$

Upper and Lower Confidence Values

The Upper and Lower confidence values are calculated based on .05 degree of confidence "α"

$$\text{No}_{\text{DataCells}} := \text{length}(\text{five}_{\text{Cells}}) \qquad \text{No}_{\text{DataCells}} = 243$$

$$\alpha := .05 \qquad T\alpha := \text{qt}\left[\left(1 - \frac{\alpha}{2}\right), \text{No}_{\text{DataCells}}\right] \qquad T\alpha = 1.97$$

$$\text{Lower}_{95\%\text{Con}} := \mu_{\text{5grids.actual}} - T\alpha \cdot \frac{\sigma_{\text{5grids.actual}}}{\sqrt{\text{No}_{\text{DataCells}}}} \qquad \text{Lower}_{95\%\text{Con}} = 980.308$$

$$\text{Upper}_{95\%\text{Con}} := \mu_{\text{5grids.actual}} + T\alpha \cdot \frac{\sigma 06_{\text{actual}}}{\sqrt{\text{No}_{\text{DataCells}}}} \qquad \text{Upper}_{95\%\text{Con}} = 994.552$$

These values represent a range on the calculated mean in which there is 95% confidence.

Graphical Representation

Distribution of the "Cells" data points are sorted in 1/2 standard deviation increments (bins) within +/- 3 standa
deviations

$$\text{Bins} := \text{Make}_{\text{bins}}(\mu_{\text{5grids.actual}}, \sigma_{\text{5grids.actual}})$$

$$\text{Distribution} := \text{hist}(\text{Bins}, \text{five}_{\text{Cells}})$$

$$\text{Distribution} = \begin{pmatrix} 2 \\ 6 \\ 8 \\ 25 \\ 32 \\ 47 \\ 45 \\ 42 \\ 23 \\ 9 \\ 3 \\ 1 \end{pmatrix}$$

The mid points of the Bins are calculated

$$k := 0..11 \qquad \text{Midpoints}_k := \frac{(\text{Bins}_k + \text{Bins}_{k+1})}{2}$$

The Mathcad function pnorm calculates a portion of normal distribution curve based on a given mean and standard deviation

$$\text{normal}_{\text{curve}_0} := \text{pnorm}(\text{Bins}_1, \mu_{\text{5grids.actual}}, \sigma_{\text{5grids.actual}})$$

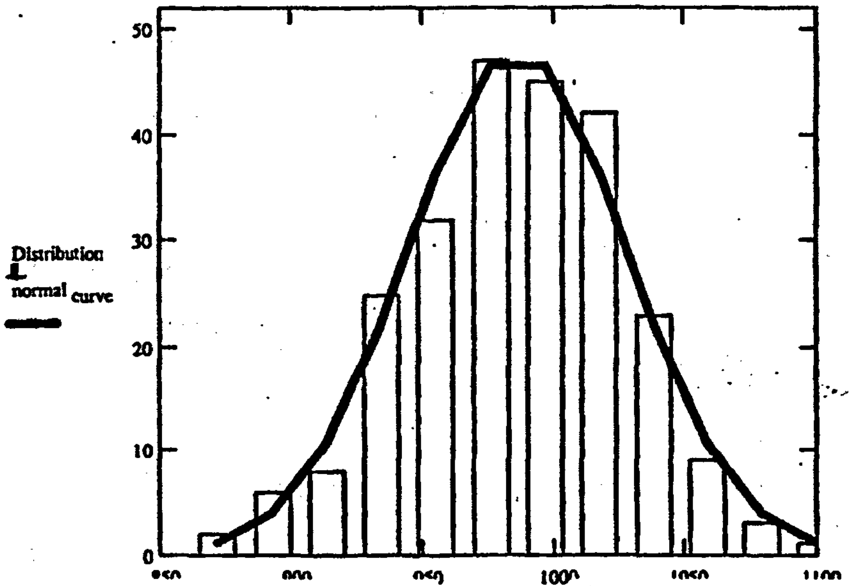
$$\text{normal}_{\text{curve}_k} := \text{pnorm}(\text{Bins}_{k+1}, \mu_{\text{5grids.actual}}, \sigma_{\text{5grids.actual}}) - \text{pnorm}(\text{Bins}_k, \mu_{\text{5grids.actual}}, \sigma_{\text{5grids.actual}})$$

$$\text{normal}_{\text{curve}} := \text{No}_{\text{DataCells}} \cdot \text{normal}_{\text{curve}}$$

Results For Trehcn 17 ower 5 grids Oct. 2006

The following schematic shows: the the distribution of the samples, the normal curve based on the actual mean and standard deviation, the kurtosis, the skewness, the number of data points, and the the lower and upper 95% confidence values. Below is the Normal Plot for the data.

Data Distribution



minpoint = 702

$\text{Standard}_{\text{error}} = 2.66$

Skewness = ⁻0.242

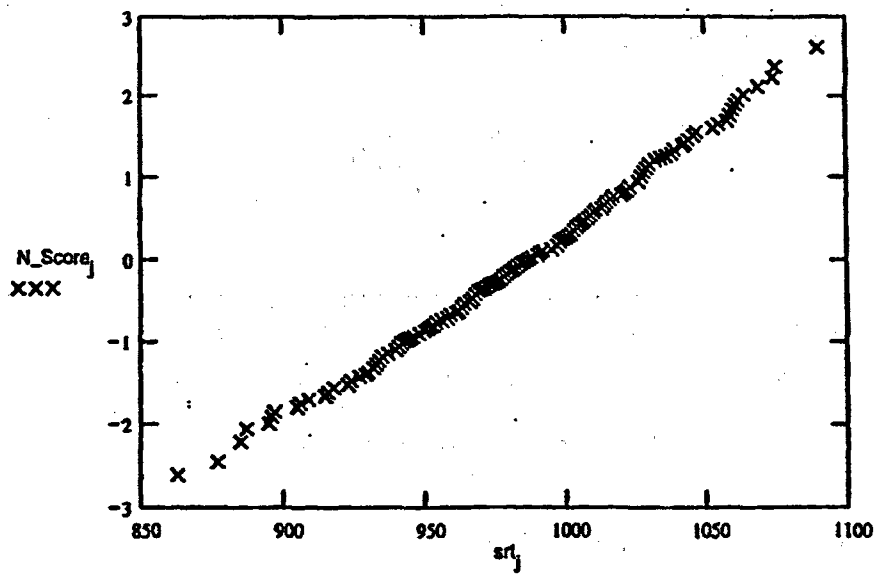
Kurtosis = ⁻0.082

$\text{Lower}_{95\%\text{Con}} = 980.308$ $\text{Upper}_{95\%\text{Con}} = 994.552$

$\mu_{\text{5grids.actual}} = 985.547$ $\sigma_{\text{5grids.actual}} = 41.462$

A Kurtosis value which is less than +/- 1.0 and approaches 0 is indicative of a normal distrubution.

Normal Probability Plot



A Normal Probability Plot indicates the distrubution of this data is not completely normal

Therefore when considering the entire 2006 data (all 6 grids) set which is skewed, the corrosion rate from 1986 to 1992 was

$$\frac{\left(\mu 86_{\text{actual}} - \mu 06_{\text{actual}}\right)}{1992 - 1986} = 10.18$$

Therefore when considering the entire 2006 data (all 6 grids) set which is skewed, the apparent corrosion rate from 1986 to 2006 was

$$\frac{\left(\mu 86_{\text{actual}} - \mu 06_{\text{actual}}\right)}{2006 - 1986} = 3.054$$

When considering only the 5 lower grids of the 2006 data set which is normally distributed, the corrosion rate from 1986 to 1992 was

$$\frac{\left(\mu 86_{\text{actual}} - \mu_{\text{5grids.actual}}\right)}{1992 - 1986} = 6.387$$

This is very consistent with the Bay 5 trench results

When considering only the 5 lower grids of the 2006 data set which is normally distributed, the apparent corrosion rate from 1986 to 2006 was

$$\frac{\left(\mu 86_{\text{actual}} - \mu_{\text{5grids.actual}}\right)}{2006 - 1986} = 1.916$$

This is very consistent with the Bay 5 trench results

1R21LR-022
Pg 1 of 2

General Electric	**Ultrasonic Thickness Measurement Data Sheet**	File Name:	N/A
Oyster Creek		Date:	10/22/2006
Refueling Outage - 1R21		UT Procedure:	ER-AA-335-004
Page 1 of 2		Specification	IS-328227-004

Examiner: Leslie Richter	Level: II	Instrument Type:	Panametrics 37DL Plus
Examiner: N/A	Level: N/A	Instrument No:	031124909

Transducer Type: D795 | Serial #: 104012 | Size: 0.200" | Freq: 5 Mhz | Angle: 0°
Transducer Cable Type: Panametrics Length: 5' | Couplant: Soundsafe | Batch No: 19620
Calibration Block Type: C/S Step Wedge | Block Number: CAL-STEP-080

SYSTEM CALIBRATION

INSTRUMENT SETTINGS		Initial Cal. Time	Calibration Checks		Final Cal. Time	
Coarse Range:	5.0"	11:59	13:00	13:30	14:30	
Coarse Delay:	N/A	Calibrated Sweep Range = 0.500"	Inches to: 1.500" Inches			
Delay Calib:	N/A	Thermometer: 246647	Comp. Temp: 82°		Block Temp: 79°	
Range Calib:	N/A	W/O Number: ~~R2086928~~				
Instrument Freq.	N/A	Total Crew Dose 7 mr	C2013477 Drywell Containment Vessel Thickness Examination. [illegible] 10-22-06 External UT Inspections.			
Gain:	74 db					
Damping:	N/A					
Reject:	N/A					
Filter:	N/A					

Bay - 1

PASSPORT# 00546049 07
AR# A2152754 E09
ATTACHMENT 4
PAGE 1 OF 2

E09
PT

BAY	Point Number		Vertical Location			Horizonal Location			

See Attached for Locations and Thickness Readings

COMMENTS: Coated surface is rough at all reading points. Unable to slide off of best measurement spot. Plot measurement numbers are more accurate if measuring tape is placed 13" to the right from the center of the weld on the nozzle, then follow down passing through point # 8.

[illegible] L III 10-22-06

Reviewed by: Lee Stone Level II Date 10/22/2006

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	D48	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	0.899	
	19	D38	L24	0.890	0.865	
	20	D18	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 92-072-19 page 1 of 1
All horizonal measurements taken 13" to the right of the centerline of the reinforcement ring (Boss).
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 6, based on surface curvature.

10-22-06

PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT 4
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1R21LR-022
Pg 2 of 2
[illegible] c III 10-22-06

1R21 LR-012 Pg 1 of 2

General Electric	**Ultrasonic Thickness Measurement Data Sheet**	File Name:	N/A
Oyster Creek		Date:	10/20/2006
Refueling Outage - 1R21		UT Procedure:	ER-AA-335-004
Page 1 of 2		Specification	IS-328227-004

Examiner:	Scott Erickson Scott R. Erickson	Level:	II	Instrument Type:	Panametrics 37DL Plus		
Examiner:	N/A,	Level:	N/A	Instrument No:	031120708		
Transducer Type:	D7908	Serial #:	338302	Size:	0.200"	Freq: 7.5 Mhz	Angle: 0°
Transducer Cable Type:	Panametrics	Length:	5'	Couplant:	Soundsafe	Batch No:	19620
Calibration Block Type:	C/S Step Wedge	Block Number:	CAL-STEP-136				

SYSTEM CALIBRATION

INSTRUMENT SETTINGS		Initial Cal. Time	Calibration Checks		Final Cal. Time	
Coarse Range:	2.0"	22:05	N/A	N/A	23:50	
Coarse Delay:	N/A	Calibrated Sweep Range = 0.500"	Inches to 1.500" Inches			
Delay Calib:	N/A	Thermometer: 246647	Comp. Temp: 78°	Block Temp: 75°		
Range Calib:	N/A	W/O Number: C2013477				
Instrument Freq.	N/A	Total Crew Dose	Drywell Containment Vessel Thickness Examination. External UT Inspections.			
Gain:	54 db	1 mr				
Damping:	N/A					
Reject:	N/A					
Filter:	N/A					

Bay - 3

BAY	Point Number	▨	Vertical Location		▨	Horizonal Location		▨	Thickness Reading
		▨	See Attached for Locations and Thickness Readings					▨	

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AR# A2152754 E08
ATTACHMENT 4
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COMMENTS: N/A

MM'allister L III 10-22-06

Reviewed by: Lee Stone Lee Stone Level II Date 10/19/2006

BAY 3

	Point	Vertical	Horizontal	1992 value	2006 Value	Comments
	1	D16	R63	0.795	0.795	N/A
	2	D18	R48	1	0.999	
	3	D17	R33	0.857	0.850	
	4	D13	L5	0.898	0.903	
	5	D25	L8	0.823	0.819	
	6	D15	L56	0.968	0.972	
	7	D29	R4	0.826	0.816	
	8	D34	L4	0.78	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 6, based on surface curvature.

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AR# A2152754 E09
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PT 4

1R21LR-0012 Pg 2 of 2
MM LIII 10-22-06

Report # 1R21LR-019
Pg 1 of 2

General Electric	**Ultrasonic Thickness Measurement Data Sheet**	File Name:	N/A
Oyster Creek		Date:	10/20/2006
Refueling Outage - 1R21		UT Procedure:	ER-AA-335-004
Page 1 of 2		Specification	IS-328227-004

Examiner: Leslie Richter		Level:	II	Instrument Type:	Panametrics 37DL Plus		
Examiner: N/A		Level:	N/A	Instrument No:	031124909		
Transducer Type: D795	Serial #: 104012	Size:	0.200"	Freq:	5 Mhz	Angle: 0°	
Transducer Cable Type: Panametrics Length: 5'		Couplant:	Soundsafe		Batch No:	19620	
Calibration Block Type: C/S Step Wedge	Block Number:	CAL-STEP-136					

SYSTEM CALIBRATION

INSTRUMENT SETTINGS		Initial Cal. Time	Calibration Checks		Final Cal. Time	
Coarse Range:	5.0"	15:38	15:51	16:45	17:28	
Coarse Delay:	N/A	Calibrated Sweep Range = 0.500" Inches to 1.500" Inches				
Delay Calib:	N/A	Thermometer: 246647		Comp. Temp: 82°	Block Temp: 76°	
Range Calib:	N/A	W/O Number:	C2013477			
Instrument Freq.	N/A	Total Crew Dose 2 mr	Drywell Containment Vessel Thickness Examination. External UT Inspections.			
Gain:	72 db					
Damping:	N/A					
Reject:	N/A					
Filter:	N/A					

Bay - 5

BAY	Point Number		Vertical Location			Horizonal Location			Thickness Reading

See Attached for Locations and Thickness Readings

PASSPORT# 00546049 07
AR# A2152754 E09
ATTACHMENT 4
PAGE 5 OF 20

COMMENTS: N/A

[illegible] LIII 10-22-06

Reviewed by: Scott Erickson Scott R Erickson Level II Date 10/19/2006

1R21LR-019 Pg 2 of 2
10-22-06

PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT Y
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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

1R21LR-005 Pg 1 of 2

General Electric	**Ultrasonic Thickness Measurement Data Sheet**	File Name:	N/A
Oyster Creek		Date:	10/19/2006
Refueling Outage - 1R21		UT Procedure:	ER-AA-335-004
Page 1 of 2		Specification:	IS-328227-004 *

Examiner: Lee Stone		Level: II		Instrument Type:	Panametrics 37DL Plus
Examiner: N/A,		Level: N/A		Instrument No:	031124909
Transducer Type: D795	Serial #: 1103007	Size: 0.200"	Freq: 5 Mhz		Angle: 0°
Transducer Cable Type: Panametrics Length: 6'		Couplant: Soundsafe		Batch No:	19620
Calibration Block Type: C/S Step Wedge		Block Number: CAL-STEP-109			

SYSTEM CALIBRATION

INSTRUMENT SETTINGS						
Coarse Range:	5.0"	Initial Cal. Time	Calibration Checks		Final Cal. Time	
Coarse Delay:	N/A	14:20	N/A	N/A	15:10	
Delay Calib:	N/A	Calibrated Sweep Range = 0.500" Inches to 1.500" Inches				
Range Calib:	N/A	Thermometer: 246737		Comp. Temp: 72°	Block Temp: 74°	
Instrument Freq.	N/A	W/O Number: C2013477				
Gain:	67 db	Total Crew Dose 12 mr.	Drywell Containment Vessel Thickness Examination. External UT Inspections.			
Damping:	N/A					
Reject:	N/A					
Filter:	N/A					

Bay - 7

BAY	Point Number	▨	Vertical Location		▨	Horizonal Location		▨	Thickness Reading

See Attached for Locations and Thickness Readings

COMMENTS: ~~N/A~~

* INSPECTION PERFORMED IAW ENGINEERING DIRECTION REF. REV 14 DRAFT. MM 10-22-06

LIII 10-22-06

Reviewed by: Kimberly Wert Kimberly Wert Level II Date 10/19/2006

PASSPORT# 00546049 07
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ATTACHMENT 4
PAGE 7 OF 20

BAY 7

	Point	Vertical	Horizontal	1992 value	2006 Value	Comments
	1	D21	R39	0.92	N/A	Could not locate area
	2	D21	R32	1.016	N/A	Could not locate area
	3	D10	R20	0.984	0.964	up/dn ranged from 0.956 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 1.026

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.

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ATTACHMENT 4
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10-19-2006

1R21LR-005 Pg 2 of 2
WMC III
10-26-06

1R21CR-006 Pg 1 of 2

General Electric	**Ultrasonic Thickness Measurement Data Sheet**	File Name:	N/A
Oyster Creek		Date:	10/19/2006
Refueling Outage - 1R21		UT Procedure:	ER-AA-335-004
Page 1 of 2		Specification	IS-328227-004

Examiner: Scott Erickson Scott R. Erickson	Level: II	Instrument Type:	Panametrics 37DL Plus
Examiner: N/A	Level: N/A	Instrument No:	031120706

Transducer Type: D7906	Serial #: 338302	Size: 0.200"	Freq: 7.5 Mhz	Angle: 0°
Transducer Cable Type: Panametrics Length: 5'	Couplant:	Soundsafe	Batch No:	19620
Calibration Block Type: C/S Step Wedge	Block Number:	CAL-STEP-080		

SYSTEM CALIBRATION

INSTRUMENT SETTINGS						
Coarse Range:	2.0"	Initial Cal. Time	Calibration Checks		Final Cal. Time	
Coarse Delay:	N/A	22:05	N/A	N/A	23:50	
Delay Calib:	N/A	Calibrated Sweep Range = 0.500"		Inches to 1.500" Inches		
Range Calib:	N/A	Thermometer:	246737	Comp. Temp: 74°	Block Temp: 72°	
Instrument Freq.	N/A	W/O Number:	C2013477			
Gain:	61 db	Total Crew Dose	Drywell Containment Vessel Thickness Examination. External UT Inspections.			
Damping:	N/A	6 mr				
Reject:	N/A					
Filter:	N/A					

Bay - 9

BAY	Point Number		Vertical Location			Horizonal Location			Thicknes Readin

See Attached for Locations and Thickness Readings

PASSPORT# 00546049 07
AR# A2152754 E09
ATTACHMENT 1
PAGE 5 OF 20

COMMENTS: N/A

L III 10-22-06

Reviewed by: Lee Stone Lee Stone Level II Date 10/19/2006

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	0.994	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.

PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT 4
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1R21CR-006 Pg 2 of 2

10-22-06

1R21CR-008 : Pg 1 of 2

10-22-06

General Electric	**Ultrasonic Thickness Measurement Data Sheet**	File Name:	N/A
Oyster Creek		Date:	10/20/2006
Refueling Outage - 1R21		UT Procedure:	ER-AA-335-004
Page 1 of 2		Specification	IS-328227-004

Examiner: Graham McNabb	Level: II	Instrument Type:	Panametrics 37DL Plus
Examiner: N/A	Level: N/A	Instrument No:	031124909

Transducer Type: D795	Serial #: 104010	Size: 0.200"	Freq: 5 Mhz	Angle: 0°
Transducer Cable Type: Panametrics Length: 5'	Couplant: Soundsafe		Batch No:	19620
Calibration Block Type: C/S Step Wedge	Block Number: CAL-STEP-080			

SYSTEM CALIBRATION

INSTRUMENT SETTINGS	
Coarse Range:	5.0"
Coarse Delay:	N/A
Delay Calib:	N/A
Range Calib:	N/A
Instrument Freq.	N/A
Gain:	58 db
Damping:	N/A
Reject:	N/A
Filter:	N/A

Initial Cal. Time	Calibration Checks		Final Cal. Time	
2:15	N/A	N/A	5:15	

Calibrated Sweep Range = 0.500" Inches to 1.500" Inches

Thermometer:	246534	Comp. Temp:	74°	Block Temp:	72°
W/O Number:	C2013477				
Total Crew Dose	6 mr	Drywell Containment Vessel Thickness Examination. External UT Inspections.			

Bay - 11

BAY	Point Number	▨	Vertical Location		▨	Horizonal Location		▨	Thickness Reading
			See Attached for Locations and Thickness Readings						

PASSPORT# 00546049 07
AR# A2152754 E09
ATTACHMENT [illegible]
PAGE 11 OF [illegible]

COMMENTS: N/A

L III 10-22-06

Reviewed by: Scott Erickson Scott R. Erickson Level II Date 10/20/2006

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 6, based on surface curvature.

L III 10-22-06

PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT 4
PAGE 2 OF 2

1R21LR-008 Pg 2 of 2

1R21LR-010 Pg 1 of 2

General Electric	**Ultrasonic Thickness Measurement Data Sheet**	File Name:	N/A
Oyster Creek		Date:	10/19/2006
fueling Outage - 1R21		UT Procedure:	ER-AA-335-004
Page 1 of 2		Specification	IS-328227-004

Examiner: Scott Erickson Scott R. Erickson	Level: II	Instrument Type:	Panametrics 37DL Plus
Examiner: N/A	Level: N/A	Instrument No:	031120708

Transducer Type: D799	Serial #: 104044	Size: 0.312"	Freq: 5 Mhz	Angle: 0°	
Transducer Cable Type: Panametrics Length: 5'	Couplant: Soundsafe	Batch No: 04120B			
Calibration Block Type: C/S Step Wedge	Block Number: CAL-STEP-109				

SYSTEM CALIBRATION

INSTRUMENT SETTINGS						
Coarse Range:	5.0"	Initial Cal. Time	Calibration Checks		Final Cal. Time	
Coarse Delay:	N/A	3:00	N/A	N/A	4:15	
Delay Calib:	N/A	Calibrated Sweep Range = 0.500"	Inches to 1.500" inches			
Range Calib:	N/A	Thermometer: 246737	Comp. Temp: 72°	Block Temp: 70°		
Instrument Freq.	N/A	W/O Number: C2013477				
Gain:	51 db	Total Crew Dose 0 mr	Drywell Containment Vessel Thickness Examination. External UT Inspections.			
Damping:	N/A					
Reject:	N/A					
Filter:	N/A					

Bay - 13

BAY	Point Number		Vertical Location			Horizonal Location			Thickness Reading
		▨			▨			▨	

See Attached for Locations and Thickness Readings

PASSPORT# 00546049 07
AR# A2152754 E09
ATTACHMENT 5
PAGE 13 OF 22

COMMENTS: N/A

III 10-22-06

Reviewed by: Lee Stone Level II Date 10/19/2006

BAY 13

	Point	Vertical	Horizontal	1992 value	2006 Value	Comments
	1	U1	R45	0.672	N/A	Could not locate area
	2	U1	R38	0.729	N/A	Could not locate area
	3	D21	R48	0.941	0.923	
	4	D12	R36	0.915	0.873	
	5	D21	R6	0.718	0.708	
	6	D24	L8	0.655	0.658	
	7	D17	L23	0.618	0.602	
	8	D24	L20	0.718	0.704	
	9	D28	R41	0.924	0.915	
	10	D28	R12	0.728	0.741	
	11	D28	L15	0.685	0.669	
	12	D28	L23	0.885	0.886	
	13	D18	D40	0.932	0.814	
	14	D18	R8	0.868	0.870	
	15	D20	L9	0.683	0.666	
	16	D20	L29	0.829	0.814	
	17	D9	R38	0.807	N/A	Could not locate area
	18	D22	R38	0.825	N/A	Could not locate area
	19	D37	R38	0.912	0.916	

5
8
8
19

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 curvature.

PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT 4
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III 10-22-06

1R21LR-06-Pg 2 of 2

1R21CK-015 Pg 1 of 2

General Electric	**Ultrasonic Thickness Measurement Data Sheet**	File Name:	N/A
Oyster Creek		Date:	10/20/2006
fueling Outage - 1R21		UT Procedure:	ER-AA-335-004
Page 1 of 2		Specification	IS-328227-004

Examiner: Matt Wilson	Level: II	Instrument Type:	Panametrics 37DL Plus		
Examiner: N/A	Level: N/A	Instrument No:	031124709		
Transducer Type: D795	Serial #: 1103008	Size: 0.200"	Freq: 5 Mhz	Angle: 0°	
Transducer Cable Type: Panametrics Length: 5'	Couplant: Soundsafe	Batch No:	19620		
Calibration Block Type: C/S Step Wedge	Block Number: CAL-STEP-088				

SYSTEM CALIBRATION

INSTRUMENT SETTINGS						
		Initial Cal. Time	Calibration Checks		Final Cal. Time	
Coarse Range:	5.0"	10:30	12:10	12:33	13:05	
Coarse Delay:	N/A	Calibrated Sweep Range = 0.500" Inches to 1.500" Inches				
Delay Calib:	N/A	Thermometer:	246484	Comp. Temp: 82°	Block Temp: 76°	
Range Calib:	N/A	W/O Number:	C2013477			
Instrument Freq.	N/A	Total Crew Dose 2 mr	Drywell Containment Vessel Thickness Examination. External UT Inspections.			
Gain:	67 db					
Damping:	N/A					
Reject:	N/A					
Filter:	N/A					

Bay - 15

BAY	Point Number	▨	Vertical Location		▨	Horizonal Location		▨	Thickness Reading
		▨			▨			▨	

See Attached for Locations and Thickness Readings

PASSPORT# 00546049 07
AR# A2152754 E08
ATTACHMENT 4
PAGE 15 OF 32

COMMENTS: N/A

Matt Wilson L III 10-22-06

Reviewed by: Lee Stone Lee Stone Level II Date 10/20/2006

BAY 15

	Point	Vertical	Horizontal	1992 value	2006 Value	Comments
	1	D12	R26	0.786	0.779	0.711 to 0.779
	2	D22	R21	0.829	0.798	0.777 to 0.798
	3	D33	R17	0.932	0.935	
	4	D30	R7	0.795	0.791	
	5	D26	L3	0.85	0.855	0.817 to 0.855
	6	D6	L8	0.794	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	L65	0.825	0.843	0.798 to 0.843

Data obtained from
NDE Data Sheets 92-072-21 page 1 of 1
Note: scanned 0.25" area around recorded 2006 value number - see comments for ranges.

1R21LK-010 F3 [illegible]

Report 1R21LK-07
Pg. 1 OF 2
~~016~~ 021

General Electric	**Ultrasonic Thickness Measurement Data Sheet**	File Name:	N/A
Oyster Creek		Date:	10/19/2006
Refueling Outage - 1R21		UT Procedure:	ER-AA-335-004
Page 1 of 2		Specification:	IS-328227-004

Examiner: Matt Wilson *Matt Wilson*		Level:	II	Instrument Type:	Panametrics 37DL Plus		
Examiner: N/A		Level:	N/A	Instrument No:	031124709		
Transducer Type: D795	Serial #: 104010	Size:	0.200"	Freq:	5 Mhz	Angle: 0°	
Transducer Cable Type: Panametrics Length: 5'		Couplant:	Soundsafe	Batch No:	19620		
Calibration Block Type: C/S Step Wedge	Block Number: CAL-STEP-088						

SYSTEM CALIBRATION

INSTRUMENT SETTINGS		Initial Cal. Time	Calibration Checks		Final Cal. Time	
Coarse Range:	5.0"	15:38	N/A	N/A	17:18	
Coarse Delay:	N/A	Calibrated Sweep Range = 0.500"	Inches to 1.500" Inches			
Delay Calib:	N/A	Thermometer: 246534	Comp. Temp: 82°		Block Temp: 78°	
Range Calib:	N/A	W/O Number: C2013477				
Instrument Freq.	N/A	Total Crew Dose	Drywell Containment Vessel Thickness Examination. External UT Inspections.			
Gain:	67 db	2 mr				
Damping:	N/A					
Reject:	N/A					
Filter:	N/A					

Bay - 17

BAY	Point Number		Vertical Location			Horizonal Location			Thickness Reading

See Attached for Locations and Thickness Readings

PASSPORT# 00546049 07
AR# A2152754 E08
ATTACHMENT 4
PAGE ☐ OF 20

COMMENTS: N/A

10-22-06

Reviewed by: Scott Erickson *Scott R. Erickson* Level II Date 10/19/2006

[illegible] Page 2002 021
10-22-06

PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT 4
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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 .663
	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.

Matthew E Wilson 10-19-2006

-020

Page 1 of 2

General Electric	**Ultrasonic Thickness Measurement Data Sheet**	File Name:	N/A
Oyster Creek		Date:	10/22/2006
Refueling Outage - 1R21		UT Procedure:	ER-AA-335-004
Page 1 of 2		Specification	IS-328227-004

Examiner: Matt Wilson Matthew Wilson	Level:	II	Instrument Type:	Panametrics 37DL Plus	
Examiner: N/A	Level:	N/A	Instrument No:	031124709	
Transducer Type: D795	Serial #: 104010	Size: 0.200"	Freq: 5 Mhz	Angle: 0°	
Transducer Cable Type: Panametrics Length: 6'	Couplant:	Soundsafe	Batch No:	19620	
Calibration Block Type: C/S Step Wedge	Block Number:	CAL-STEP-088			

SYSTEM CALIBRATION

INSTRUMENT SETTINGS		Initial Cal. Time	Calibration Checks		Final Cal. Time	
Coarse Range:	5.0"	14:26	15:36	N/A	16:09	
Coarse Delay:	N/A	Calibrated Sweep Range = 0.500"	Inches to 1.500"	Inches		
Delay Calib:	N/A	Thermometer:	246534	Comp. Temp: 82°	Block Temp: 82°	
Range Calib:	N/A	W/O Number:	~~R2088926~~ see			
Instrument Freq.	N/A	Total Crew Dose 7 mr	C2013477 Drywell Containment Vessel Thickness Examination. External UT Inspections.			
Gain:	67 db					
Damping:	N/A					
Reject:	N/A					
Filter:	N/A					

Bay - 19

BAY	Point Number	▨	Vertical Location		▨	Horizonal Location		▨	Thickness Reading
		▨			▨			▨	

See Attached for Locations and Thickness Readings

PASSPORT# 00546049 07
AR# A2152754 E08
ATTACHMENT 4
PAGE 15 OF 32

COMMENTS: N/A

10-22-06

Reviewed by: Lee Stone Level II Date 10/22/2006

02

10-22-06

pg. 2 of 2

BAY 19

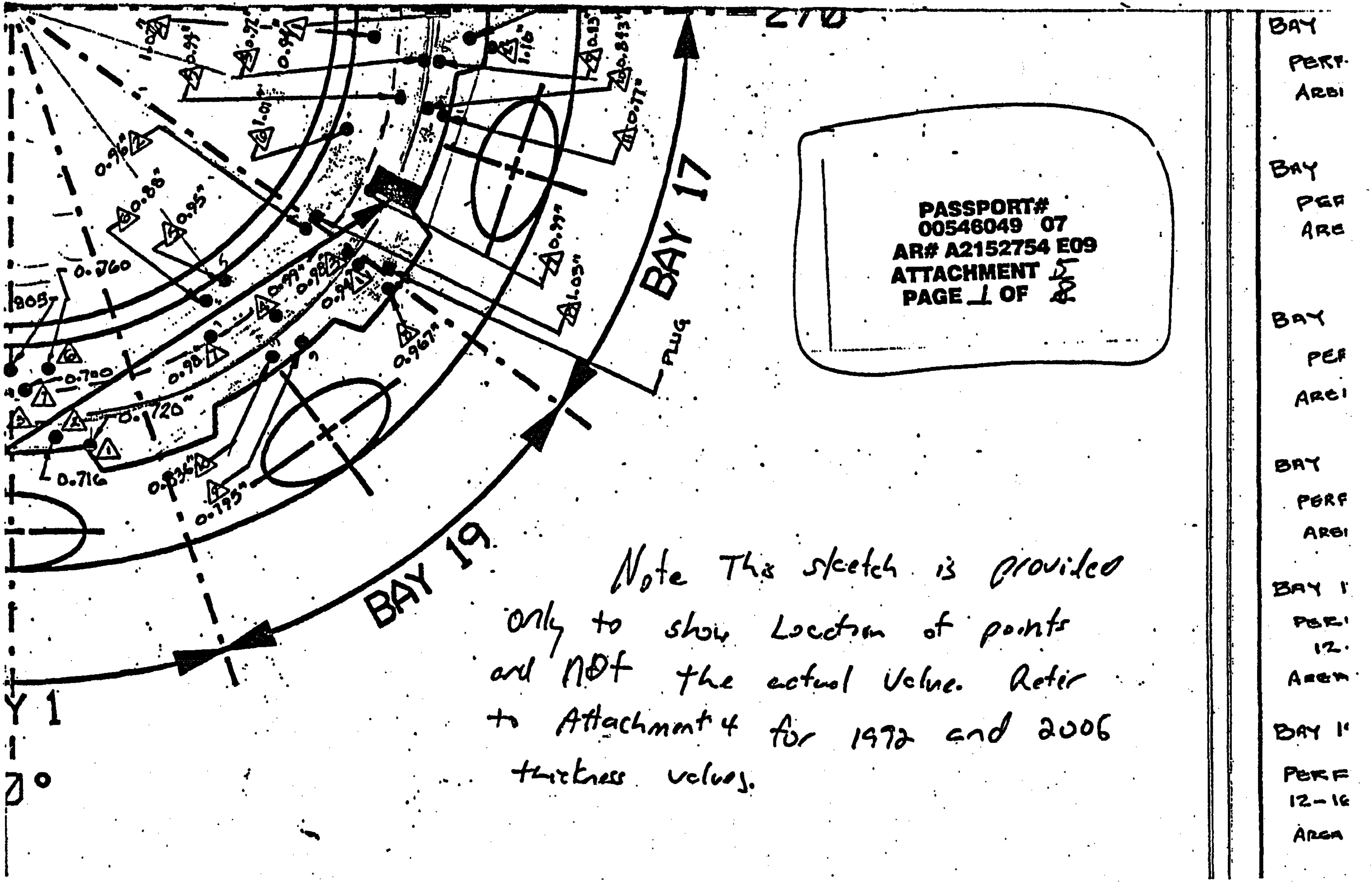
	Point	Vertical	Horizontal	1992 value	2006 Value	Comments
	1	D30	R60	0.932	0.904	up .897 dn .867
	2	D52	R58	0.924	0.921	up .850 dn .907
	3	D33	R40	0.955	0.932	up .894 dn .905
	4	D32	R11	0.94	N/A	Could not locate area
	5	D31	R3	0.95	0.932	up .883 dn .897
	6	D52	L65	0.86	N/A	Could not locate area
	7	D54	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

New Value

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 Wit 10/22/06

PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT 6
PAGE 22 OF 22

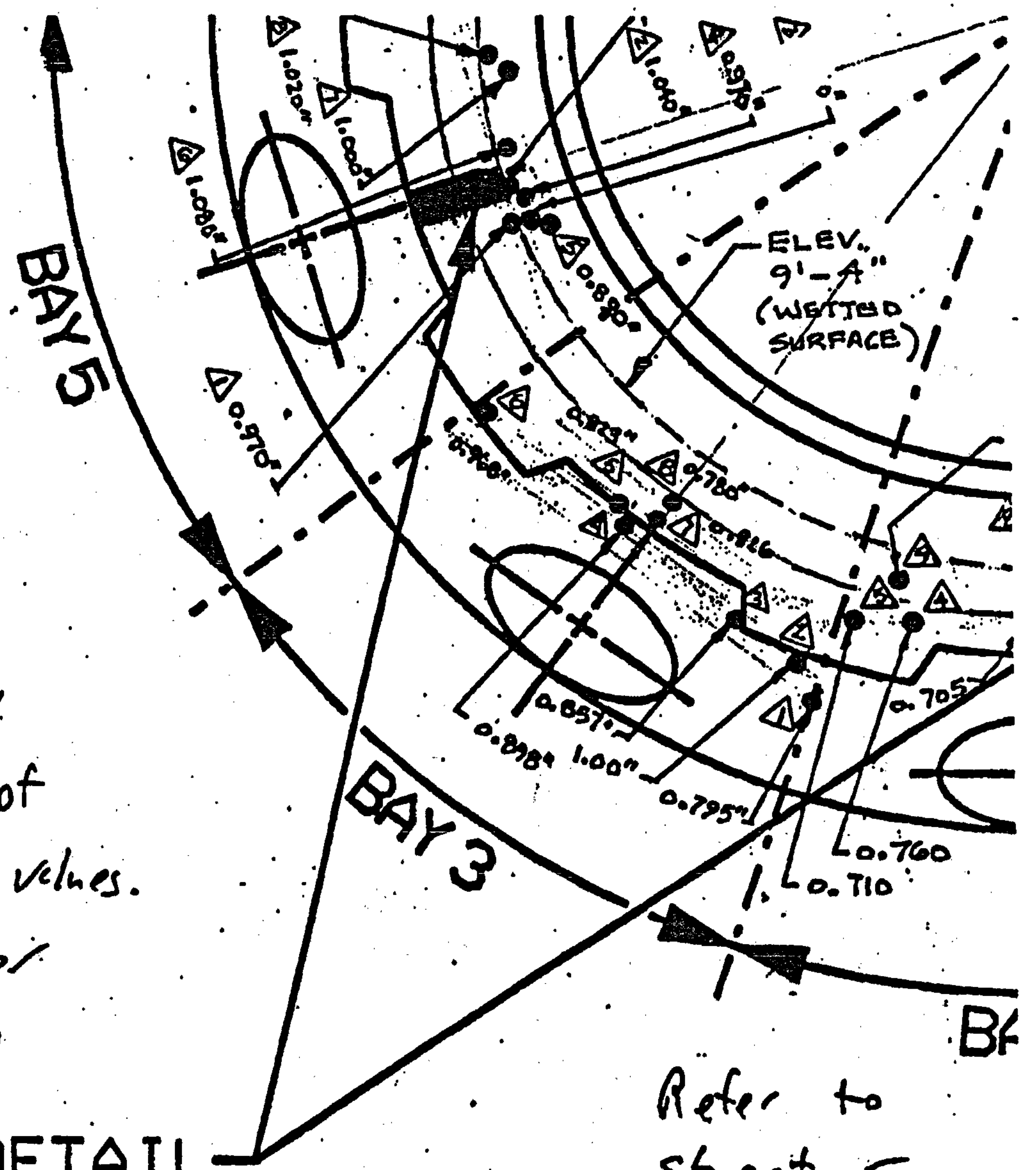


PASSPORT# 00546049 07
AR# A2152754 E09
ATTACHMENT 5
PAGE 1 OF 2

Note This sketch is provided only to show Location of points and NOT the actual Value. Refer to Attachment 4 for 1992 and 2006 thickness values.

PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT 5
PAGE 2 OF 8

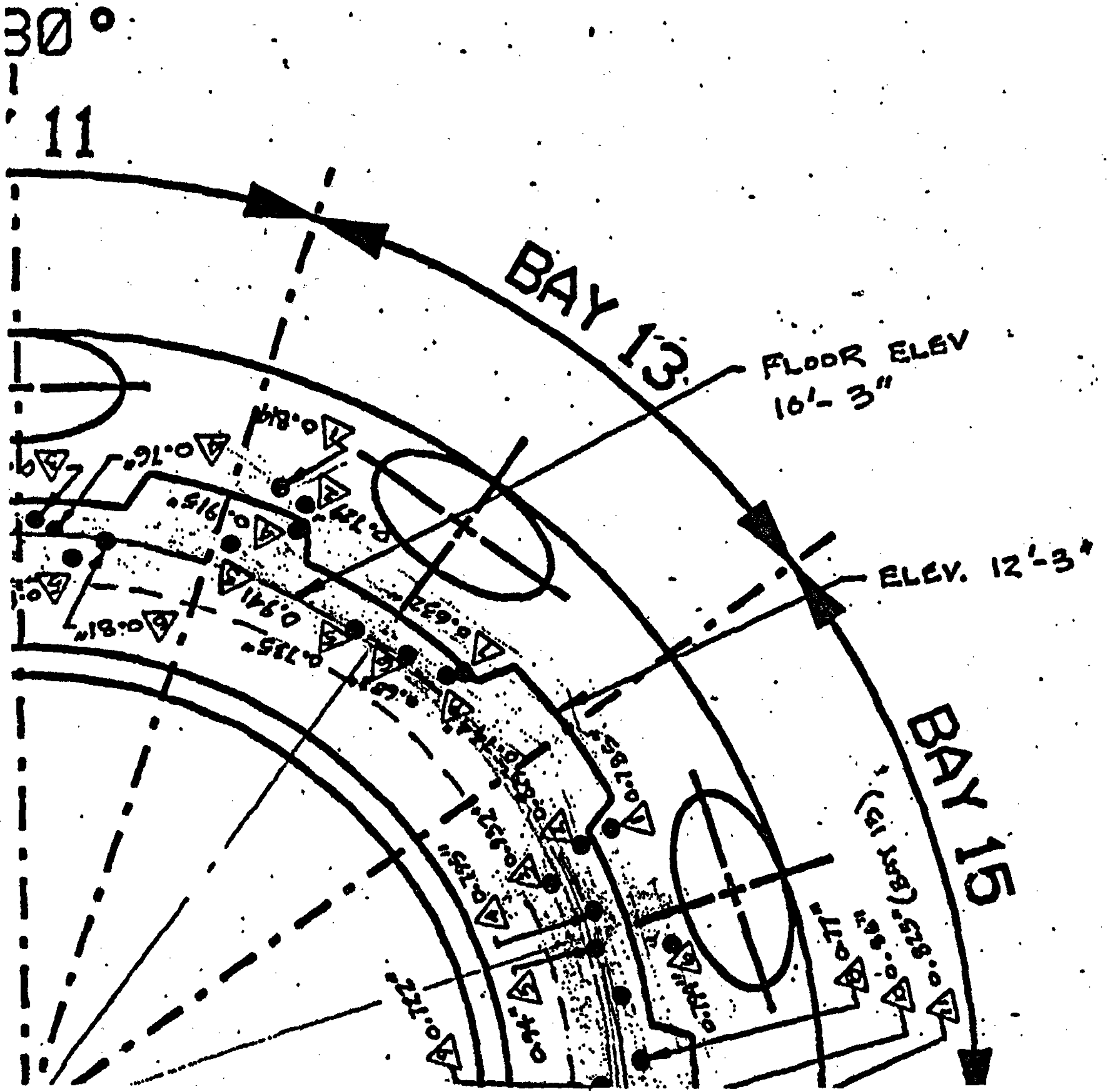
This sketch is provided only to show Location of points and not the actual values. Refer to Attachment 4 for 1992 and 2006 Thickness Readings



SEE DETAIL
CROSS SECTION AREA
OF TRENCH

Refer to sheet 5 for Additional Points

KEY
(SCA



△ - DATA POINT UT
WITH SHELL THICKNESS
FOR EACH INDIVIDUAL
BAY

PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT 5
PAGE 3 OF 8

Refer to page 8 for additional points

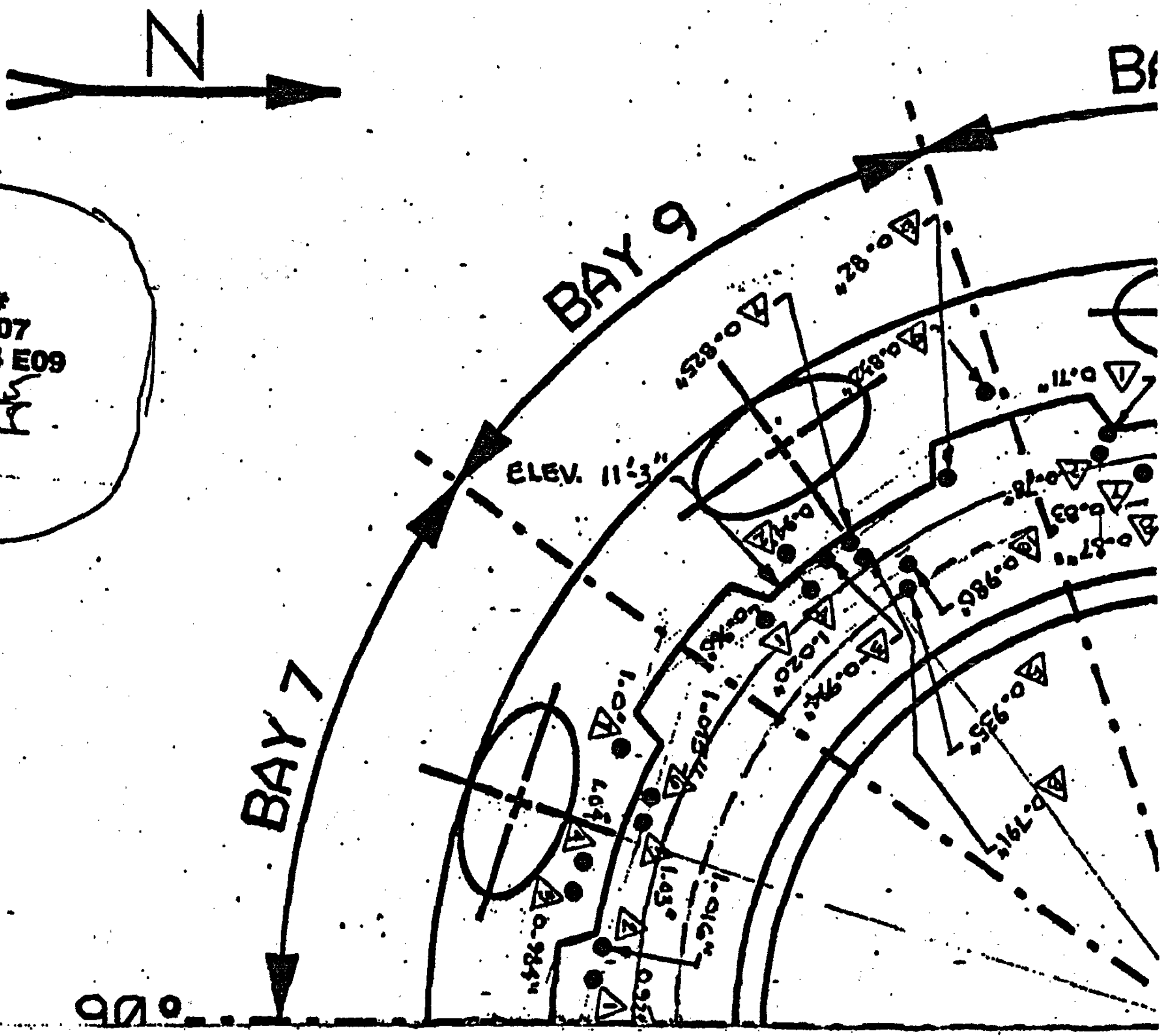
BAY
PER F
AREA

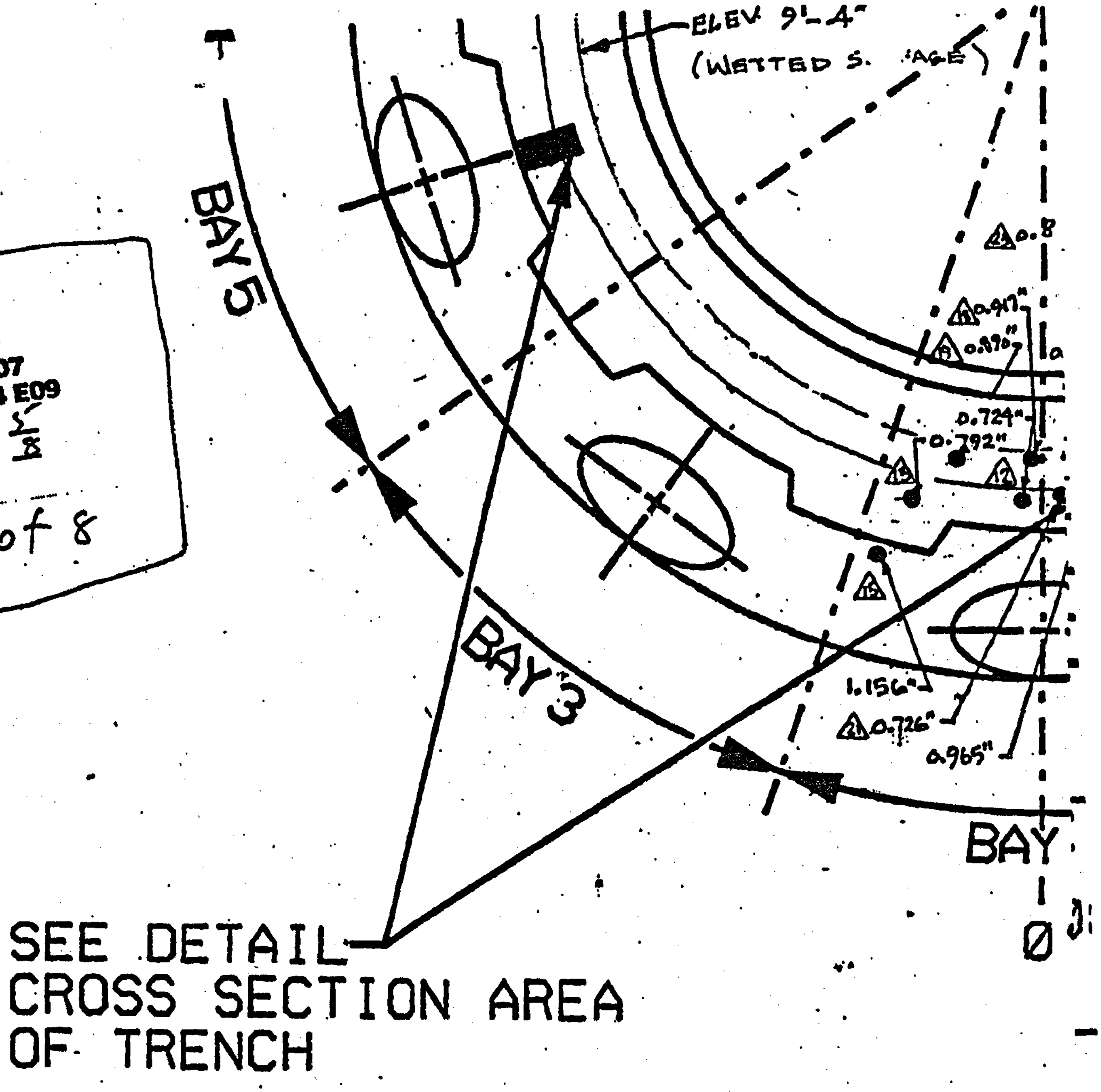
BAY
PERFO
AREA

BAY 5
PERFO
AREA

BAY 7
PERFO
AREA

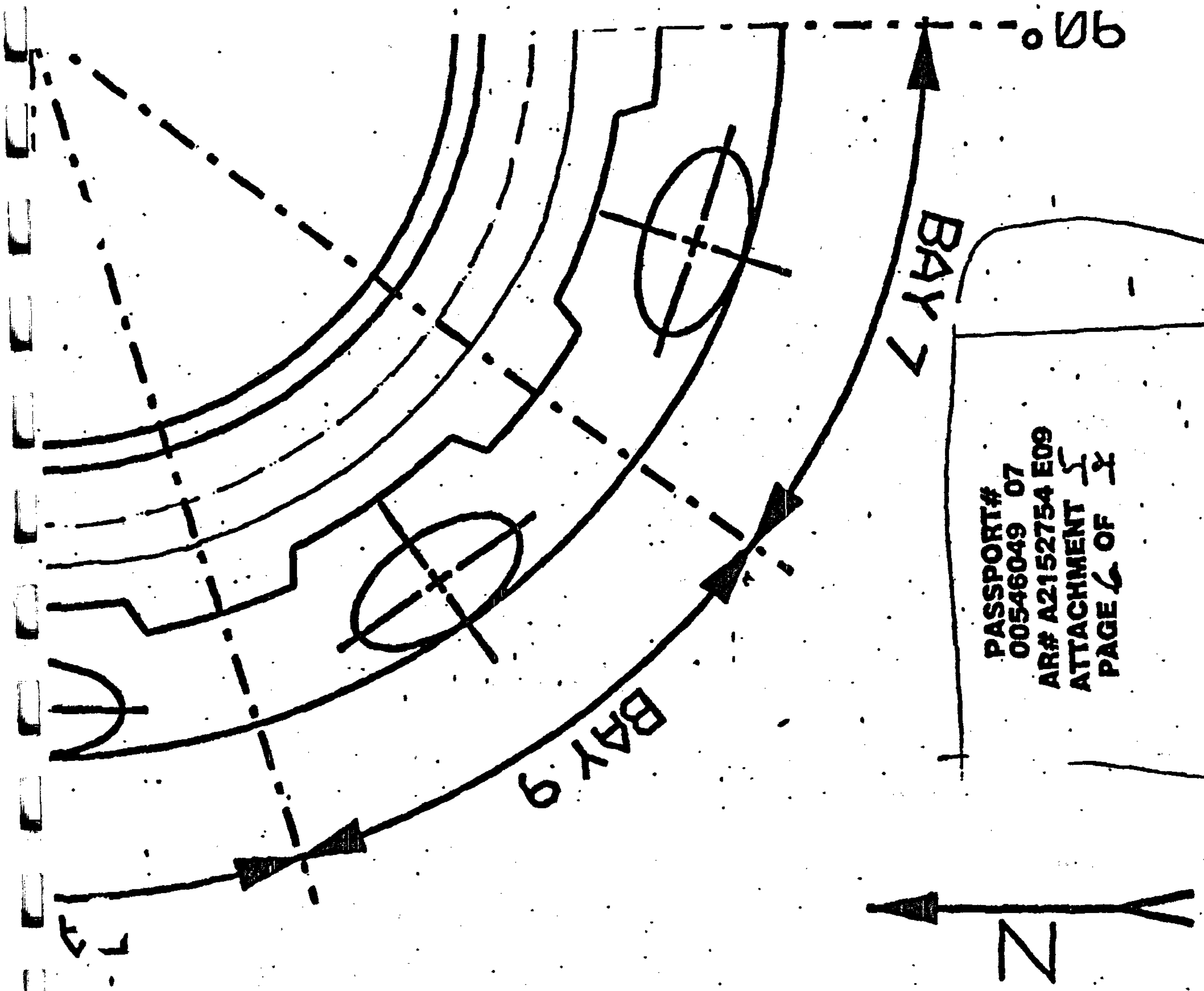
PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT 5
PAGE 4 OF 5




ELEV 9'-4"
(WETTED S. AGE)
BAY 5
BAY 3
BAY
0
0.8
0.917"
0.890"
a
0.724"
0.792"
1.156"
0.726"
0.965"
SEE DETAIL
CROSS SECTION AREA
OF TRENCH

KEY I

(SCALE

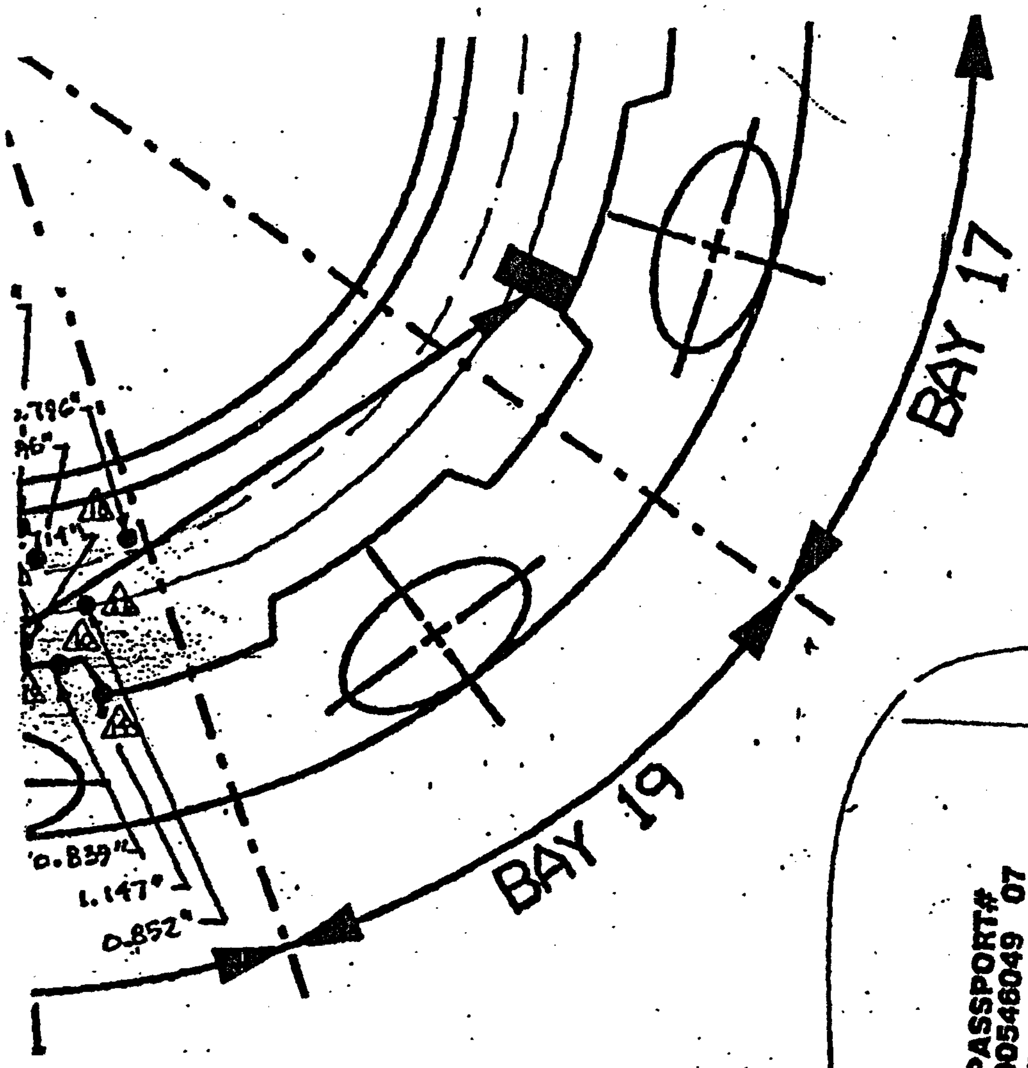


PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT 5
PAGE 6 OF 8

page 6

PLAN PART II

NONE)



PASSPORT# 00546049 07
AR# A2152754 E09
ATTACHMENT 5
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PLAN PART II

NONE)

PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT 5
PAGE 8 OF 8

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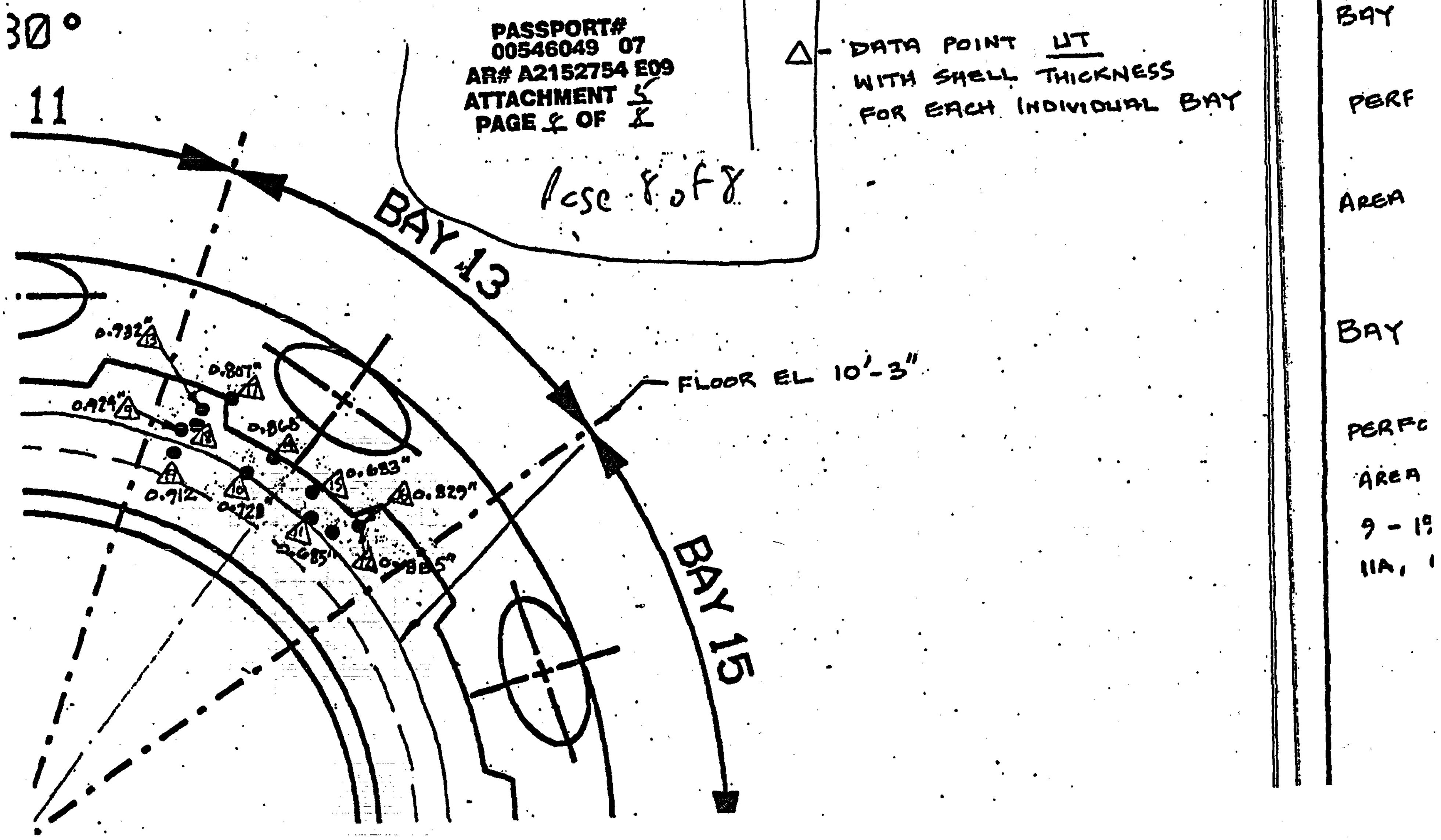
△ - DATA POINT UT WITH SHELL THICKNESS FOR EACH INDIVIDUAL BAY



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Attachment 6

PASSPORT#
00546049 07
AR# A2152754 E09
ATTACHMENT ~~7~~ 6 PT
PAGE 1 OF 2 11/3/08

Bay	Point	Vertical	Horizontal	Under Inside Floor	Under Wetted Concrete	1992 value	NDE Data Sheet	2006 Value	Corrosion Rate 1992 to 2006	Corrosion Rate Under floor above Wetted Area	Corrosion Rate in Wetted Area
1	6	D48	R16	Yes	Yes	0.76	IR21LR-022	0.731	2.071		2.071
1	7	D39	R5	Yes	Yes	0.7	IR21LR-022	0.669	2.214		2.214
1	8	D48	R0	Yes	Yes	0.805	IR21LR-022	0.783	1.571		1.571
1	9	D36	L38	Yes		0.805	IR21LR-022	0.754	3.643	3.643	
1	16	D50	R40	Yes	Yes	0.796	IR21LR-022	0.795	0.071		0.071
1	17	D48	R16	Yes	Yes	0.86	IR21LR-022	0.846	1.000		1.000
1	18	D38	L2	Yes		0.917	IR21LR-022	0.899	1.286	1.286	
1	19	D38	L24	Yes		0.89	IR21LR-022	0.865	1.786	1.786	
1	22	D32	R13	Yes		0.852	IR21LR-022	0.854	-0.143		
1	23	D48	R15	Yes	Yes	0.85	IR21LR-022	0.828	1.571		1.571
5	1	D40	R13 *1	Yes	Yes	0.97	IR21LR-019	0.948	1.571		1.571
5	2	D42	R3 *1	Yes	Yes	1.04	IR21LR-019	0.955	6.071		6.071
5	3	D44	R10 *1	Yes	Yes	1.02	IR21LR-019	0.989	2.214		2.214
5	4	D44	R/L7 *1 *2	Yes	Yes	0.97	IR21LR-019	0.948	1.571		1.571
5	5	D46	R/L11 *1 *2	Yes	Yes	0.89	IR21LR-019	0.88	0.714		0.714
5	6	D44	L4	Yes	Yes	1.06	IR21LR-019	0.981	5.643		5.643
13	7	D48	L24	Yes	Yes	0.99	IR21LR-019	0.974	1.143		1.143
5	8	D46	L28	Yes	Yes	1.01	IR21LR-019	1.007	0.214		0.214
9	5	D36	L4	Yes		0.985	92-072-22 Page 1 fo 5	0.964	1.500	1.500	
9	8	D22	L45*	Yes	Yes	0.791	92-072-22 Page 1 fo 8	0.781	0.714		0.714
11	5	D32	L14	Yes		0.831	92-072-10 page 1 of 4	0.823	0.571	0.571	
11	6	D27	L22	Yes		0.8	92-072-10 page 1 of 5	0.756	3.143	3.143	
11	7	D31	R20	Yes		0.831	92-072-10 page 1 of 6	0.817	1.000	1.000	
11	8	D40	R13	Yes	Yes	0.85	92-072-10 page 1 of 7	0.825	1.786		1.786
13	9	D28	R41	Yes		0.924	92-072-24 page 1 of 10	0.915	0.643	0.643	

156754 E09
Attachment 6

Bay	Point	Vertical	Horizontal	Under Inside Floor	Under Wetted Concrete	1992 value	NDE Data Sheet	2006 Value	Corrosion Rate 1992 to 2006	Corrosion Rate Under floor above Wetted Area	Corrosion Rate in Wetted Area
13	10	D28	R12	Yes		0.728	92-072-24 page 1 of 11	0.741	-0.929		
13	11	D28	L15	Yes		0.685	92-072-24 page 1 of 12	0.669	1.143	1.143	
15	3	D33	R17	Yes		0.932	1R21LR-015	0.935	-0.214		
15	5	D26	L3	Yes		0.85	1R21LR-015	0.855	-0.357		
15	9	D36	L40	Yes		0.722	1R21LR-015	0.749	-1.929		
17	3	D32	R28	Yes		0.898	1R21LR-021	0.894	0.286	0.286	
17	4	D52	R30	Yes	Yes	0.951	1R21LR-021	0.963	-0.857		
17	5	D36	R12	Yes		0.913	1R21LR-021	0.822	6.500	6.500	
17	6	D52	L6	Yes	Yes	0.992	1R21LR-021	0.909	5.929		5.929
17	7	D36	L26	Yes		0.97	1R21LR-021	0.97	0.000		
17	8	D52	L40	Yes	Yes	0.99	1R21LR-021	0.96	2.143		2.143
									0.000		
19	2	D52	R66	Yes	Yes	0.924	1R21LR-020	0.921	0.214		0.214
19	3	D33	R49	Yes		0.955	1R21LR-020	0.932	1.643	1.643	
19	4	D32	R11	Yes		0.94	1R21LR-020	Not Located			
19	5	D53	R2	Yes	Yes	0.95	1R21LR-020	0.932	1.286		1.286
19	6	D52	L65	Yes	Yes	0.86	1R21LR-020	Not Located			
19	7	D39	L12	Yes	Yes	0.969	1R21LR-020	0.891	5.571		5.571

Minimum Rate	0.286	0.071
Maximum Rate	6.500	6.071
Average Rate	2.280	2.334

Minimum Thickness Recorded in 2006 0.669

Assuming a maximum corrosion rate of 6.5 MPY and an uncertaintly of 20 mils the 0.669 location will thin to the following in 2008 0.636

Assuming a Aveeage corrosion rate of 2.3 MPY and an uncertaintly of 20 mils the 0.669 location will thin to the following in 2008 0.644

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MHC 10-26-06

1R21LR-032 Pg ~~20~~ 1 of 2

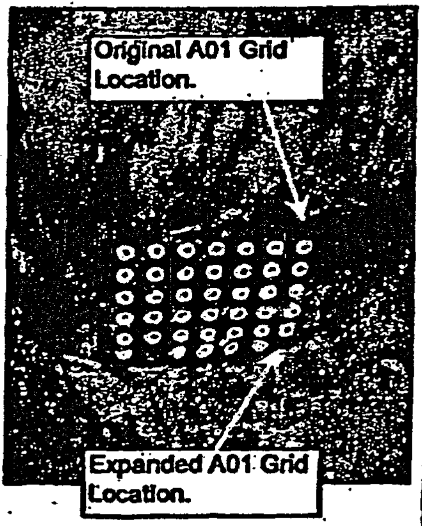
General Electric		**Ultrasonic Thickness Measurement Data Sheet**	Report Number:	1R21LR- 32
Oyster Creek			Date:	10/26/2006
Refueling Outage -	1R21		UT Procedure:	ER-AA-335-004
Page 1 of	2		Specification:	IS-328227-004

Examiner: Leslie Richter			Level:	II	Instrument Type:	Panametrics 37DL Plus	
Examiner: N/A			Level:	N/A	Instrument No:	031125409	
Transducer Type: DV 506	Serial #: 072581		Size:	0.438"	Freq: 5 Mhz		Angle: 0°
Transducer Cable Type: Panametrics	Length: 5'	Couplant:	Soundsafe		Batch No:	19620	
Calibration Block Type: C/S Step Wedge		Block Number:	CAL-STEP-136				

SYSTEM CALIBRATION

INSTRUMENT SETTINGS						
		Initial Cal. Time	Calibration Checks		Final Cal. Time	
Coarse Range:	2.0"	9:20	9:35	9:38	10:00	
Coarse Delay:	N/A	Calibrated Sweep Range = 0.500" Inches to 1.500" Inches				
Delay Calib:	N/A	Thermometer: 246647		Comp. Temp: 68°	Block Temp: 65°	
Range Calib:	N/A	W/O Number:	~~C2013479~~	C2013727-02		
Instrument Freq.	N/A	Total Crew Dose 45 mr	MHC 10-26-06 Drywell Containment Vessel Thickness Examination. Internal UT Inspections.			
Gain:	55 db					
Damping:	N/A	**Trench 1 Bay 5 Extended Grid Data**				
Reject:	N/A					
Filter:	N/A					

The UT transducer was positioned in the same orientation at each grid point.


Original A01 Grid Location.

Expanded A01 Grid Location.

Area extended deeper into Trench								
Location ID		Trench 1		Bay	5	Elev.	10' 3"	
6	1.182	1.145	1.088	1.085	1.088	1.083	1.060	6
5	1.142	1.106	1.070	1.105	1.094	1.077	1.084	5
4	1.147	1.070	1.083	1.085	1.125	1.087	1.059	4
3	1.161	1.133	1.131	1.127	1.094	1.060	1.052	3
2	1.165	1.152	1.148	1.138	1.130	1.113	1.096	2
1	1.151	1.142	1.142	1.125	1.144	1.138	1.148	1
	G	F	E	D	C	B	A	

Tscr.	AVG.
0.660	1.113
Min Reading	Max. Reading
1.052	1.182

COMMENTS:

The removal of concrete from trench exposed six more inches of liner. The template was placed below previous grid location with the centerline of the top row 1" +/- 1/16" from previous grid bottom row. The holes were painted on the liner using the 8"x 8" template, readings were then taken with template removed.

An area approximately 14"x 6" of extended trench area was scanned 100% with the minimum reading of 1.047" and a maximum reading of 1.150" recorded.

The 100% scan inspection was performed using a D799 (Serial # 104141) transducer and the grid points inspection was preformed using a DV 506 transducer.

V" was stamped above grid point 6D.

Reviewed by: Lee Stone

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1R21LR-032 Pg 2 of 2
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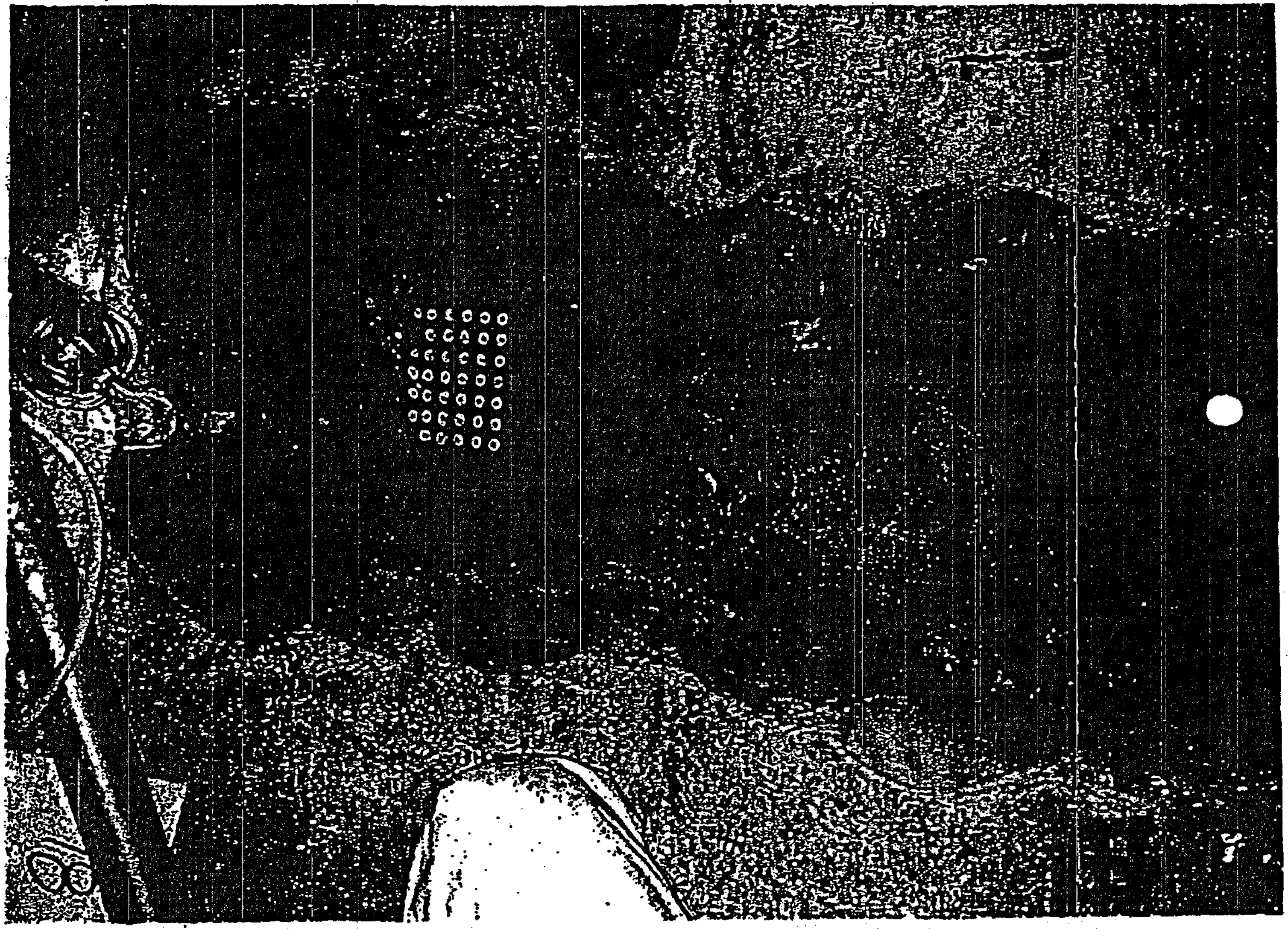

BAY 5 TRENCH 1

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Exelon.
Nuclear

Memorandum

Asset Management # AM-2006-011
Revision 3

Date: November 6, 2006

To: Howie Ray
Peter Tamburro

cc: Roman Geslor
Richard Hall

From: Steve Leshnoff

Subject: Final Report of the Third Party Independent Review of Oyster Creek Drywell Containment Corrosion Evaluation in Bay 5 and Bay 17 Trenches

The purpose of this memo is to document the independent third party review (ITPR) of the Oyster Creek (OC) Drywell Containment Corrosion Evaluation in Bay 5 and Bay 17 Trenches and to provide you with the results related to that review. The review was performed in accordance with Training & Reference Material (T&RM) HU-AA-1212, Revision 1, Technical Task Risk/Rigor Assessment, Pre-job Brief, Independent Third Party Review, and Post-Job Brief.

Purpose of the Review

Ultrasonic Testing (UT) measurements of the drywell thickness at and below the interior floor at the elevation of the sand bed were obtained during OC 1R21 Refueling Outage. The intent was to complete the assessment of the potential for on-going corrosion both above and below the drywell floor. The purpose of this review is to establish that the appropriate statistical methods were used to evaluate the data and that the correct conclusions were drawn from the statistical evaluation of the data.

Scope of Review

I performed a detailed review of the statistical methods that were used in the evaluation of the UT measurements. The evaluation included the following steps, each of which was reviewed:

- Establish that the UT data from a measurement template was normally distributed using the kurtosis tests
- Derive the standard deviation and standard error for each of the data distributions
- Derivation of the 95% confidence intervals for the data.

- Determination of the lower range of the calculated mean thickness for which there is 95% confidence.
- Calculation of the apparent corrosion rate on an average basis in the trench in Bay 5 and in the trench in Bay 17.

Limitations

There were no limitations to this review.

Conclusions

All of the statistical tests and steps were appropriate and necessary and were applied correctly. The apparent corrosion rate is minimal. Revision D to Technical Evaluation A2152754 E09 impacts only the narrative description of the UT data collection activities and includes added detailed discussion in the conclusion without modification.

Revision G to Technical Evaluation A2152754 E09 concerns the data collected in the trench in Bay 17. The revision aligns the lower 5 grids of 6 grids, in a single row, taken in 2006 with the 5 grids, in one row, taken in 1986. The alignment develops two comparable normal distributions such that a basis is established to determine an apparent average corrosion rate in the trench in Bay 17.

Comments

Refer to Attachment A for technical comments and resolution to those comments on Revision G of the technical evaluation. The comments did not warrant an Issues Report.

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ATTACHMENT A

AM-2006-011
Revision 3

REFERENCE DOCUMENT NO. /REV: OC Drywell Containment Corrosion Evaluation in Bay 5 and Bay 17 Trenches

COMMENTS		RESOLUTION	ACCEPTANCE OF RESOLUTION	
1	No comments on Revision G to Technical Evaluation A2152754 E09 c			
2				
3				
4				
5				
6				
7				
8				
9				
10				
END				

. Leshnoff	11/6/06	Peter Tamburro	11/06/06
SUBMITTED BY	DATE	RESOLVED BY	DATE

MPR
ASSOCIATES INC.
ENGINEERS

Privileged and Confidential

November 3, 2006

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ATTACHMENT 9
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Mr. F. Howie Ray
Manager, Mech/Struct Design
Oyster Creek Generating Station
AmerGen Energy Company, LLC
U.S. Route #9
Forked River, NJ 08731-0388

Subject: Third Party Independent Review of Oyster Creek Drywell Water Evaluation

Dear Mr. Ray:

MPR has completed a HU-AA-1212 Independent Third Party Review of the Oyster Creek drywell evaluation concerning standing water found in drywell shell inspection trenches in the 10' 3" concrete floor in the drywell. This review included the following documents:

- Technical Evaluation A/R A2152754 E06, with attachments
- Technical Evaluation A/R A2152754 E09, with attachments
- ECR 06-00879

Based on this review, we generated two comments, one concerning reported local wall thinning in Bay 17 possibly exceeding limiting dimensions for being considered local, and one concerning the relatively low pH value (and possible corrosivity) of trench/drywell gap water during outages when the migration of CRD water through the concrete pad to the inspection trenches and drywell wall occurs. These were transmitted to you via email on November 2. Both comments have been resolved as follows:

- Local wall thinning in Bay 17: Technical Evaluation A/R A2152754 E09 has been revised to include another local thinning acceptance criterion documented in Oyster Creek calculation C-1302-187-5320-024. The UT measurements of concern meet this acceptance criterion and this issue is considered resolved.
- Characterization of the water in the drywell: Section 2.8 of Technical Evaluation A/R A2152754 E06 has been revised to clarify the following points:
  - Any subsequent water (such as reactor coolant) entering the concrete floor-to-drywell gap will increase in pH due to its migration through and contact with the concrete. This will reduce its corrosivity compared to neutral pH water.

- The corrosion of drywell steel surfaces in contact with gap water is expected to occur only during outages when oxygen is present. Corrosion during operation is expected to be almost nil since the drywell operates inerted and no oxygen is present to drive the corrosion reaction. During outages, shell corrosion losses in the gap are expected to be small since the exposure time is very limited and the water pH is expected to be relatively high.
- The expected low corrosion losses in the concrete-to-drywell gap area have been confirmed by examination of steel surfaces in the trenches which has revealed only superficial corrosion of the drywell shell.

With the resolution of these concerns, we consider that the Technical Evaluations and attachments successfully address:

- The structural integrity of the concrete and drywell shell,
- The adequacy of repairs, and the effect of the repairs on the assumptions or inputs used for safety and other analyses, and
- The impacts of past water migration and current repairs on design and the licensing bases.

We also reviewed the technical bases for the Technical Evaluation and conclude that all inputs are accurate or conservative, assumptions are conservative, chemical analysis results are used appropriately, and corrosion evaluations are correct and results used accurately.

Please let me know if you have any questions about this letter.

Sincerely,

J. E. Nestell, PhD