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Document Title: Summary Report of Corrective Action Taken from Operating Cycle 12 through 14R

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Abstract:

This report summarizes the activities performed by GPUN to mitigate the corrosion mechanism attacking the Oyster Creek Drywell vessel. The report provides a "road map" of the documents created to implement corrective actions taken during the 14R refueling outage.

A bay-by-bay discussion of the condition of the vessel, results of UT inspections and structural evaluation, with respect to code requirements, is included.

It is concluded that, by completing 14R activities, future corrosion has been stopped in the sand bed region, but that the pending pressure reduction submittal to NRC must be approved to provide a corrosion allowance for upper elevations.

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EXECUTIVE SUMMARY

The potential for corrosion of the drywell vessel was first recognized when water was noticed coming from the sand bed drains in 1980. It was confirmed by ultrasonic thickness (UT) measurements taken in 1986 during 11R. Since that time a great deal of evaluation, inspection, analysis, planning and corrective action has been directed toward mitigating the problem. The first extensive corrective action, i.e. installation of a cathodic protection system, proved to be ineffective.

In 1990 an intensified effort was initiated. As a result of laboratory experiments the corrosion mechanism in the sand bed was determined to be galvanic. The upper regions of the vessel, above the sand bed, were handled separate from the sand bed region because of the significant difference in corrosion rate and physical difference in design. Corrective action for the upper vessel involved providing a corrosion allowance by demonstrating, through analysis, that the design pressure was conservative. A Technical Specification change request was submitted to the NRC in July of 1991 to reduce the design pressure from 62 psig to 44 psig. The new design pressure, when approved, coupled with effective measures to prevent water intrusion into the gap between the vessel and the concrete will allow the upper portion of the vessel to meet ASME code for the projected life of the plant.

The high rate of corrosion in the sand bed region required prompt corrective action of a physical nature. Corrective action was defined as; (1) removal of sand to break up the galvanic cell, (2) removal of the corrosion product from the vessel and (3) application of a protective coating. Keeping the vessel dry was also identified as a requirement even though it would be less of a concern in this region once the coating was applied. The work was initiated during 12R by removing sheet metal from around the vent headers to provide access to the sand bed from the Torus Room. During operating cycle 13 some sand was removed and access holes were cut into the sand bed region through the shield wall. The work was finished during 14R.

After sand removal, the concrete floor was found to be unfinished with improper provisions for water drainage. Corrective actions taken in this region during the 14R outage 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.

During the 14R outage UT measurements of the drywell vessel were taken from the sand bed region. In general these measurements verified projections that had been made based on measurements taken from inside the drywell. There were however, several areas thinner than projected. In all cases these areas were found to meet ASME code requirements after structural analysis. The details of this analytical work are presented in Section 6 of this report.

The cleaning, reshaping and coating effort that was completed in 14R should mitigate corrosion in the sand bed area. Since this was accomplished while the vessel thickness was sufficient to satisfy ASME code requirements, the drywell vessel in the sand bed region is no longer a limiting factor in plant operation. Inspections will be conducted in future refueling outages to ensure that the coating remains effective. In addition, UT measurements will also be taken. The frequency and extent of these measurements will be evaluated after 15R.

DRYWELL CORROSION MITIGATION PROJECT

BA 402950

1.0 INTRODUCTION

1.1 Background

Leakage was observed from the drains in the sand bed, which surround the lower exterior surface of the carbon steel drywell vessel, during the 1980, 1983 and 1986 refueling outages. Inspections performed during the 1986 refueling outage 11R confirmed that corrosion was occurring in the sand bed region (elevation 8 feet, 11¼ inches to 12 feet, 3 inches). Later investigations confirmed that corrosion was also taking place at elevations above the sand bed. A program of repetitive ultrasonic thickness (UT) measurements was established to monitor the corrosion in the vessel. During 12R (1988) a cathodic protection system was installed in the sand bed region to minimize corrosion in this area where the rate of corrosion was greatest. The monitoring program was also expanded during 12R.

By the Spring of 1990 it was evident from the UT monitoring program that the cathodic protection system installed during 12R was not sufficient to abate the high corrosion rate in the sand bed. A multi discipline project team was formed and charged with identifying the corrosion mechanism and developing a corrective action plan. The team had determined by the fall of 1991 that the corrosion was galvanic in nature. Circumstances that helped to promote this phenomenon were the fact that water had leaked into the sand bed region and that the drain system failed. The water contained impurities that were leached out of the insulation material in the upper elevations. Corrective action for the sand bed region required that water leaking into the cavity be stopped and that the galvanic cell be broken.

It was determined that the original design pressure for the vessel was unrealistically high. A Technical Specification change request was developed and submitted to the NRC on July 7, 1991. The change involved a reduction in the design pressure for the vessel from 62 psig to 44 psig. When approved this will provide a corrosion margin, for the upper elevation, sufficient to insure ASME code compliance through the life of the plant.

1.2 Sand Bed Repair

To disrupt the galvanic cell, the water leak must be stopped and the sand in the sand bed region would have to be moved away from the vessel. Since the sand performed a structural function in the original design concept, removal of the sand had to be supported by analysis. GE Nuclear Energy Division of San Jose, California performed the above analysis. The results confirmed that if the sand was removed, the structure would still meet ASME code requirements. (See references 2.1 -2.3). Based on the results of this analysis a plan was developed to: (a) remove the sand, (b) clean the vessel of the corrosion product, (c) measure wall thickness from the exterior of the drywell, (d) weld repair of localized thin areas if necessary and (e) apply a protective coating.

2.0 REFERENCES

2.1 GE Nuclear Energy, DRF # 00664, Index No. 9-3, Revision 0 "An ASME Section VIII Evaluation of Oyster Creek Drywell for Without Sand Case - Part 1 Stress Analysis",

2.2 GE Nuclear Energy, DRF # 00664, Index No.9-4, Re 2 "An ASME Section VIII Evaluation of Oyster Creek Drywell thout Sand Case - Part 2 Stability Analysis"

2.3 Teledyne Engineering Services, "Justification for U ion III, Subsection NE, Guidance in Evaluating the Oyste: ywell", Technical Report TR-7377-1

2.4 OC-MM-402950-004, "Removal of Sand from Sand Bed"

2.5 OC-MM-402950-006, "Reactor Building Torus Wire Lif. pports"

2.6 ABB Impell Report No. 370194-01, "Structural Evalua of the Reactor Building with Manways in the Drywell Shield Wall t Oyster Creek Nuclear Station"

2.7 OC-MM-402950-009, "Setup for Boring Holes in Drywell Shield Wall"

2.8 OC-MM-402950-007, "Boring of Holes in Drywell Shield Wall"

2.9 MPR Associates, MPR-TR-83156-001, "Test Plan for Concrete Cutting Tests for Manway Holes in Shield Wall"

2.10 MNCR-93-0062, Reactor Building Shield Wall Concrete Formation, 1/25/93

2.11 FCN 088664, Cut Rebar Location

2.12 OC-MM-402950-010, "Cleaning and Coating the Drywell Exterior in the Sand Bed Area"

2.13 GPUN Memo, 5383-93-008, S.M. French to S.C. Tumminelli, "Oyster Creek Drywell Scale", dated 1/20/93

2.14 GPUN Laboratory Report 5383-92-1204, Rev.0, "Oyster Creek Drywell Scale Evaluation", dated 12/15/92

2.15 GPUN Calculation, #C-1302-243-5340-067, Rev.0, "Calculation for Drywell Wall Loss"

2.16 GPUN Memo, 5320-92-029, T. H. Chang to J. C. Flynn, "Assessment for F Frame Rebar Location at the Sand Bed Region", dated 2/5/93

2.17 MNCR-92-0188, Sand Bed Concrete Floor Condition, 12/28/92

2.18 GPUN Memo 5511-92-073, Baig to Distribution, dated 9/8/92.

2.19 GPUN TDR - 948, "Statistical Analysis of Drywell Thickness Data"

2.20 OC-IS-402950-008, "Drywell Vessel Thickness Examinations from Sand Bed"

2.21 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

2.22 GPUN Memo 5320-93-020, K. Whitmore to J.C.Flynn, "Inspection of Drywell Sand Bed Region and Access Holes", dated January 28, 1993.

2.23 GPUN Calculation # C-1302-187-5320-024, Rev. 0, Oyster Creek Drywell External UT Evaluation in Sandbed," dated 4/16/93.

2.24 Isotope Survey of Sand Removed from Oyster Creek Sand Bed.

2.25 GPUN System Chemistry Laboratory Analysis Report, dated 1/15/93, See DRF 133903.

3.0 CYCLE 13 WORK

3.1 Sheet Metal Removal

During the 13R outage (1991) sheet metal was removed from around the ten vent headers in the Torus room to provide access into the top of the sand bed region. Due to schedule constraints some of this work was deferred to the operating cycle.

3.2 Sand Removal

The high rate of drywell corrosion in the sand bed required that the sand be removed as soon as possible. To accomplish this, a scheme was devised to remove the sand through the vent header gaps and the holes put in the shield wall for cathodic protection installation by using a high volume vacuum machine (Vacuum Engineering Corporation VecLoader HEPA VAC). (See reference 2.4). The work was started in November of 1991 and stopped in April of 1992. Some sand was removed from all bays. Approximately sixty percent of the sand calculated to be in the sand bed (77 - 55 gallon drums of sand) was removed. Before work could be done from the top of the torus, the Safety department required that the existing safety line be replaced. (See reference 2.5).

3.3 Access Holes

Completion of the sand bed repair required access to the sand bed region. Access paths from both inside the drywell and from the Torus room were considered. With the aid of the Kepner Tregoe (KT) decision analysis technique, the Torus room option was finally chosen. A structural analysis of the Reactor building and the concrete shield wall was conducted by ABB Impell Corporation to determine if cutting access holes in the shield wall was acceptable structurally. The analysis was done for ten twenty inch diameter holes, one in the vicinity of each vent header. The results verified that this approach was acceptable. (See reference 2.6).

To expedite the work, since the results of the structural analysis were not available, the job was split into two work packages. One covered equipment setup (reference 2.7) and the other the actual cutting of the holes (reference 2.8).

A full scale mockup of one half a bay was constructed at the Forked River site adjacent to Building 2 to debug the core boring setup that would be used to cut the access holes in the drywell shield wall. MPR Associates developed a test plan for this purpose (reference 2.9). The mockup proved to be very useful. Several changes were made to the work packages as a result of the mockup tests. In addition, the mockup proved to be a valuable asset for training and orientating workers for the unique work environment associated with this project. A specialty contractor, Urban H.A.R.T, Inc., was retained to train Emergency Medical Technicians in rescue techniques, provide space training and acclimate workers to the sand bed environment.

Work platforms were built in four bays. The other six bays had platforms which were installed during the cathodic protection project. Temporary shielding was also installed next to the vent header to reduce worker radiation exposure.

The cutting process was initiated on 9/8/92 and completed on 11/19/92. The process included cutting ten holes completely through to the sand bed region and removing the concrete core for a distance of six feet (see Figure 1). The total length of the holes was approximately eight feet. Video cameras installed in the sand bed region through the vent header gap provided a clear picture of the drill bit as it broke through into the region. A concrete core approximately two feet thick was left in the hole to serve as a radiation shield during plant operation. The larger pieces of core material (rubble) were bagged and carried up to the 23 foot elevation. Small pieces were vacuumed up using an electric vacuum machine staged in the northeast corner room at the minus 19 foot elevation. In general, this phase of the work went very well. Much more steel was encountered in the shield wall than anticipated and this affected the overall productivity. In bays 15 and 9 voids were encountered that affected the drill rig water cooling system. Water leaked out of the core hole and seeped through the shield wall. Catch basins and "wet vacs" were used to capture the water. Reference 2.10 documents the condition of the shield wall concrete as witnessed from access holes. Reference 2.11 documents the shield wall reinforcement that was cut in the process of cutting the access holes.

4.0 14R WORK

4.1 General

Reference 2.12 documents this phase of work which is referred to as the cleaning/coating phase.

Training and qualification of the workers was completed prior to plant shutdown thus allowing work to start on 11/28/92, the first day of the 14R outage. The schedule called for two ten hour shifts working seven days a week. After mobilization of equipment and supplies, the first activity was to remove the two foot concrete plug in each of the holes. Once the plug was out, a team of safety and radcon inspectors surveyed the bays before workers were allowed to enter the holes.

4.2 Sand Removal

There were thick crusts of corrosion product laying on top of the sand. (See Fig. 2). It was necessary to remove this material before the task of removing sand could begin. In most bays, very little corrosion product was left on the vessel. (See Fig. 3). The oxide crusts may have spalled off the vessel as the plant went to cold shutdown in preparation for the 14R outage. The last video views taken during the operating cycle 13 sand removal effort showed that some material had fallen off the vessel, but not to the extent found. The corrosion product pieces were removed and bagged. The sand was then removed using an electric VecLoader vacuum. Appendix A contains

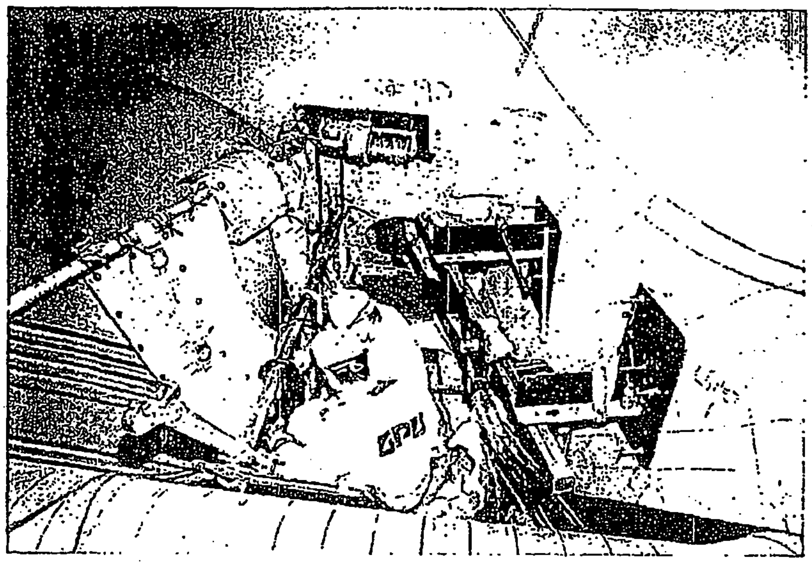

Figure 1

Access hole drilling set up view from the top of the Torus.

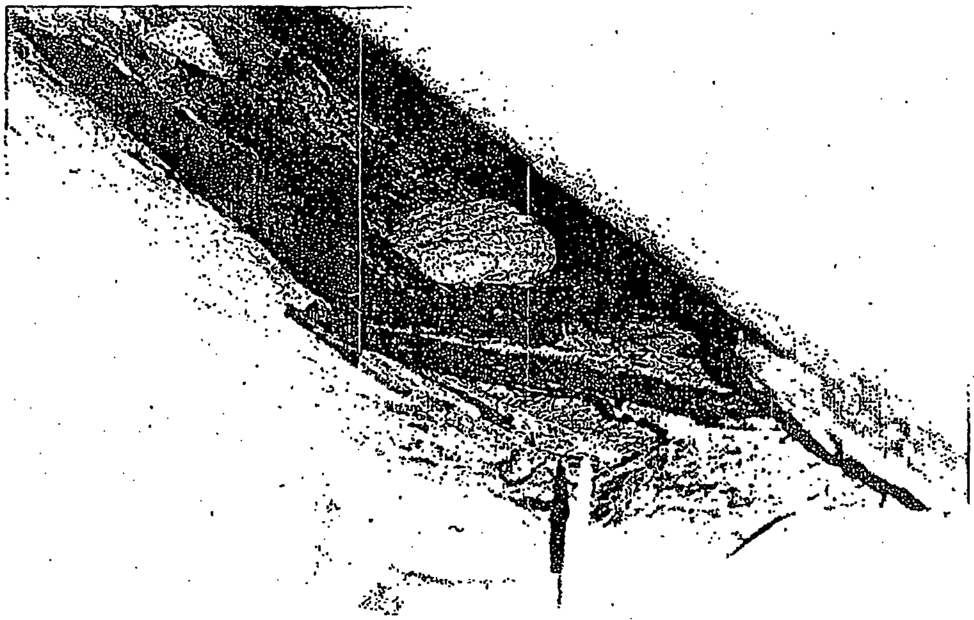

Figure 2

Sand Bed Region - Typical condition found on initial entry.

Figure 3

Corrosion product on drywell vessel.

a list of the waste materials created during this work. The thickness of some of the corrosion product raised a concern regarding how much base metal was left on the vessel. One 12 x 12 inch (approximate) piece of oxide crust with a thickness varying in the range of 1.25 to 1.50 inches was sent to the GPUN Materials Laboratory for analysis (see reference 2.13, 2.14 and 2.15). The result of the analysis essentially validated projections based on UT readings from inside the drywell and later readings taken from the sand bed region. In general, two bays were worked at one time. Initially, the bays judged to be in the worst shape, i.e. the most corroded, were worked first. However, due to reactor cavity water leaking into bays 11, 13 and 15 during the third week of the outage, work in these bays was postponed until after the completion of refueling and the refueling cavity was drained.

4.3 Surface Preparation

As part of the qualification process for surface preparation and coating that preceded the outage, workers were trained in the use of tools. The tools had been evaluated to ensure that the surface preparation effort removed corrosion product and loose rust without removing metal from the vessel. Pneumatic wire brush and needle gun tools were the primary means of preparing the vessel surface for the coating system. Devoe Devprep 88 cleaner was used to clean grease, oil, salts and loose rust off the surface prior to applying the coating. The Devprep was washed off by high pressure hydrolasing.

4.4 As Found Conditions

Inspection of the sand bed region after the sand was removed brought to light some conditions that deviated from the construction drawings. The shield wall reinforcement that the construction drawings showed as passing through the sand bed is one example. Only one row of bars was visible, and only about half that row in most bays. The condition of the sleeves that cover the bars was good, i.e. no evidence of deep corrosion. This resulted in an additional space of about nine inches and this extra space between the vessel and the reinforcement made working in this area easier than had been anticipated. Engineering Mechanics personnel inspected this condition and found evidence that the second row of reinforcement was buried in the shield wall. (See reference 2.16).

A more serious finding was the condition of the floor in the sand bed. The concrete was not finished, there were holes and craters along side the vessel, there was no evidence of a drainage ditch as shown on the drawings and in most cases the drain pipes were higher than the floor. (See Figs. 4 and 5). This was a general condition in all bays, however some were worse than others. Apparently the finish pour of concrete was not installed. This condition had a significant effect on the project's schedule and cost. To make the drain system effective the holes and craters needed to be filled, and the floor leveled using a suitable material compatible with both concrete and the steel shell. (See Figs. 6 and 7). The Devoe epoxy product 184 was used to refurbish the floor. This was done after evaluation of the suitability of the material in the sand bed environment. This condition was documented using a MNCR (see reference 2.17). As a part of the floor refurbishment, a wedge of Devoe 140S caulking material was placed at the intersection of the vessel shell and the floor. The caulking material will keep water away from the vessel in the event a volume of water greater than the drains capacity is introduced into the area. (See Figs. 8 and 9).

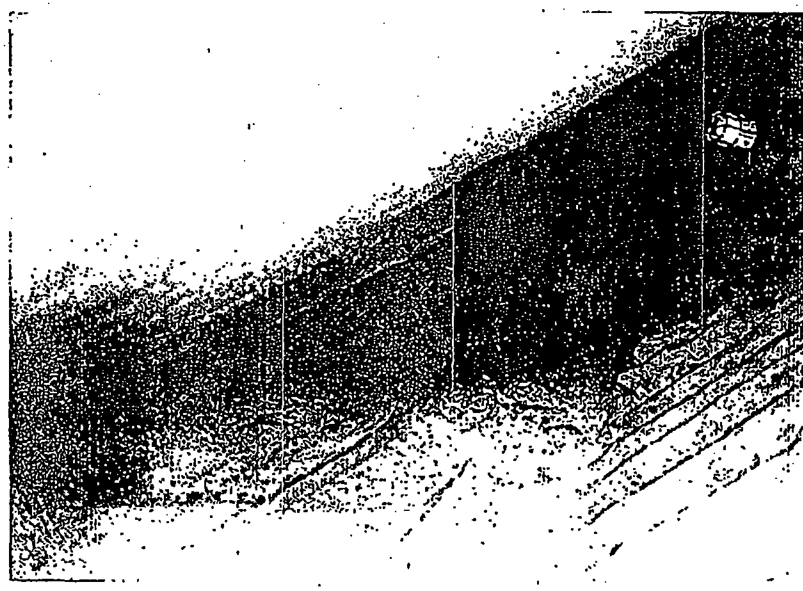

Figure 4

As found condition of floor bed.

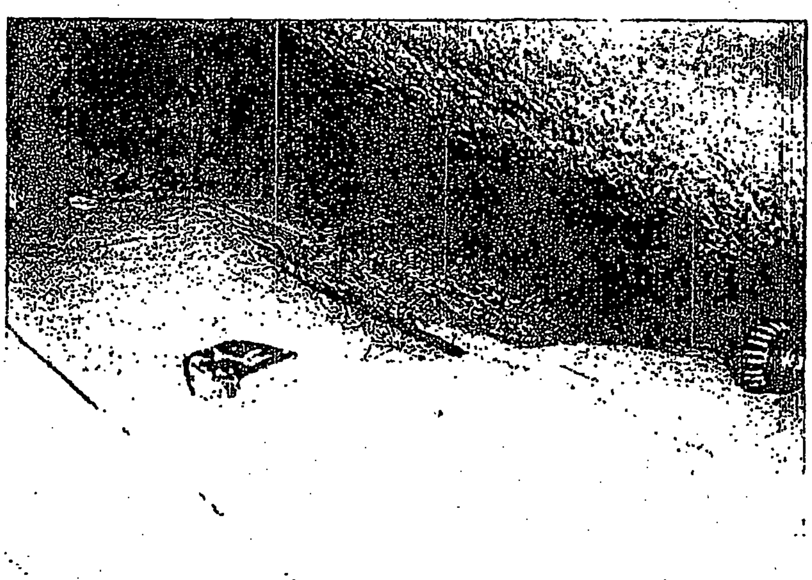

Figure 5

Deep depression in floor adjacent to drywell vessel.

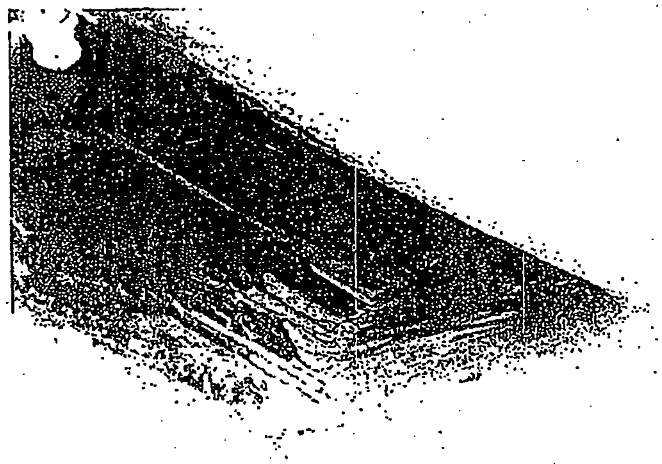

Figure 6

Finished floor & vessel.

Figure 7

Drain after floor has been refurbished.

Figure 8

Close up of caulking.

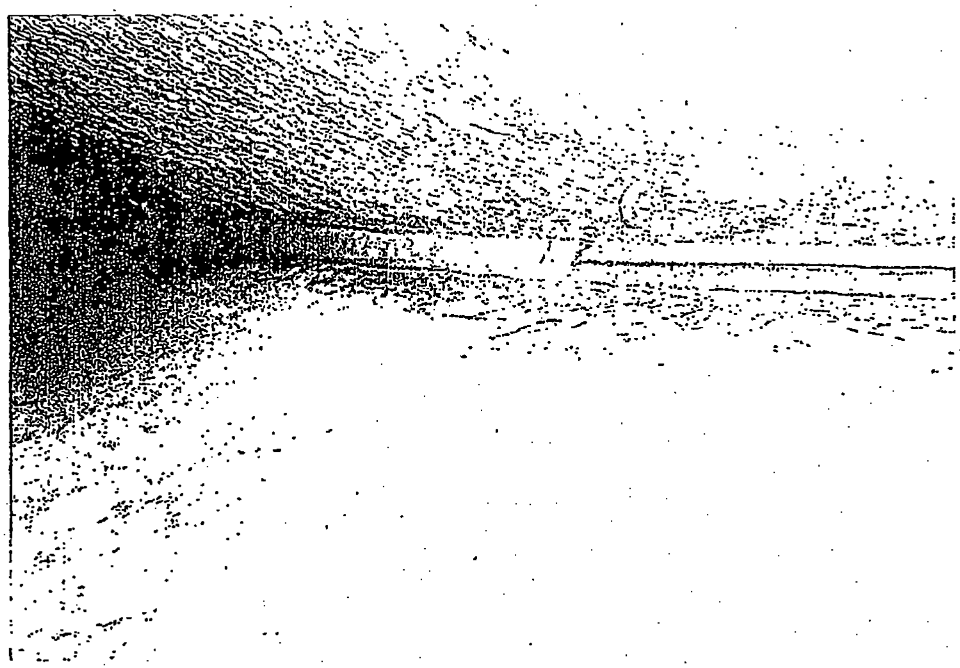

Figure 9

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

4.5 Coating of the Drywell Shell

The coating system consists of a prime coat of Devoe Pre-prime 167 rust penetrating sealer and two top coats of Devoe 184 epoxy coating. The first top coat was tinted light gray and the second one a darker gray. This helped to insure complete coverage of the surface and avoid the potential for a localized galvanic cell to develop. All coating work was done using brushes and 3/4 inch nap rollers.

4.6 Access Hole Closure

The access holes provide direct access to an area that is a high radiation area during operation. Therefore a barrier is required to restrict access. This was accomplished by placing sand bags in the entire length of the hole. The bags weigh about twenty five pounds each and can be removed during future outages to conduct inspections and repairs of the coating if necessary. One row of small plastic bags (3 x 5 inches) was filled with granular boron carbide to help shield any neutron radiation that might stream from the 20 inch access holes.

4.7 Repair Contingency

As a precautionary measure, a repair approach designed to address local, as opposed to global, drywell repair requirements was identified and partially funded. Representatives from CBI, MPR and GPUN met in August 1992 to discuss repair strategies (see reference 2.18). The outcome of the meeting was that the most appropriate repair scheme for relatively small areas would be weld overlay. Competitive bids were solicited from three sources to provide weld procedures and to test the feasibility of doing the repair in the sand bed by using the mockup. CBI was the successful bidder. The mockup demonstration was very successful. It demonstrated that the weld overlay repair process was not only feasible, but relatively straight forward in spite of limited working space. However, the mockup demonstration raised a technical concern regarding the effect of residual stresses introduced into the vessel during the welding process. CBI submitted a quote for analysis to resolve this concern. However, no further action was taken when it became obvious that weld repair of the vessel was not necessary.

5.0 UT READINGS

5.1 General

The UT readings taken from the inside of the drywell do not cover the entire surface of the sand bed area because most of the area is below the internal drywell floor and therefore not accessible from inside the drywell. The access provided during 14R from the Torus room provided an opportunity to investigate the entire area. A number of UT readings in each bay were taken to evaluate the condition of the vessel. See reference 2.19 for a description of UT readings from inside the drywell.

5.2 **Initial Approach for UT Inspections from the Sand Bed**

It was recognized in the pre-14R planning process that UT readings from the sand bed should be taken once access was achieved. To this end a specification was prepared and issued (reference 2.20). However, it was not clear, during the planning stage, how the detail requirements of the specification would be carried out. It was known that the surface was irregular, but the degree of irregularity was pure speculation. During a meeting held on 8/21/92 it was decided to assign a GPUN materials engineer (S. Saha) the responsibility for deciding the extent of UT coverage and selection of the locations to be UT'd. This was done to ensure consistency. NDE would have the final word as to whether or not the areas were prepared properly for UT readings. At this point in time it was planned to identify the two thinnest locations in three bays and prepare a six inch by six inch grid similar to the grids used to monitor from the inside of the drywell. The bays selected would be the three in the worst condition as determined from UT readings taken previously from inside the drywell and visual observations during the sand removal effort. These bays were 19, 17 and 11. If during the process of getting a bay ready for coating, additional suspect areas were identified, readings would also be taken in those areas.

How to identify the thinnest areas to locate the inspection grids presented a dilemma that was also discussed at the 8/21/92 meeting. Several schemes were discussed. The most promising being one using a UT probe to survey the bays for relative thickness through rust and pits. The NDE representative accepted an action item to pursue this approach. Two major challenges were involved with this assignment. One, to replicate the physical condition of the drywell surface so that inspection techniques could be evaluated and two, to anticipate the physical space limitations associated with conducting inspections in the sand bed. The second one was not a problem as it turned out. There is adequate space in the sand bed region to conduct inspections. However, all attempts to replicate the physical condition of the drywell surface failed. This drove us to experimenting with a UT probe suspended in a film of water to compensate for surface irregularities. Since we were only looking for relative thickness this appeared to be a solution. Once the thinnest location was selected we planned to prepare the surface so that reliable UT readings could be obtained.

5.3 **Modified Approach**

As is documented below, once access to the sand bed region of bays 17 and 19 was obtained it was soon apparent that meaningful UT information could not be obtained without preparing the surface by grinding on the drywell shell where heavy corrosion had taken place. Several probes were tried. None provided useful information including the experimental immersion probe. The corroded vessel shell resembled a cratered golf ball surface. The areas where the heaviest corrosion had taken place appeared obvious from a visual inspection since the inside shell wall was relatively uniform. The GPUN metallurgist (S. Saha) identified on a sketch, areas to be prepared for UT readings. At a later time he reviewed the surface preparation and thickness data and identified additional locations to ensure that the thinnest areas were surveyed. He has documented his observations in Section 6 of this TDR. Because of a high level of confidence in the visual inspection and the fact that the surface preparation for adequate UT inspection required removal of some metal not corroded, the idea of preparing six inch by six inch grids was abandoned. That approach no longer seemed necessary or prudent.

Sam Saha visually surveyed each bay and identified locations for UT readings that provided an adequate profile of the areas judged to be the thinnest in the bay. The acceptance criteria was that a bay would be deemed to be acceptable if the general area thickness is determined by UT readings to be equal to or greater than 0.736 inches. The 0.736 inch limit is based on an analysis which shows that the drywell meets ASME code requirements (references 2.1 and 2.2). Thickness readings less than 0.736 inches were referred to the GPUN Engineering Mechanics group for evaluation. Each evaluation is documented in Section 6 of this report.

5.4 **Selection of Locations for UT Surveys**

As detailed in paragraph 5.3, the selection of locations for ultra-sonic thickness measurements rested on the visual examination of the vessel shell in each bay. The vessel shell, from the sand bed side, looked like a typical golf ball, i.e. a rough surface full of dimples except that the dimples varied in size. It was reasoned that since the inside surface of the vessel shell is smooth and not corroded, any thin area on the outer surface should represent the minimum thickness in that region. It was further reasoned that if six to twelve scattered spots, located in the area of worst corrosion, are ground smooth and the thickness of each spot is measured by UT method we will have a high level of confidence that we have identified the thinnest shell thickness for a bay. This approach is conservative since, (a) we are forcing a statistical bias in choosing only the thinnest areas and (b) grinding of the selected spots to obtain a flat surface for reliable UT readings will remove additional good metal. This conservative approach for selection of UT spots was finally adopted after assuring that the interior vessel wall is indeed smooth. This was proven in bays 17 and 19 by obtaining a uniform backwall reflection of the sound waves with UT equipment. GPUN metallurgist (S. Saha) located, mapped and identified the worst corroded areas in each bay for thickness measurements. The selected spots and the measured thickness are discussed in Section 6 of this TDR.

5.5 **Structural Acceptance Criteria**

<u>Acceptance Criteria - General Wall</u>

The acceptance criteria used to evaluate the measured drywell thickness is based upon GE reports 9-3 and 9-4 (Ref. 2.1 & 2.2) as well as other GE studies (Ref. 2.21) plus visual observations of the drywell surface (Ref. 2.22). The GE reports used an assumed uniform thickness of 0.736 inches in the sand bed area. This area is defined to be from the bottom to top of the sand bed, i.e., El. 8 feet, 11½ inches to El. 12 feet, 3 inches 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 a reading or measurements are below 0.736 inches, more detailed evaluation is required.

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 meaning-ful value is referred to as the thickness for evaluation. It is computed by accounting for the depth of the spot where the thickness measurement were made and 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. Also, the surface contains some depressions 12 to 18 inches in diameter not closer than 12 inches apart, edge to edge (Ref. 2.22). The depth of surface roughness using the drywell shell impressions taken in the roughest bay was calculated. Two locations in bay #13 were selected since bay 13 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 inches was used in this calculation as a conservative depth of uniform dimples for the entire outside surface of the drywell in the sand bed 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 and averaged with respect to the top of local areas. 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.

<u>Acceptance Criteria - Local Wall:</u>

If the thickness for evaluation is less than 0.736 inches, then the use of specific GE studies is employed (Ref. 2.21). 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 sand bed 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 used to adjust the actual buckling values appropriately. Details are provided in the body of the calculation.

<u>Acceptance Criteria - Very Local Wall (2½ Inch Diameter):</u>

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 (required) = (2/3) * (0.736) = 0.490 inches

Where 2/3 is Sm/1.5Sm and is the ratio of the allowable stresses.

6.0 RESULTS

6.1 General

The locations and thickness measurements for each bay are sketched and tabulated in paragraphs 6.2 through 6.11.

The Engineering Mechanics section reviewed all of the UT readings and documented their conclusions in a calculation. (See reference 2.23). Following is a summary for each bay.

All "location" measurements in the graphics contained in Sections 6.2 through Section 6.11 are measured from the intersection of the drywell shell and vent pipe/reinforcement plate welds for vertical measurements and from the drywell shell butt weld for horizontal measurements.

Average micrometer measurements listed in the tables are the average of four readings taken at 0/45°/90°/135° azimuth within a 1 inch band surrounding spots that were ground for UT measurements. These were only taken in areas where remaining wall thickness was below 0.736 inches.

6.2 Bay #1 Data

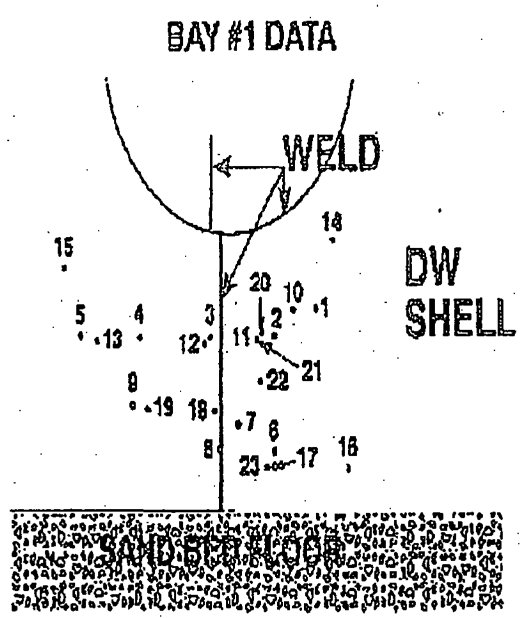

Figure 10

Bay 1 Data - Table 1

Location	UT Measurements (inches)	Avg 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	—

A. Overview of Bay's Physical Condition

The shell in bay 1 is characterized by a rough surface full of dimples of varying sizes up to ½ inch in diameter. The most remarkable feature is the presence of a band 8 inches to 18 inches wide which is 4 to 6 inches below the vent pipe reinforcement plate weld and about 30 inches in length. This bathtub ring contains the worst corrosion. Spots #1, 2, 3, 4, 5, 11, and 12 are located in this bathtub ring. Below the band the corrosion is much less. Above the band no corrosion was seen (spot #14 and #15) and the original red lead coating was still visible.

B. Summary of Structural Evaluation

The 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 (see Fig. 10). Beyond the bathtub ring on both sides, the shell appears to be uniform in thickness at a conservative value of 0.800 inches. Measurements 14 and 15 confirm that the thickness above the bathtub ring is at 1.154 inches starting at elevation 11 feet, 00 inches. 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 is recalculated based on the GE report 9-4 (Ref. 2.2). 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.

Locations 1, 2, 3, 4, 5, 10, 11, 12, 13, 20, and 21 are confined to the bathtub ring as shown in Figure 10. 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 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 (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. 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 2. 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 a full 0.108 inch reduction from the conservative estimate of a 0.800 inch 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. 2.21).

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 sand bed 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 inch 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 inch area used in the analysis. Therefore, this small 4 x 4 inch 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 a 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.

SUMMARY OF Measurements BELOW 0.736 Inches

Table 2

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

6.3 Bay #3 Data

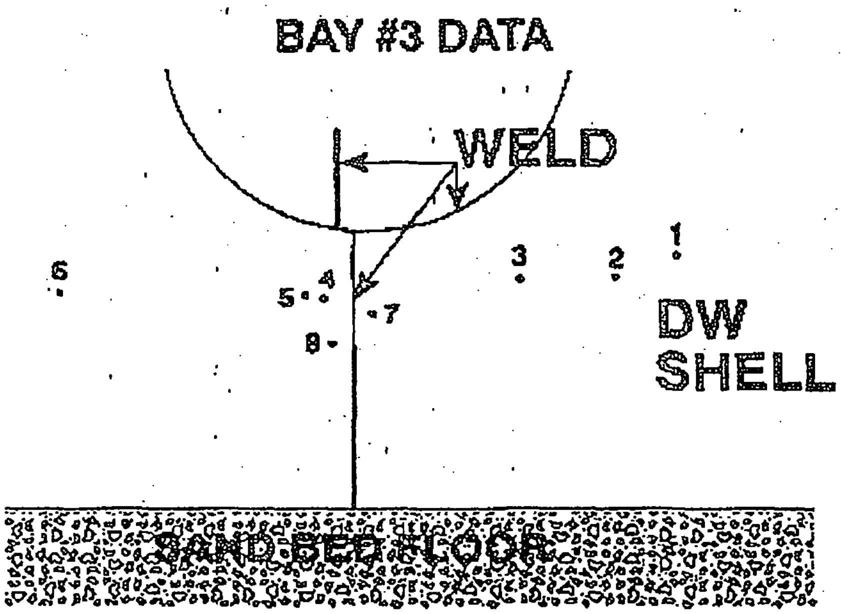

Figure 11

Bay 3 Data - Table 3

Location	UT Readings (inches)	Avg 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	—

A. Overview of Bay's Physical Condition

Except for a "band" approximately 6 inches below the vent header weld and 8 - 10 inches wide, the corrosion observed was uniform and characterized by a uniformly dimpled surface. The upper portion of the shell beyond the "bathtub ring" and the vent pipe was not corroded. The original "red lead" primer coating is still visible. The reinforcement bar sleeves, on the concrete side, were corroded uniformly. No perforation was seen in any of these sleeves. The concrete floor was in poor shape. It had a huge crater about half the length of the bay running along the drywell shell. It was about 18 inches deep at the worst location. No drainage channel was found on the floor. From the visual appearance, it was evident that the concrete floor was never constructed to the original design.

B. Summary of Structural Evaluation

The outside surface of this bay is rough, similar to bay one, 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. Eight locations were selected to represent the thinnest areas based on the visual observations of the shell surface (see Fig. 11). 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.

6.4 Bay #5 Data

NOTE: In this bay the drywell shell (butt) weld is about 8 inches to the right of center line of the vent pipe. Therefore, all measurements were taken from a line drawn on shell which approx. coincide with the vent pipe center line.

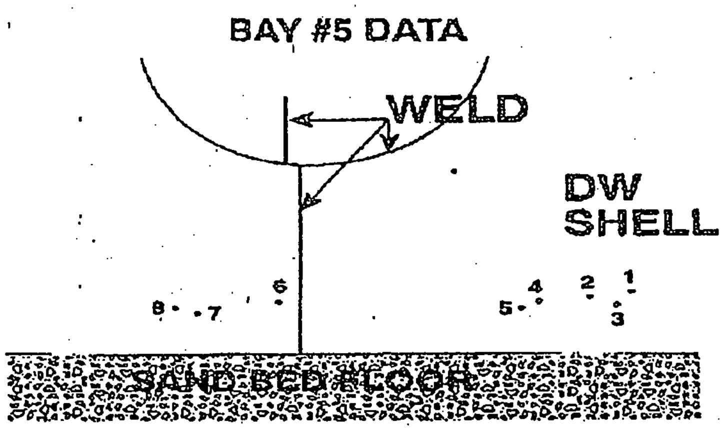

Figure 12

Bay 5 Data - Table 4

Location	UT Readings (inches)	Avg 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	—

A. Overview of Bay's Physical Condition

This bay was very similar to bay 3 in physical condition except that, (1) the floor crater was 12 inches deep at the worst location and (2) the localized low spots from corrosion were clustered at the junction of bays 3 and 5, 30 - 32 inches above the floor.

B. Summary of Structural Evaluation

Eight locations were selected to represent the thinnest areas based on the visual observations of the shell surface (see Fig. 12). These locations are a deliberate attempt to produce a minimum measurement. Table 4 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.

6.5 Bay #7 Data

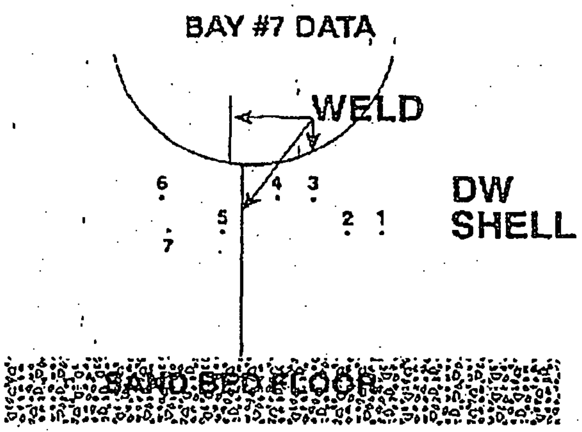

Figure 13

Bay 7 Data - Table 5

Location	UT Readings (inches)	Avg Micrometer (inches)
1	0.920	—
2	1.016	—
3	0.954	—
4	1.040	—
5	1.030	—
6	1.045	—
7	1.000	—

A. Overview of Bay's Physical Condition

The drywell surface showed uniform dimples in the corroded area, but it was shallow in depth. The bathtub ring, seen below the vent header in other bays, was not very prominent in this bay. The sleeves for the reinforcement bars showed no perforations and were uniformly corroded. The concrete floor had no drainage channel, was unfinished and had a few small craters.

B. Summary of Structural Evaluation

Seven locations were selected to represent the thinnest areas based on the visual observations of the shell surface (see Fig. 13). 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 1 inch is estimated for this bay and therefore, it is concluded that the bay is acceptable.

6.6 Bay #9 Data

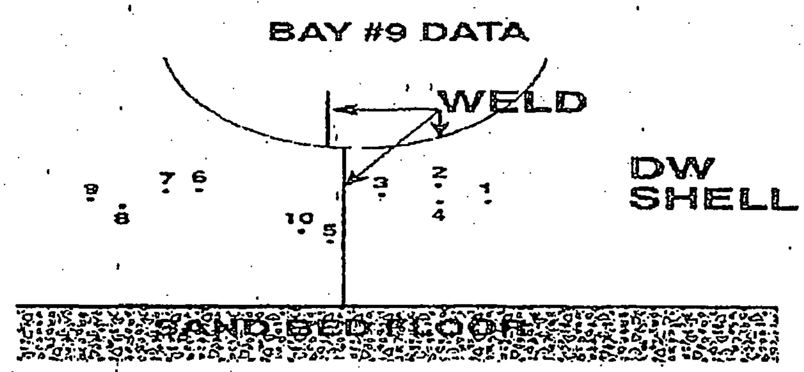

Figure 14

Bay 9 Data - Table 6

Location	UT Readings (inches)	Avg 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	—

A. Overview of Bay's Physical Condition

This bay was similar to bay 7 in physical condition except that the bathtub ring that is 6 to 9 inches wide and 6 to 8 inches below the vent pipe reinforcement plate contained some localized corrosion. Above this band no corrosion had occurred.

B. Summary of Structural Evaluation

Ten locations were selected to represent the thinnest areas based on the visual observations of the shell surface (see Fig. 14). These locations are a deliberate attempt to produce a minimum measurement. Table 6 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.

6.7 Bay #11 Data

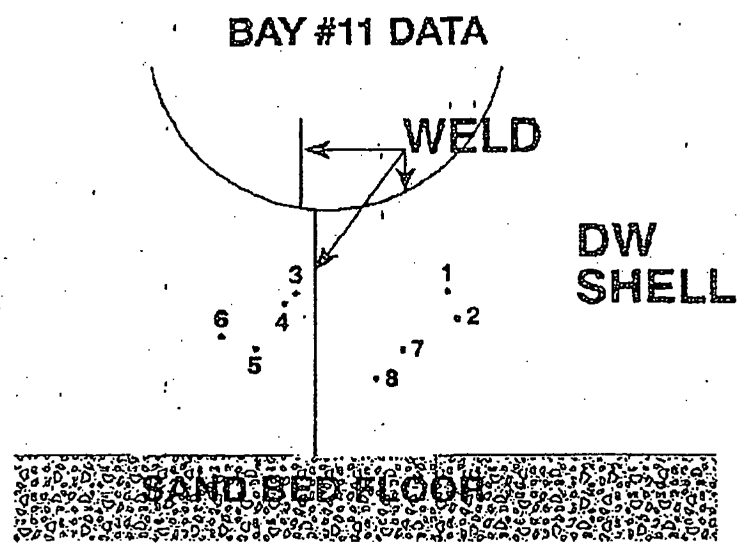

Figure 15

Bay 11 Data - Table 7

Location	UT Readings (inches)	Avg 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	—

A. Overview of Bay's Physical Condition

This bay was wet, during the initial inspection, from the water leaking out of the reactor cavity. The water was seen trickling/dripping down the concrete wall on the inside of the sand bed. No water stream/trickle was seen on the drywell shell. Most of the localized corroded spots were on the upper right hand side (i.e. toward bay 9) 10 to 12 inches below the vent pipe reinforcement plate. The shell on the left hand side (i.e. toward bay 13) showed an uniformly corroded (dimpled) surface. The concrete reinforcement bar sleeves were corroded but not perforated. The concrete floor was unfinished and no drainage channel was seen.

B. Summary of Structural Evaluation

Eight locations were selected to represent the thinnest areas based on the visual observations of the shell surface (see Fig. 15). 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, except one location. Location 1 as shown in Table 8, 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 8. 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 8.

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.

Summary of Readings Below 0.736 Inches

Table 8

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

6.8 Bay #13 Data

NOTE: Spots with suffix (e.g. 1A or 2A) were located close to the spots in question and were ground carefully to remove minimum amount of metal but adequate enough for UT.

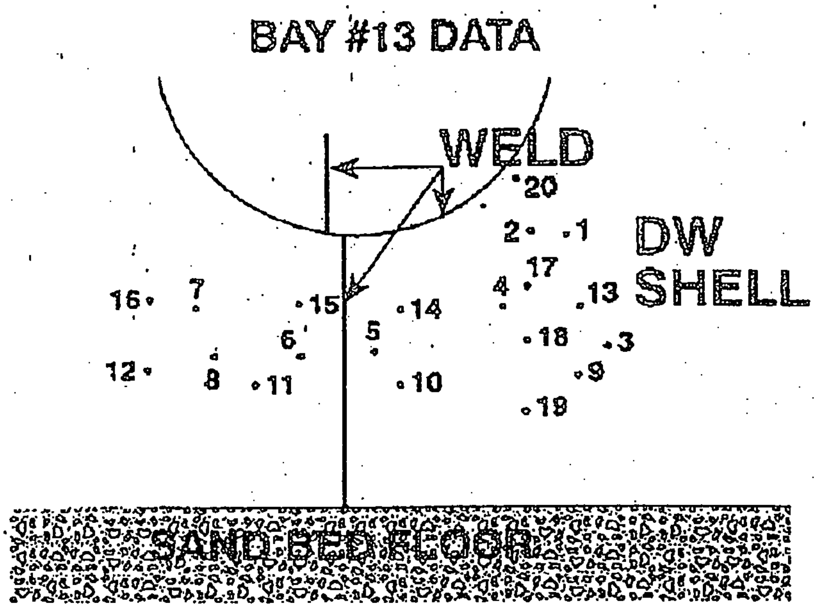

Figure 16

Bay 13 Data - Table 9

Location	UT Reading (inches)	Avg 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	—

A. Overview of Bay's Physical Condition

The drywell shell in this bay appeared uniformly dimpled except around a plug in the upper right hand corner (towards bay 11). The plug was located in the worst corroded area of the shell, but it was not corroded. The bathtub ring below the vent pipe reinforcement plate was less prominent than was seen in other bays. The concrete floor in this bay was in better shape as compared to other bays, but it was still uneven and craters were present. There was no drainage channel. The reinforcement bar sleeves were uniformly corroded, but no perforations of the sleeves were seen.

B. Summary of 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 sand bed. 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 thicknesses 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. 2.2). 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.

Locations 5, 6, 7, 8, 10, 11, 14, and 15 are confined to the bathtub ring as shown in Figure 16. 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 Figure 16. The results indicate that all subsequent measurements were above 0.736 inches. The average micrometer readings taken for these locations confirm the depth of measurements at these locations. In spite of the fact that the original readings were taken at heavily ground locations, they are the one used in the evaluation.

The individual measurements must also be evaluated for structural compliance. Table 9 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 9 (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 9. 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 10. 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 a 0.800 inch 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. 2.21).

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 sand bed 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 inch area used in the analysis. Therefore, this small 6 x 6 inch 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 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.

Summary of Measurements Below 0.736 Inches

Table 10

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

6.9 Bay #15 Data

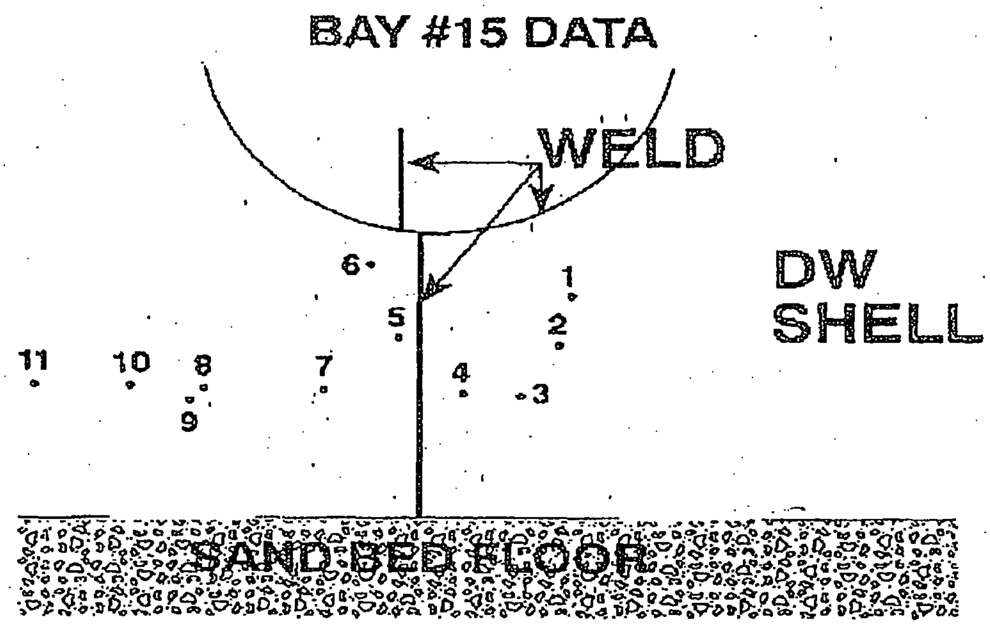

Figure 17

Bay 15 Data - Table 11

Location	UT Readings (inches)	Avg 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	—

A. Overview of Bay's Physical Condition

The drywell shell in this bay was uniformly dimpled and the upper part of the shell (i.e. near the vent pipe/reinforcement blade and up) was not corroded. The original "red lead" primer was still visible in this region. The bathtub ring was less prominent than other bays. The reinforcement bar sleeves were corroded, but not perforated. The concrete floor had no drainage channel and there were craters in the floor.

B. Summary of Structural Evaluation

Eleven locations were selected to represent the thinnest areas based on the visual observations of the shell surface (see Fig. 17). These locations are a deliberate attempt to produce a minimum measurement. Table 11 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 11, 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 11. 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 12.

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.

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

<u>Table 12</u>

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

6.10 Bay #17 Data

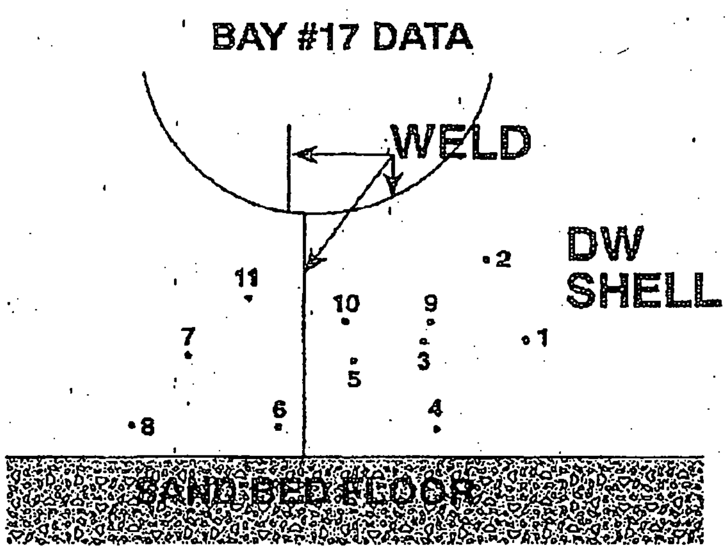

Figure 18

Bay 17 Data - Table 13

Location	UT Readings (inches)	Avg 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	—

A. Overview of Bay's Physical Condition

This bay (along with bay 19) provided the first glimpse of the conditions of the drywell shell. The most remarkable feature of this bay was the presence of the bathtub ring 8 to 10 inches wide that was located 8 to 10 inches below the vent tube reinforcement plate. UT spots # 1,3,5 and 7 are located in this band which is the most corroded area in this bay. Spots # 1 through 8 were ground carefully to minimize loss of good metal. Spots # 9,10 and 11 were ground flat and most likely removed good metal. The reinforcement bar sleeves were corroded, but not perforated. The concrete floor was unfinished with no sign of a drainage channel.

B. Summary of Structural Evaluation

Eleven locations were selected to represent the thinnest areas based on the visual observations of the shell surface (see Fig. 18). These locations are a deliberate attempt to produce a minimum measurement. Table 13 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 13, 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 13. 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 14.

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.

Summary of Measurements Below 0.736 Inches

Table 14

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

6.11 Bay #19 Data

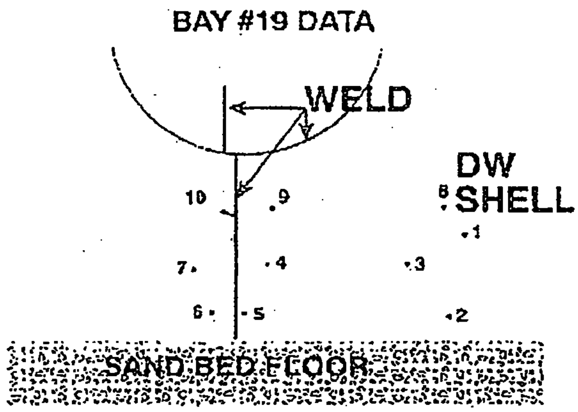

Figure 19

Bay 19 Data - Table 15

Location	UT Readings (inches)	Avg 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	—

A. Overview of Bay's Physical Condition

The physical condition of this bay was similar to bay 17 except that UT spots 1 through 7 were ground carefully to minimize loss of good metal, whereas spots 8, 9 and 10 were ground flat.

B. Summary of Structural Evaluation

Ten locations were selected to represent the thinnest areas based on the visual observations of the shell surface (see Fig. 19). These locations are a deliberate attempt to produce a minimum measurement. Table 15 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.

7.0 CONCLUSION

The cleaning and coating effort that was completed in 14R will stop corrosion in the sand bed area. Since this was accomplished while the vessel thickness was sufficient to satisfy ASME code requirements the drywell vessel in the sand bed region is no longer a limiting factor in plant operation. Inspections will be conducted in future refueling outages to insure that the coating remains effective. In addition, UT investigations from inside the drywell will also be taken. The frequency and extent of these investigations will be evaluated after 15R.

APPENDIX A

WASTE DISPOSAL

This Appendix describes the disposition of waste generated during the implementation of the project. The various wastes generated are given below:

1.	Sand	172 barrels (55 gallon/barrel)
2.	Concrete	59 barrels
3.	Corrosion scale	7 barrels
4.	Concrete slurry	16 barrels
5.	Coating products,	(Approximately 1000 cans, application tools etc. buckets, brushes, rollers,etc.)

The sand removed from the sand bed was slightly contaminated. Reference 2.24 provides the activity levels found in various barrels of sand.

The threshold of activity below which a bulk waste is considered clean is as follows:

cesium 137 $\leq 1.1 \times 10^{-7}$ micro curies/gm.

All other isotopes = no detectable activity with a γ scan machine with a range of 1×10^{-8} uc/gm - mirco curies/gm.

About 15 barrels of sand were bagged and used as shielding in the ten twenty inch diameter access manways. The remaining sand will be stored in building #9 at the Forked River site until the sand activity reduces below the threshold activity.

Approximately 59 barrels of concrete were removed while cutting the access manways. Thirty two barrels of concrete came in large pieces and was disposed of as clean waste after frisking. Twenty seven barrels of bulk concrete are being surveyed by the plant chemistry department using gamma scan, and depending on the outcome, will be disposed of as clean waste , if the criteria for the threshold limits can be met. If very low activity levels are found as in the case of sand, it will be stored in building #9. If activity levels are higher, the concrete will be disposed of as regular low level radwaste.

Approximately seven barrels of corrosion scale were removed. The material was frisked and released as non radioactive waste. Chemical analysis was performed by GPUN Materials Lab in Reading for the presence of hazardous metals. Reference 2.25 provides the lab test results. The corrosion scale was released as clean non radioactive waste as no hazardous metals were found.

Approximately 16 barrels of concrete slurry were removed during the access manway core boring operation. The slurry was allowed to settle, the water was checked for ph and then processed through radwaste (ph was below the limit). Concrete was disposed of as regular low level radwaste.

Paint cans, paint barrels, brushes, rollers and similar items that were used during the Devoe coating application processes, were kept on-site until the coating got hardened and then were frisked and released as clean waste. Paint cans generally had to be coated on the exterior with the epoxy coating to eliminate the sticky condition prior to frisking for radioactivity.