Meeting Minutes
Interim Status Dangerous Waste Tank Systems
Hanford Federal Facility Agreement and Consent Order
Milestone M-32-00

PROJECT MANAGERS MEETING
January 23, 1997

The undersigned indicate by their signatures that these meeting minutes reflect the actual occurrences of the above dated Project Mangers Meeting (PMM).

Date: 9-4-97
W. R. Brown, Representative, Fluor Daniel Hanford, Inc.

Date: 9-29-97
D. E. Jackson, Project Manager, Department of Energy, Richland Operations Office

Date: 9/4/97
J. M. Thurman, Representative, Lockheed Martin Hanford Corporation

Date:
R. W. Wilson, Unit Manager, Washington State Department of Ecology

Purpose: Discuss current Double-Shell Tank Farm issues related to Milestone M-32-00.

Meeting minutes are attached. The minutes are comprised of the following:

- Attachment 1 - Agenda
- Attachment 2 - Summary of Discussion, Agreements and Actions
- Attachment 3 - Attendance List
- Attachment 4 - Status of Inspection Activities (handout)
- Attachment 5 - "Results of the Performance Demonstration Tests on Double-Shell Mockup" (PNNL-11444, December 1996)
- Attachment 6 - Tank Selection (handout)

MEMO

Interim Status Dangerous Waste Tank System
Hanford Federal Facility Agreement and Consent Order
Milestone M-32-00 Project Managers Meeting minutes
January 23, 1997

The following Tri-Party Agreement M-32-00 Project Managers Meeting minutes have not been signed by the Washington State Department of Ecology (Ecology). Ecology provided comments (cc:message, dated November 3, 1997) that the U.S. Department of Energy, Richland Operations Office believes are too old to accurately be assessed. Therefore, the minutes are issued without Ecology's signature.

This meeting was held on January 23, 1997 to discuss the proposed Double-Shell Tank interim milestone addition to the major M-32-00.

Attachment(s): cc:message, R. W. Wilson (Ecology) to A. R. Sherwood (WMH), "DST Meeting Minutes," dated November 3, 1997

ATTACHMENT

Author: Robert W (Bob) Wilson at ~HANFORD02A
Date: 11/3/97 3:47 PM
Priority: Normal
TO: Ana R Sherwood at ~HANFORD21A
CC: Laura J Cusack
CC: Alisa D Huckaby
Subject: DST Meeting Minutes
------------------------------ Message Contents ------------------------------

Ana,

Below are comments assembled from Alisa's notes and review of the January 23, 1997 DST M-32 meeting minutes. With these additions the minutes should be complete from our perspective. Other meeting minutes are too old for us to accurately assess at this point. After review of the comments below, please forward for my signature. These are items Alisa felt pertinent to the January 23rd meeting that were not reflected in the current draft meeting minutes:

A) In the introduction, Dale requested that budget limitations be considered by the sub-panel.

B) Jerry Polakony presented results of the examination of 103 AW wall and reviewed eight conclusions as a result of the examination as follows:

1- No reportable indications in primary or secondary walls.

2- Rust on tank walls presented n few problems for equipment.

3- c-scan maps were provided for each one foot coverage.

4- Remote controlled, magnetic wheel scanner was effective with scanning speed at 4.5 inches/second and scan width at 10.74 inches.

5- Water was an effective couplant.

6- Less than 5 gallons of water used to inspect 35 ft of tank wall.

7- System able to detect and characterize inclusions and welded attachments in secondary tank wall (nothing found in primary tank wall).

8- Scanning from top to bottom an advantage in cleaning tank wall.

MILESTONE M-32-00
PROJECT MANAGERS MEETING
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Agenda

8:00 am	Introduction (D. E. Jackson, M. L. Ramsay)
8:15 am	Status of Inspection Activities (K. V. Scott)
8:30 am	Qualification of UT System/Performance Test (G. J. Posakony)
9:30 am	Tank AW-103 Data Review (G. J. Posakony)
10:30 am	Examination Plans for February 97- July 98 (K. V. Scott)
11:30 am	Lunch
1:00 pm	Tank Selection (K. V. Scott)
1:30 pm	Open Discussion - UT Methods, Extent Examination
3:30 pm	Panel Caucus
4:00 pm	Summary/Closing Statement (D. E. Jackson, M. L. Ramsay)

MILESTONE M-32-00
PROJECT MANAGERS MEETING
January 23, 1997

Summary of Discussion, Agreements and Actions

This meeting was held to discuss the Double-Shell Tank (DST) ultrasonic (UT) examination status and results with the Sub-Panel of the Tank Structural Integrity Panel (Sub-TSIP).

INTRODUCTIONS - Introductions were made around the table. Mr. Spencer Bush, of the Sub-TSIP, said that using 6 tanks to evaluate all 28 tanks is based on finding nothing wrong with the tanks. Mr. Kamal Bandyopadhyay, of the Sub-TSIP, agreed that 6 tanks are acceptable as a representative of all 28 Double-Shell Tanks (DSTs). Mr. Dale Jackson, of the U.S. Department of Energy, Richland Operations Office (RL), said that we would ultrasonically test 6 tanks and then determine the need for more examination, if any. It was also noted that it is likely that other tanks will be tested in the future in the course of conducting ongoing or recurring assessments of tank integrity. Mr. Jackson said that the purpose of today's meeting was to verify the validity of the current integrity assessment approach. He said that the issue was can we collect the right kind of information and determine the integrity and quality of the data being collected.

STATUS OF INSPECTION ACTIVITIES - Mr. Keith Scott, of SGN Eurisys Services Corp. (SESC), basically followed his handout (attachment 4). Mr. Scott said that in the event that inspection acceptance criteria is exceeded an expert panel (other than the Sub-TSIP) would be invited to convene and evaluate the significance of such data. While not in his handout, reportable criteria has been determined to be 3/16" for axial cracks, 0.25t for pits, and 0.1t for thinning. Mr. Scott explained that not requiring cleaning of the tank wall was important to the activities (saves time/money). He said that no reportable indications were found on the AW-103 tank.

QUALIFICATION OF UT SYSTEM/PERFORMANCE TEST - Mr. Gerald Posakony, of the Pacific Northwest National Laboratory (PNNL), passed out a report (attachment 5) on the "Results of the Performance Demonstration Tests on Double-Shell Mockup," (PNNL-11444, December 1996). Mr. Posakony said that the equipment performing the ultrasonic test had to be capable of remote inspection. He said that the test plates had simulated pits, wall thinning, and stress corrosion cracking (these were lab grown). Other qualifications required during the mock-up test were that all operators had to meet SNT-TC-1A-92 (a testing standard with operator certification guidelines), the test had to be performed according to the inspection procedure, and the test criteria for successful completion of the mock-up test had to be met. Mr. Posakony explained that the P-scan system used is a commonly accepted method that provides data from the plan view, front view, and end view.

The mock-up test was performed on a 1/4 section of a full scale tank. There were no welds in the test plates. Equipment skips over welds (about 1" is not covered).

Mr. Bandyopadhyay said that he had heard that this type of inspection was not successful at Savannah River. Mr. Scott said that the Savannah River examination ran 6" wide, top to bottom, in four locations with no reportables. He said that the unsuccessful tests were conducted at West Valley where the tanks are in a more humid environment and have lots of corrosion. The test equipment did have trouble operating there. Mr. Bush remembered the same as Mr. Scott. Mr. Scott said that if cracks were present, they would be expected at other locations than at the welds. The equipment inspects within ½" of a weld. Mr. Posakony said that the mock-up test did not try to apply the scanner in the weld area. Their intent was to show that the equipment worked, later they would determine its limitations. Mr. Bush said that the question will come up "did you inspect the weld area." Mr. Scott said that Hanford's tanks have been stress relieved. Weld residual stresses should be low. As it turned out, the equipment provided for the ultrasonic tests is steerable, therefore it may be able to inspect some weld area. Following more discussion on the weld area, a video of the mock-up test was shown. Mr. Posakony said that all sample defects were manufactured and that fracture mechanics were used to determine criteria. The equipment uses a T-Scan (thickness), P-Scan (angle view), and C-Scan (side and end view). ASME Section VIII guidelines were used to compute the reliability of the equipment. The mock-up test reviewed personnel, procedures, equipment, and confidence levels to national standards. The SAIC crew was not allowed to review results after their first judgement (in other words, SAIC had only one chance to interpret the UT results). The results from the mock-up test were that all 30 defects were detected with one false call. This gave a confidence level of 0.958 with a probability of detection of 0.9, that is, there is a 95.8% confidence that this system will detect 90% of the defects. The only improvement suggested by Mr. Posakony is in the detection of very thin sections.

TANK AW-103 DATA REVIEW - Mr. Posakony showed a video of the AW tank UT test. Each 10" x 35' strip took 6-8 hours to complete once equipment was deployed. The primary wall was found to be within design tolerance. The secondary tank had more indications than the primary wall; there was no pitting, but inclusions were found. The secondary tank also had some stud indications due to construction activities (weld patch, scaffolding, rebar).

EXAMINATION PLANS FOR FEBRUARY 97- JULY 98 - Mr. Scott said that in FY 97 approximately $350K has been spent to date (this does not include the cost of the contract package, awarding the contract, nor the initial planning). SAIC inspection vendor does not own the equipment. SAIC built the deployment sled. Mr. Bruce Thompson, of the Sub-TSIP, asked how we calibrate the equipment if we do not own it. Mr. Posakony said that we have a calibration procedure with test blocks incorporated into it. Procedures require a pre- and post-calibration test. Mr. Scott said that the AW tank has been in service since the mid-1980s and that no cleaning was required. When asked if other tanks will be as clean as the conditions found in the AW tank, he explained that the aging waste tanks are hotter, used since the early 1970s, and tend to rust more, but that generally the tanks did not differ much (as seen from the visual [video] inspections performed on them earlier). Mr. Thompson suggested quantifying the wall condition to judge when a wall would be too dirty and need cleaning. He suggested looking for a distinct distortion/amplitude of results, relationship to probability of detection (compare test plates to actual test/may be done with existing data), or performing a test on a dirty wall, then cleaning it and performing a cross comparison. Mr. Scott asked for the Sub-TSIP member's opinion of the test. Mr. Thompson said it was a good job, with good data, and a good test method and analysis of test results. He said that, for him, three issues existed: wall scale (cleaning) need, ability to inspect the weld region, and the number of tanks that need to be in the sample. Mr. Bush agreed that cleaning was an issue. Mr. Posakony said that the AW tank wall condition gave us a baseline and that the next test can be evaluated against it. Mr. Scott took an action to quantify a point where wall cleaning would be necessary.

Mr. Mark Ramsay, of RL, asked Mr. Scott to price out cost to perform a SST visual of the internal surface once the tank's contents have been retrieved.

<u>TANK SELECTION</u> - Again, Mr. Scott followed his handout (attachment 5) in discussing the factors taken into account during the tank selection activities. The handout identifies the six DSTs that will be included in the UT examinations.

<u>OPEN DISCUSSION</u> - The afternoon session began with a discussion of the inspection needs for the DST bottom (air slots) and knuckle region. There are approximately 64 air slots under each tank. They are approximately 2" wide and run straight for 13' and then turn to join an adjacent slot, which in turn joins another, until 16 channels meet at the tank center. Tank AZ has metal covers over its slots. The wall thickness in the area of the knuckle varies from 7/8" to 15/16". In the region where the tank knuckle ends and the tank bottom begins is potentially a point of significant stress. Mr. Posakony mentioned that he believed that detection of a finding in these area would be possible; however determining its size would be a problem. Mr. Posakony took several suggestions for potential inspection methods.

Mr. Bush suggested inspecting a vertical weld. Mr. Thompson asked if a mock-up test would be run on weld samples if a weld was to be inspected. Mr. Posakony explained that weld inspections were not in the charter of this assessment as all DST welds were radiographed at construction.

Mr. Bush agreed with the test criteria selected for qualifying the equipment to detect wall thinning, pitting, and cracking. He stated that the knuckle was the area of concern.

Mr. Scott asked for the Sub-TSIP's recommendations as to whether inspecting the primary tank bottom (air slots) would be of benefit given the limited area available and test implementation difficulties. Mr. Bush stated that in his opinion, stress corrosion cracking was more likely to occur at the entrance to the air slots where the tank knuckle ends and the tank bottom begins. Mr. Posakony suggested using air to push the test equipment into the slot (or some other device to drive the probe into those slots without a plate block) and a cable to pull the equipment out. He recognized that debris in the slot might hamper the equipment. Mr. Scott asked if the Sub-TSIP thought the benefits of the test justified the difficulties associated with the test. Mr. Bush mentioned that the area available for inspection was not a high percentage and may be of limited value.

Ms. Alisa Huckaby, of the Washington State Department of Ecology (Ecology), asked how much a demonstration on the knuckle would cost. Mr. Scott did not know at this time. Mr. Scott stated that he wanted to inspect all regions (wall, knuckle, bottom) as much as possible with the next tank as this will minimize the cost. He pointed out that it did no good to inspect more walls without looking at the knuckle region as it is here that failures would be the most serious. Mr. Jackson asked what happens if we can not get the knuckle region. Mr. Bush said that the Sub-TSIP was interested in the knuckle region because it could provide some advanced warning of tank failure. He said that the wall inspections give some conclusions as to the tank conditions, but that the knuckle inspections would substantially increase confidence. Mr. Scott asked if the detection mode could be used as a gate to eliminate the minor stuff we are not interested in (instead of sizing mode use only a detection mode). He suggested that we use findings of either zero or significant even if sizing is not possible above a threshold value. Mr. Bush allowed that perhaps it could. Mr. Posakony asked all to bear in mind that if the 0.2t criteria was used and found, that it was not critical, it meant that the point/area must be monitored. Mr. Bush agreed that if findings are encountered, it does not mean that the tank can not be used rather that the tank needs monitoring.

Mr. Scott asked the Sub-TSIP if the amount of tank bottom examination we are going to get in the air slot is worth the effort. Mr. Bush guessed the inspection would cover approximately 1% of the tank bottom (a fan beam might increase the inspection area, but he did not know if it was possible). He said that there was not much return for the effort, but if indications were found at the end of the knuckle, then that would increase the need for the bottom inspections. He said that even if the knuckle inspection did not include looking for pitting, major pitting would be detected. If the region showed pitting then it would suggest that some bottom inspection was needed even if only a small percentage.

<u>SUMMARY/CLOSING STATEMENT</u> - Mr. Scott summarized by saying that the Sub-TSIP suggested that the tank wall inspection be modified to include a vertical weld, that the knuckle region was an important area to inspect for cracks, that the primary tank bottom was an important area to inspect for pitting, and that getting the cost of all inspections will be used to evaluate the benefits of the each inspection. Mr. Bandyopadhyay agreed to write a letter summarizing the Sub-TSIP's conclusions concerning the validity of the ultrasonic data, the extent of examination, and the flaw acceptance criteria.

Attachment 3
MILESTONE M-32-00
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Attendees

NAME	ORGANIZATION
Geneva Balone	U.S. Department of Energy, Richland Operations Office
Kamal Bandyopadhyay	Sub-Tank Structural Integrity Panel
W. Russ Brown (am only)	Fluor Daniel Hanford
Spencer Bush	Sub-Tank Structural Integrity Panel
Brad Erlandson (pm only)	Lockheed Martin Hanford Corp.
Norm Hepner	Washington State Department of Ecology
Alisa Huckaby	Washington State Department of Ecology
Dale Jackson	U.S. Department of Energy, Richland Operations Office
Greg Leshikar	SGN Eurisys Services Corp.
Gerald Posakony	Pacific Northwest National Laboratory
Mark Ramsay	U.S. Department of Energy, Richland Operations Office
Keith Scott	SGN Eurisys Services Corp.
Ana Sherwood	Rust Federal Services of Hanford Inc.
Bruce Thompson	Sub-Tank Structural Integrity Panel
Jack Thurman (am only)	Lockheed Martin Hanford Corp.

M-32-00 PROJECT MANAGERS MEETING

January 23, 1997

Morning

NAME	ORGANIZATION	TELEPHONE	MSIN
Ana R Sherwood	RUST	376-6391	H6-22
DALE JACKSON	DOE-RL	376-4851	A5-15
Alisa D. Huckaby	Ecology	736-3034	B5-18
NORM Hepner	Ecology	736-3048	B5-18
Mark Ramsay	DOE-RL	376-7724	S7-54
Yerena Balone	DOE-RL	372-2225	A5-15
JACK THURMAN	LMHC	373-5609	R1-51
SPENCER BUSH	RSI7	509-943-0233	
GERALD J. POSAKONY	PNNL	509-375-2138	K5-26
BRUCE THOMPSON	AMES LAB	515-294-9649	
Kamal Bandyopadhyay	BNL	516-344-2032	
Keith Scott	SESC	509 376-5445	H5-52
Greg Leshikar	SESC	373-4434	S2-24
RUSS BROWN	FDH-TPAI	376-4026	B2-35

M-32-00 PROJECT MANAGERS MEETING

January 23, 1997

Afternoon

NAME	ORGANIZATION	TELEPHONE	MSIN
Ana K. Sherwood	RUST	376-6391	H6-22
Alisa D. Huckaby	Ecology	509/736-3034	B5-18
Brad Erlandson	LMHC	372-2678	R2-36
Greg Leshikar	SESC	373-4434	S2-24
Genena Ellis-Balone	DOE-RL	372-2225	A5-15
SPENCER BUSH	RSA	943-0233	
G. S. POSAKONY	PNNL	375-2138	K5-26
Mark Ramsay	DOE-RL	376-7924	S7-54
Bruce Thompson	Ames Lab	515-294-9649	
Kamal Bandyopadhyay	BNL	516-344-2032	
Keith Scott	SESC	5093[illegible]-5445	H5-52
Norm Hepner	Ecology	736-3048	B5-18
DALE JACKSON	DOE-RL	376-4857	A5-15

Attachment 4

MILESTONE M-32-00
PROJECT MANAGERS MEETING
January 23, 1997

Status of Inspection Activities
(handout)

Status of Inspection Activities

K. V. Scott

January 1997

Timeline

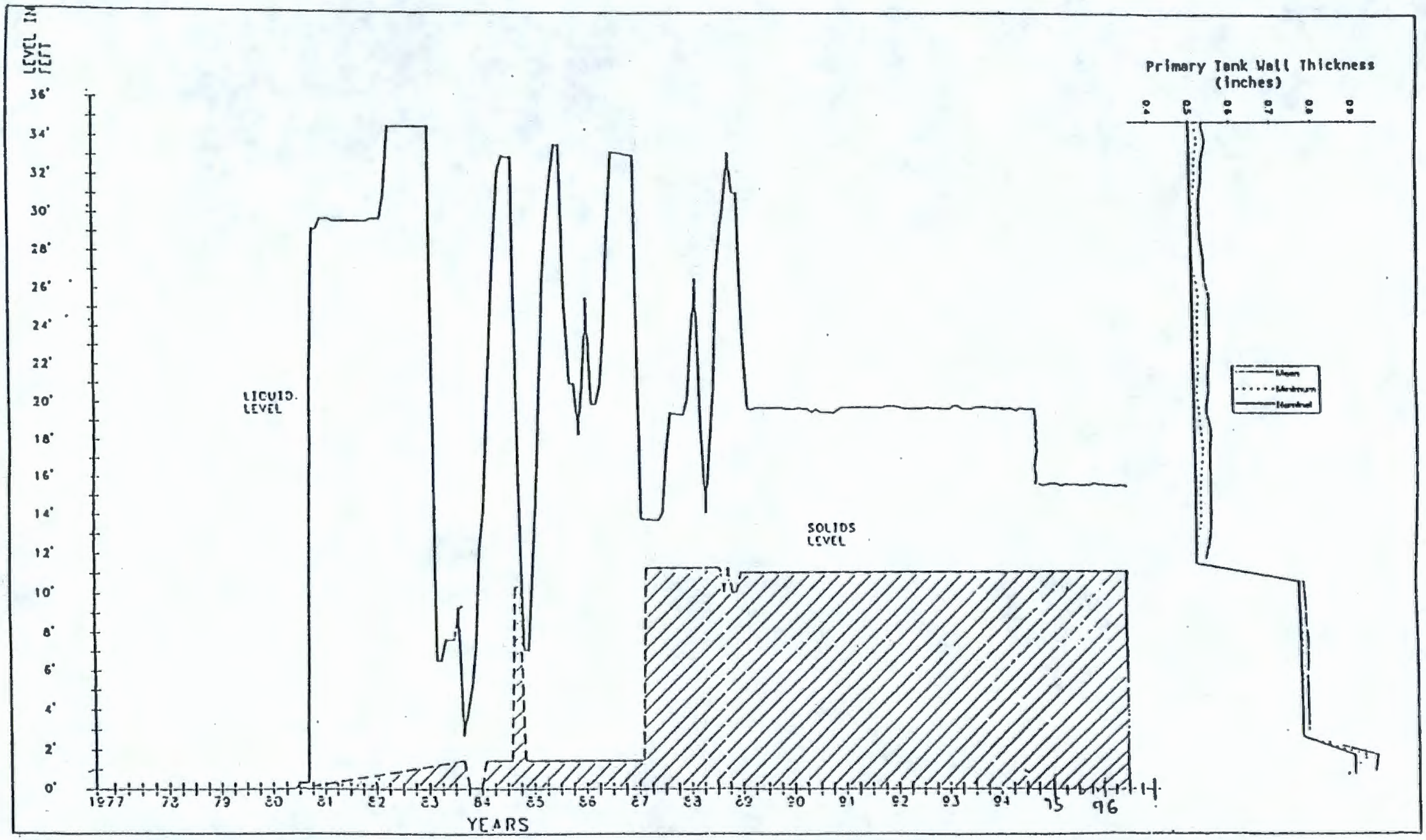
- Agreement to collect and review inspection data
  June 25, 1996
- Contract for wall inspection
  September 27, 1996
- System Performance Test
  November 14-21, 1996
- Tank AW-103 wall inspection
  November 22-25, 1996

AW-103 Wall Examination

- Inspection Acceptance Criteria

  - Axial cracks 3/16 inch deep
  - Pits 0.5 t
  - Thinning 0.2 t

- Vertical strips, full length of cylindrical wall
- Both primary and secondary tanks
- Two 10.25-inch wide strips on each tank
- Tank wall cleaning was not required



Comparison of As-Measured and ASTM-Specified Plate Thickness with Waste Level, DST 241-AW-103

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"Results of the Performance Demonstration Tests on Double-Shell Mockup"
(PNNL-11444, December 1996)

PNNL-11444

Ultrasonic Nondestructive Examination of Double-Shell Tanks

"Results of the Performance Demonstration Tests on Double-Shell Mockup"

Report Prepared

for

K. V. Scott
SGN Eurisys Services Corporation
Richland, WA 99352

by

G. J. Posakony and T. T. Taylor
Battelle Pacific Northwest National Laboratory
Richland, WA 99352

December 1996

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FIGURES

APPENDICES

Double-Shell Performance Demonstration Tests at the Mock-Up Facility in 337 Building

Executive Summary

As part of the requirements for validating the performance of the ultrasonic system proposed for the nondestructive examination of double-shell tanks at the Hanford Site, the vendor was required to complete a performance demonstration test (PDT) at the mock-up facility located in the 337 Building, 300 Area. This facility is a quarter section of a full scale tank and is designed for training and demonstrations. It simulates actual tanks that are located in the 200 Area.

Science Applications International Corporation (SAIC) was the successful bidder for the initial phase of the nondestructive examination project. They proposed using a P-Scan ultrasonic imaging system as the primary inspection instrument. The mechanical delivery system was an AWS-5 remotely controlled, maneuverable, magnetic-wheel crawler scanning system for performing the examination. Both the ultrasonic instrument and scanning system are manufactured by Force Institutes in Denmark. These systems have proven effective in detecting and sizing anomalies such as pits, wastage, corrosion and weld defects in a variety of industrial applications. This type of system has been used for inspection of waste tanks at Savannah River.

The PDT consisted of examination of a series of plates with machined defects and laboratory grown stress corrosion cracks. Initially a series of 10 plates were fabricated for the test, and PNNL measured defect sizes and locations. Five of these plates were selected for the performance demonstration. These plates were mounted in a cutout on the vertical wall of the tank mock-up. The magnetic-wheel crawler was deployed through a 24-inch riser at the top of the tank and maneuvered into position to perform the test. Video cameras mounted on the crawler and area-view cameras provided location information. The plates were scanned, results were recorded and C-Scan, B-Scan side and end views were provided to the analysis team.

The American Society for Mechanical Engineers (ASME) Section V, Article 4 was used as the basis for SAIC's ultrasonic procedure. The process used by PNNL for analyzing the PDT data and system performance was based on the approach described in ASME, Section XI, Appendix VIII. This process is designed as a screening criteria for evaluating system performance based on probability of detection (POD) and accuracy of sizing.

There were 30 machined defects and laboratory grown stress corrosion cracks in the five plates used for the PDT. SAIC detected all 30 defects and cracks but recorded one false call. Analysis of the detection performance indicates that the system has a 90% POD with 95% confidence for defects used in the PDT. The error in measuring wall thinning type defects was 0.0028" RMS (criteria +/- 0.01 inches). The error for crack depth measurement was 0.093" RMS. Based on the SOW, this is acceptable as the criteria established was +/- 0.1-inch. After analyzing the system performance in POD, false call probability (FCP) and depth sizing, the conclusion reached was that the system has the capability for reliable and accurate measurement of anomalies in Hanford's double-shell tank.

Double-Shell Performance Demonstration Tests (PDT)

On August 5, 1996, Westinghouse Hanford Company issued a Request for Proposal (RFP) WA25652-AA for the nondestructive evaluation (NDE) of double-shell waste storage tanks at the Hanford Site in Richland, WA. The successful bidder was to provide all design, materials, services, equipment, labor and documentation to safely perform the examination in accordance with specifications in the statement of work (SOW).

1.0 Highlights of Statement of Work

The aim of the nondestructive examination was to demonstrate that an ultrasonic procedure could effectively and accurately detect and size anomalies that might be present in the straight sections of the vertical walls of the double-shell tanks at Hanford. However, before proceeding with the field examination, the supplier was required to complete a performance demonstration test (PDT) at the double-shell mock-up facility at the 337 Building in the 300 Area to demonstrate that their system could meet established specifications. A system was defined as including the equipment, procedure and personnel. Specifications for the PDT included the detection and sizing of:

a. Pits	ability to size depths within +/- 0.050 inches
b. Thinning	variable thickness - ability to measure thickness within +/- 0.010 inches
c. Cracks	ability to detect and size the depth of cracks at the inner wall surface within +/- 0.10 inches
d. Location	locate anomaly within +/- 1 inch.

Westinghouse was responsible for developing and providing reference plates with known defects simulating wall thinning, pitting, and laboratory grown stress corrosion cracks that were to be used for the performance demonstration tests.

Examinations were to be performed in accordance with procedures developed from the American Society for Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section V, Article 4, "Ultrasonic Examination Methods for Inservice Inspection," 1995 edition. The supplier was responsible for developing procedures for the ultrasonic examinations of the mock-up and tanks on the Hanford Site.

The goal for the examination of the double-shell tanks was to be able to detect pits with depth exceeding 25% of the wall thickness, wall thinning that exceeds 10% of plate thickness. The nominal thickness ranges from 0.5" to 0.875". The SOW also required detection of cracks on the inside wall of the tanks that exceed 0.18 inches in depth.

Personnel participating in the examination were to be certified in accordance with the recommended guidelines of the American Society for Nondestructive Testing's SNT-TC-1A-92. Prior to the examination, the supplier was required to provide documentation describing their personnel qualification practice and document the qualifications of all personnel who would participate in the PDT and potentially in the actual inspection of the double-shell tanks.

A copy of the Westinghouse Hanford Request for Proposal and the SAIC response is included in Appendix B. SAIC Company Practice and Personnel Qualification appear in SAIC report titled, "Ultrasonic Inspection of Double Shell Tank (DST) 241-AW-103" dated December 6, 1996, SAIC Project 01-0286-04-7357-001. This report also contains detailed information describing the results of inspection of Tank 241-AW-103.

2.0 Means for Establishing System Performance Qualification

The methodology used to develop POD, FCP and sizing performance demonstration requirements, as specified in ASME Section XI, Appendix VIII, was used for the PDT. In Appendix VIII, an inspection system is defined as including equipment, procedure and personnel used for the PDT. The evaluation of a system's performance is based on complex equations which include the number of defects in the sample base, the number of defects detected and the number of false calls reported. The procedure for screening inspection systems is not a direct measure of system capability; however, the data obtained can be used to establish the POD, sizing capability and the confidence level for the inspection. While this Appendix does not specifically address inspection of large tanks such as the double-shell tanks at Hanford, it does define a screening process for evaluating the capability of an ultrasonic system for performing such inspections.

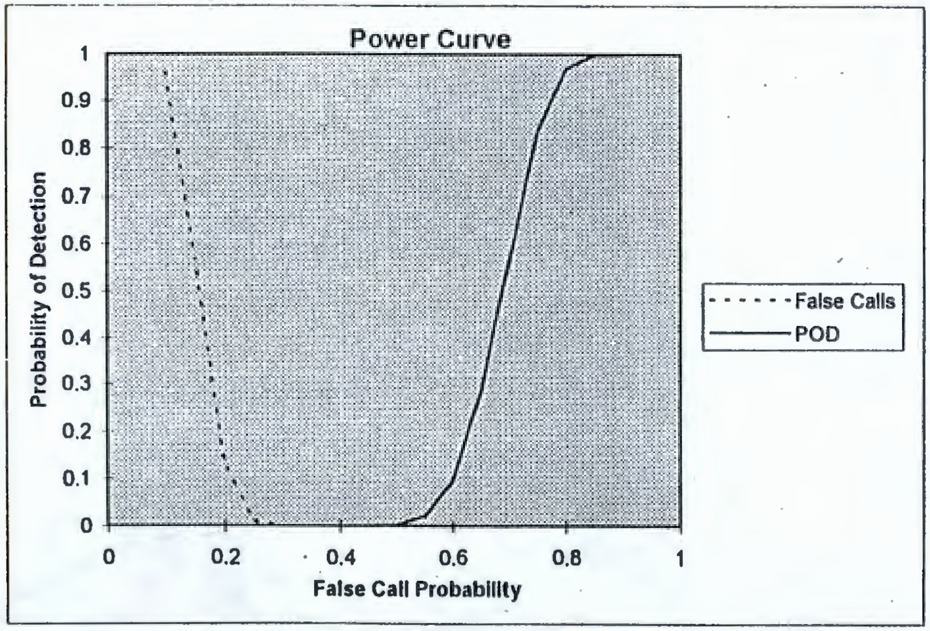
Ten plates containing mechanically simulated pits, wastage and laboratory grown stress corrosion cracks (SCC) were made available for the PDT. The size and dimensions of these flaws were established through measurements made by Pacific Northwest National Laboratory (PNNL). In defining the analysis process for the PDT, PNNL placed equal weight on detection of pits, wastage and stress corrosion cracks in the specimen plates. In accordance with the SOW, the PDT had to be successfully completed before the system could be used for inspections of the double-shell tanks.

The Section XI, Appendix VIII analysis procedure is based on statistical calculations and models that have been developed through many years of study. In the case of the double-shell tank, the number of specimens and the number of flaws in these specimens is relatively small, but it was still large enough to evaluate the performance capability of an inspection system in accordance with this section of the ASME Code. There are two separate conditions that must be met in the screening analysis for the inspection system:

- POD/False Call Probability (FCP) relationship
- capability of the inspection system to size pits, wastage and the depth of stress corrosion cracks.

An example of the analysis process for the POD/FCP relationship is described in Figure No. 1, Page 3A. The calculations are based on a 70% minimum screening guideline. To obtain the data in this figure, a grid matrix is set-up which contains 50 flaws and 100 blank grading units.

N	*X*	*POD*	*PWR (POD)*	*S*	*Y*	*FCP*	*PWR(FCP)*
50	35	0.1	4.8582E-24	100	15.	0.1	0.9601094
		0.15	3.0885E-18			0.15	0.5683151
		0.2	3.0338E-14			0.2	0.1285055
		0.25	2.9519E-11			0.25	0.0110833
		0.3	6.482E-09			0.3	0:000405
		0.35	4.9622E-07			0.35	6.691E-06
		0.4	1.709E-05			0.4	5.073E-08
		0.45	0.00031052			0.45	1.716E-10
		0.5	0.00330022			0.5	2.413E-13
		0.55	0.02195068			0.55	1.254E-16
		0.6	0.0955017			0.6	2.015E-20
		0.65	0.2801044			0.65	7.685E-25
		0.7	0.56917834			0.7	4.667E-30
		0.75	0.83691669			0.75	2.401E-36
		0.8	0.9691965			0.8	3.643E-44
		0.85	0.99805033			0.85	0
		0.9	0.9999826			0.9	0
		0.95	1			0.95	0
		1	1			1	0



Pro Passing= PWR(POD) x PWR(FCP)

Examples

PWR(POD)	*PWR(FCP)*	*Pro Passing*
70%	*20%*	*7%*
85%	*10%*	*96%*

Figure No. 1 Example of ASME Power Curve, Calculation and Plot for a Test Involving 50 Defects (Flaw Grading Units) and 100 Blank Grading Units

If the inspection system had a 70% POD and a 20% FCP, the probability that the system could pass the test would be only 7% (0.569 X 0.128). If the system had a POD of 85% and a 10% FCP, the probability of passing the PDT would be 96% (0.998 X 0.96). This performance is typical of what is accepted in industry. The example illustrates the discrimination capability of the power curves used in developing the criteria for the PDT. Actual PDT results are given in Section 4.0.

Summarizing the detection and sizing criteria defined in the SOW: wall thinning accuracy of +/- 0.010 inches, pit depth accuracy of +/- 0.05 inches and crack depth sizing accuracy to be within +/- 0.1 inches. Appendix VIII also describes an equation for depth sizing which is based on RMS values derived from the measured flaw depth, true flaw depth and the number of flaws measured. The PDT is designed to screen out systems which do not fulfill requirements for the inspection of the double-shelled tank.

3.0 Details of the Performance Demonstration Tests

3.1 Plates Used in the PDT

Five plates were used in the PDT. These plates were 14.5 by 21.5 inches, and all defects and stress corrosion cracks were located within an area 12 by 15 inches.

- <u>Plate A (0.875-inch thick)</u> Seven round-bottom drill holes in this plate were used in the PDT. They ranged in size from 0.375 to 1.22 inches in diameter and from 0.216 to 0.583 inches in depth.
- <u>Plate B (0.875-inch thick)</u> Three stress corrosion cracks in this plate were used in the PDT. They ranged in depth from 0.16 to 0.33 inches.
- <u>Plate C (0.5-inch thick)</u> Eight of the round-bottom drill holes were used in the PDT. They ranged in size from 0.199 to 0.745 inches in diameter and from 0.103 to 0.375 inches in depth.
- <u>Plate D (0.875-inch thick)</u> Three stress corrosion cracks in this plate were used in the PDT. They ranged in depth from 0.3 to 0.43 inches.
- <u>Plate E (0.875-inch thick)</u> Nine of the simulated wastage machined cutouts were used in the PDT. The remaining wall thicknesses ranged from 0.068 to 0.630 inches.

3.2 Deployment of the Plates

A cutout the size of the plates was machined in the wall of the double-shell mockup, and a bracket was fabricated for holding the plates during the PDT. The defects in the plates were covered with a thin aluminum sheet and were not visible to the inspection team. The plates were located about six feet above the floor of the tank and about two feet to the side of the hole below the 24-inch riser. The magnetic crawler was deployed through the riser and maneuvered over the test plate. This arrangement simulated conditions that might be present in the tanks.

3.3 Performance Demonstration Tests

With the plates placed in the wall cutout, the remote magnetic-wheel crawler was deployed through the 24-inch riser in the mockup. In accordance with the SAIC procedure, the crawler was maneuvered above the test plate and the plate was scanned as the crawler moved downward across the plate. Water was used as a couplant and a water-gap technique was used to minimize the amount of water required. The zero and angle beam transducers were scanned over the plate in a 20-inch wide swath. Pixel size was 0.07 x 0.07 inches. A scan protocol from top to bottom was used to ensure wetting of the surface. Each of the five plates were scanned, and SAIC staff used A-scan and C-scan as well as side and end scans to provide their technical evaluation of each anomaly.

4.0 Results of the Performance Demonstration Tests

Hard copy interpretation and color plots of the P-Scan System data were generated by SAIC. The results are shown in Figures No. 2 and 3 on pages 5 A and B, and the calculations are shown on Page 5 C.

Figure No. 2	Power Curve (per ASME Section XI, Appendix VII) used to evaluate system performance based on the 30 defects in the test plates
Figure No. 3	Comparison between PNNL (true state) and SAIC measured value and graphs of results of pits/wall thinning and crack depth measurements
Page 5 C	Calculations for POD and confidence bound.

The system used by SAIC (P-Scan equipment, procedure and personnel) performed very well. The system POD was 90% with a 95.8% confidence bound. The error in pit/wastage sizing was 0.0028 RMS. The error in crack depth measurement was 0.0933 RMS. The crack depth measurement error, which is close to the limit defined in the specification, is the result of under sizing one of the six cracks in the test plates.

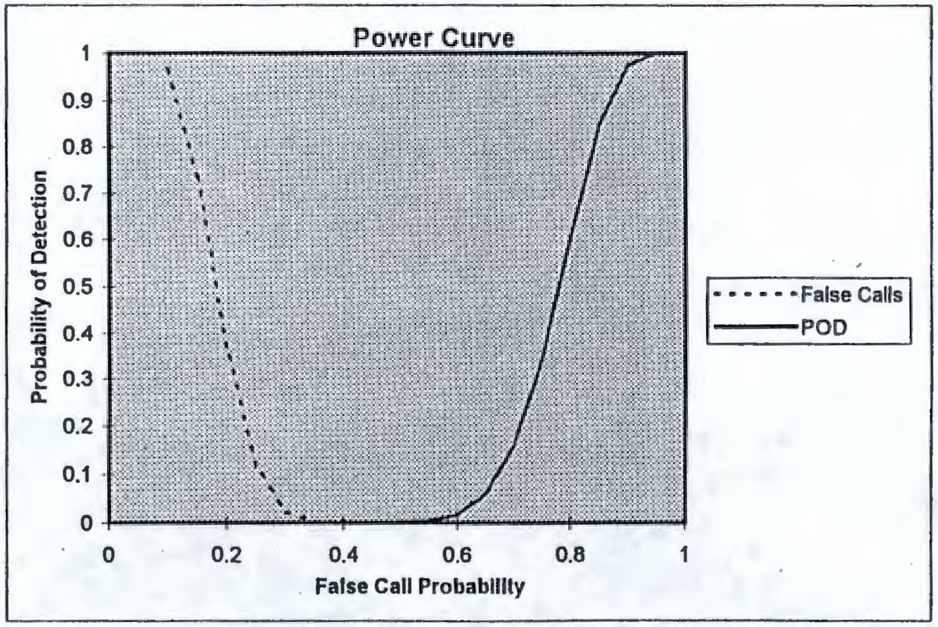
5.0 Information Provided by SAIC

SAIC provided the following results for evaluation by the PNNL team:

- Screen Height and Amplitude Linearity Tests for the Ultrasonic Equipment
- System Thickness and Sizing Calibration Test Sheets
- Thickness and sizing reports and calculated data from each of the 5 test plates

Records of data provided are given in Appendix A. These results were used in generating the data and conclusions describing the performance of the demonstration tests. Plots are provided by PNNL describing the actual location of each of the anomalies in the plates. To compare SAIC and PNNL plots, position the fiducial mark from the plate with the mark on the SAIC plots. There are two types of plots shown. The T-Scan plots are thickness plots while the P-Scan plots are 45 degree angle beam plots.

N	*X*	*POD*	*PWR (POD)*	*S*	*Y*	*FCP*	*PWR(FCP)*
30	24	0.1	3.2415E-19	53	9	0.1	0.9645224
		0.15	3.9351E-15			0.15	0.7340294
		0.2	2.776E-12			0.2	0.364317
		0.25	4.0751E-10			0.25	0.1143638
		0.3	2.1937E-08			0.3	0.0232894
		0.35	5.8488E-07			0.35	0.0031418
		0.4	9.2223E-06			0.4	0.0002817
		0.45	9.6223E-05			0.45	1.651E-05
		0.5	0.00071545			0.5	6.104E-07
		0.55	0.00398466			0.55	1.339E-08
		0.6	0.01718302			0.6	1.59E-10
		0.65	0.05857212			0.65	8.922E-13
		0.7	0.159523			0.7	1.924E-15
		0.75	0.34805426			0.75	1.151E-18
		0.8	0.60696989			0.8	1.101E-22
		0.85	0.84741908			0.85	5.955E-28
		0.9	0.97417331			0.9	1.756E-35
		0.95	0.99942654			0.95	0
		1	1			1	0



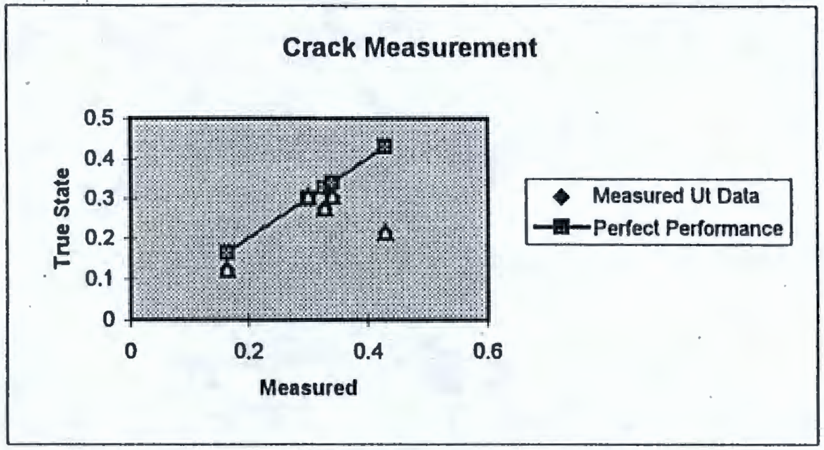
Pro Passing= PWR(POD) x PWR(FCP)

Examples

PWR(POD)	*PWR(FCP)*	*Pro Passing*
70%	*20%*	*6%*
85%	*10%*	*82%*

Figure No. 2 ASME Power Curve Developed for Performance Demonstration Tests

Wastage				Cracks			
True State	*Meas. UT*	*Diff^2*	*RMS*	*True State*	*Meas. UT*	*Diff^2*	*RMS*
0.345	0.331	0.000196	0.002858	0.163	0.123	0.0016	0.093352
0.224	0.211	0.000169		0.327	0.275	0.002704	
0.42	0.411	8.1E-05		0.3	0.304	0.000016	
0.345	0.331	0.000196		0.3	0.304	0.000016	
0.216	0.199	0.000289		0.34	0.304	0.001296	
0.583	0.579	0.000016		0.43	0.214	0.046656	
0.253	0.255	4E-06				0.052288	
0.125	0.13	0.000025					
0.103	0.106	9E-06					
0.152	0.17	0.000324					
0.375	0.418	0.001849					
0.353	0.274	0.006241					
0.175	0.174	0.000001					
0.204	0.206	4E-06					
0.176	0.166	1E-04					
0.058	0.148	0.0081					
0.063	0.156	0.008649					
0.068	0.168	0.01					
0.505	0.504	0.000001					
0.5	0.512	0.000144					
0.495	0.52	0.000625					
0.63	0.632	4E-06					
0.625	0.636	0.000121					
0.62	0.644	0.000576					



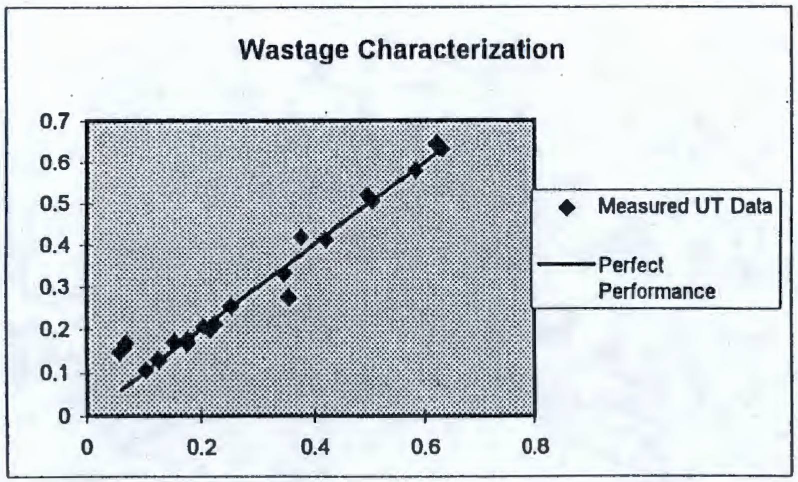


Figure No. 3 Comparison Between PNNL and SAIC Measurements and Graphs of Pit/Wastage and Crack Measurements

$n := 30 \quad x := 30 \quad s := x..n$

$P := 0.90$

$$c := 1 - \sum_{s=x}^{n} \frac{n!}{x! \cdot (n-x)!} \cdot P^x \cdot (1-P)^{n-x}$$

This simple analysis provides the lower confidence bound for POD where:

n = number of flawed grading units
x = number of flawed grading units detected
P = Probability of Detection of Ultrasonic system
c = Confidence bound

$c = 0.958 \quad \text{for} \quad P = 0.9$

$P := 0.9$

$$c1 := 1 - \sum_{s=x}^{n} \frac{n!}{x! \cdot (n-x)!} \cdot P^x \cdot (1-P)^{n-x}$$

$c1 = 0.958$

$c1 = 0.958 \quad P = 0.9$

Calculations for POD and Confidence Bound

In practice, defects and anomalies detected by the T-Scan were also evaluated with angle beam insonification. Note that the color plots are not used for measuring wall thickness or depth of pits. Since the P-Scan system records all data and holds it in electronic memory, post analysis of the A-Scan provides the actual thickness and depth information. SAIC used B-Scan, C-Scan and end view B-Scan data to locate defects and anomalies, but used the A-Scan for interpretation of wall thinning and pit depth and used tip diffraction from angle beam inspection for estimating depth of stress corrosion cracks.

The individual data sheets provided by SAIC show that the system has a capability of measuring wastage within +/- 0.015 inches provided the remaining wall is more than 0.1 inches. The system did not accurately size simulated wastage in the test plate where the remaining wall was only 0.06 inches. Pits larger than 0.25-inch diameter and deeper than 0.1 inches were sized within +/- 0.04 inches which exceeded the specification of +/- 0.05 inches. Some smaller pits were detected, but 0.25-inch diameter was considered a minimum requirement. The system detected all cracks deeper than 20% of wall thickness and sized all but one quite accurately. This particular crack was undersized in depth but length was plotted accurately.

6.0 Conclusion

Analysis of the data shows the system has a capability of achieving a 90% probability of detection with a 95.8 % level of confidence. The results of the PDT were very good in that all machined defects and laboratory grown stress corrosion cracks were detected. Sizing was within the specification defined in the statement of work. Only one false call was recorded and, with the exception for the under sizing of one of the stress corrosion cracks, the crack sizing was well within specification. Use of this system for inspection of the double-shell tanks should provide reliable and reproducible data describing the presence and size of wastage, pits and cracks.

NOTE: Changes in equipment, procedure or personnel may require system re-qualification.

7.0 References

1. *Heasler, P. G., D. J. Bates, T. T. Taylor and S. R. Doctor, "Performance Demonstration Tests for Detecting Intergranular Stress Corrosion Cracking," NUREG/CR-4464, PNL-5705, November, 1985*

2. *1995 ASME Boiler and Pressure Vessel Code, Section XI, Appendix VIII*

MILESTONE M-32-00
PROJECT MANAGERS MEETING
January 23, 1997

Tank Selection
(handout)

Tank Selection

- Tanks have similar design and operating controls
- Potential degradation mechanisms identified
- Degradation rates are expected to be slow
- All tanks should be in good condition
- Inspections will check expectations for
  - slow corrosion rate
  - no other degradation mechanisms
- Selected tanks biased towards those we expect to be slightly more degraded

Tank Condition Information

- Laboratory tests
- Leak detection
- Visual examination
- In-tank component examination

  SY-101 instrument tree
  AZ-101 thermocouple tree

- AW-103 ultrasonic examination
- No aggressive attack observed

Tank Selection Bias

- Factors considered
  - Years of service
  - Temperature
  - Corrosion chemistry
  - Sludge height
  - Hydrogen release
  - Number of waste transfers
  - Waste level fluctuation
  - Type of steel

Selected Tanks

	Age	Temp	Chem	Sludge	H_2	Transfer	Level	Steel
AW-103				X				
AN-107			X					
AY-101	X	X	X					X
AY-102	X	X		X		X		X
AZ-101	X	X						X
SY-101		X			X		X	X

Meeting Minutes
Interim Status Dangerous Waste Tank Systems
Hanford Federal Facility Agreement and Consent Order
Milestone M-32-00

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