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Ultrasonic Examination of Double-Shell Tank 241-AP-104 Examination Completed February 2005

A.F. Pardini
G.J. Posakony

March 2005

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Summary

COGEMA Engineering Corporation (COGEMA), under a contract from CH2M Hill Hanford Group (CH2M Hill), has performed an ultrasonic nondestructive examination of selected portions of Double-Shell Tank 241-AP-104. The purpose of this examination was to provide information that could be used to evaluate the integrity of the wall of the primary and secondary tank. The requirements for the ultrasonic examination of Tank 241-AP-104 were to detect, characterize (identify, size, and locate), and record measurements made of any wall thinning that might be present in the wall of the primary tank in the upper knuckle region, and any wall thinning, pitting, or cracks in the wall of the secondary tank in the lower knuckle region. Any measurements that exceed the requirements set forth in the Engineering Task Plan (ETP), RPP-22571 (Jensen 2004) and summarized on page 1 of this document, are reported to CH2M Hill and the Pacific Northwest National Laboratory (PNNL) for further evaluation. Under the contract with CH2M Hill, all data is to be recorded on disk and paper copies of all measurements are provided to PNNL for third-party evaluation. PNNL is responsible for preparing a report that describes the results of the COGEMA ultrasonic examinations.

Examination Results

The results of the examination of Tank 241-AP-104 have been evaluated by PNNL personnel. The ultrasonic examination consisted of approximately 15-ft. of the upper knuckle of the primary tank in the circumferential direction. The examination also consisted of approximately 20-ft. of the lower knuckle of the secondary tank in the circumferential direction. The examination was performed to detect any wall thinning, pitting, or cracking in the primary and secondary tank wall.

Primary Tank Wall Upper Knuckle Scan Path

Two approximately 12-in.-wide by 15-ft.-long circumferential scan paths (one above the other) were performed on the upper knuckle of the primary tank. The upper knuckle was examined for wall thinning on the primary tank wall. There were no areas of wall thinning that exceeded the reportable level of 10% of the nominal thickness in the upper knuckle of the primary tank wall.

Secondary Tank Wall Lower Knuckle Scan Path

One approximately 12-in.-wide by 20-ft.-long circumferential scan path was performed on the lower knuckle of the secondary tank. The lower knuckle was examined for wall thinning, pitting, and cracks oriented horizontally on the secondary tank wall. There were no areas of wall thinning that exceeded the reportable level of 10% of the nominal thickness. No pitting or crack-like indications were detected in the lower knuckle of the secondary tank wall.

Contents

Figures

1.0 Introduction

COGEMA Engineering Corporation (COGEMA), under a contract from CH2M Hill Hanford Group (CH2M Hill), has performed an ultrasonic nondestructive examination (UT) of selected portions of Double-Shell Tank (DST) 241-AP-104. The purpose of this examination was to provide information that could be used to evaluate the integrity of the DST. The requirements for the UT of Tank 241-AP-104 were to detect, characterize (identify, size, and locate), and record measurements made of any wall thinning that might be present in the wall of the primary tank in the upper knuckle region, and any wall thinning, pitting, or cracks in the wall of the secondary tank in the lower knuckle region. Any measurements that exceed the requirements set forth in the Engineering Task Plan (ETP), RPP-22571 (Jensen 2004), are reported to CH2M Hill and the Pacific Northwest National Laboratory (PNNL) for further evaluation. Specific measurements that are reported include the following:

- Wall thinning that exceeds 10% of the nominal thickness of the shell course plate.
- Pits with depths that exceed 25% of the nominal shell course plate thickness.
- Stress-corrosion cracks that exceed 0.10-in. (through-wall) that are detected in the inner wall of the tank, heat-affected zone (HAZ) of welds, or in the tank knuckle.

The accuracy requirements for ultrasonic measurements for the different types of defects are as follows:

- Wall thinning – measure thickness within ±0.020-in.
- Pits – size depths within ±0.050-in.
- Cracks – size the depth of cracks on the inner wall surfaces within ±0.1-in.
- Location – locate all reportable indications within ±1.0-in.

Under the contract with CH2M Hill, all data is to be recorded on disk and paper copies of all measurements are provided to PNNL for third-party evaluation. PNNL is responsible for preparing a report that describes the results of the COGEMA UT.

2.0 Qualified Personnel, Equipment, and Procedure

Qualification of personnel participating in the DST inspection program, the UT equipment (instrument and mechanical scanning fixture), and the UT procedure that will be used in the examination of the current DST is required by CH2M Hill. Personnel participating in the examinations are to be certified in accordance with the American Society for Nondestructive Testing (ASNT) Guideline SNT-TC-1A-92 and associated documentation is to be provided. The capability of the UT system, personnel, and procedure is to be validated through a performance demonstration test (PDT) administered by PNNL on a mock-up simulating the actual DST. The current procedure for the UT is to be based on the Section V, Article 4, *Boiler and Pressure Vessel Code* defined by the American Society for Mechanical Engineers (ASME).

2.1 Personnel Qualifications

The following individuals were qualified and certified to perform UT of the Hanford DST 241-AP-104:

- **Mr. Wesley Nelson**, ASNT Level III (#LM-1874) in UT, has been identified as COGEMA's UT Level III authority for this project. Mr. Nelson has been certified by COGEMA as a UT Level III in accordance with COGEMA procedure COGEMA-SVCP-PRC-014, latest revision. Further documentation has been provided to establish his qualifications. Reference: Letter from PNNL to C.E. Jensen dated August 22, 2000, "Report on Performance Demonstration Test – PDT, May 2000."

- **Mr. James B. Elder**, ASNT Level III (#JM-1891) in UT, has been contracted by COGEMA to provide peer review of all DST UT data. Mr. Elder has been certified by JBNDT as a UT Level III in accordance with JBNDT written practice JBNDT-WP-1, latest revision. Further documentation has been provided to establish his qualifications. Reference: PNNL-11971, *Final Report - Ultrasonic Examination of Double-Shell Tank 241-AN-107*.

- **Mr. William D. Purdy**, COGEMA UT Level II limited (for P-Scan data acquisition only). Mr. Purdy has been certified in accordance with COGEMA procedure COGEMA-SVCP-PRC-014, latest revision. Further documentation has been provided to establish his qualifications. Reference: Letter from PNNL to C.E. Jensen dated October 5, 2001, "Purdy Performance Demonstration Test (PDT) Report."

2.2 Ultrasonic Examination Equipment

CH2M Hill has provided the UT equipment for the examination of Tank 241-AP-104. This equipment consists of a Force Institute P-Scan ultrasonic test instrument and a Force Institute AWS-5D remote-controlled, magnetic-wheel crawler for examining the primary and secondary tank wall. Examination of Tank 241-AP-104 included utilization of the Y-arm (extended arm) scanning bridge. Ultrasonic transducers used for the examinations are commercial off the shelf. The P-Scan ultrasonic system has been qualified through a PDT administered by PNNL. Reference: PNNL-11971, *Final Report- Ultrasonic Examination of Double-Shell Tank 241-AN-107* and letter from PNNL to C.E. Jensen dated September 21, 2001, "Qualification of the Y-Arm Attachment".

2.3 Ultrasonic Examination Procedure

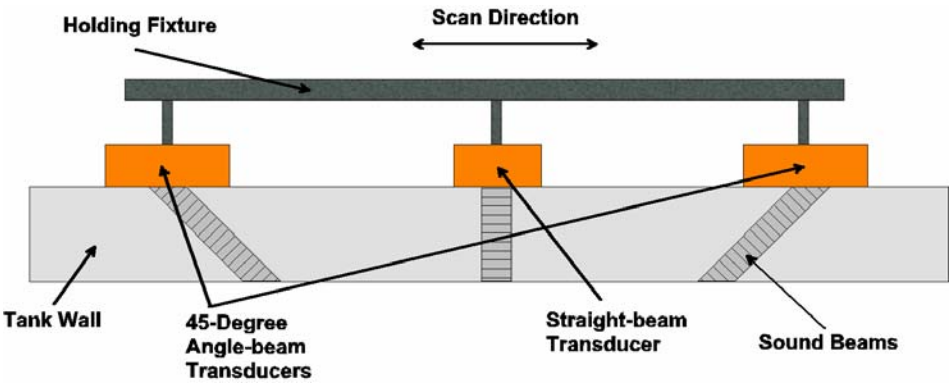
COGEMA has provided the UT procedure for the examination of Tank 241-AP-104. This procedure, COGEMA-SVUT-INS-007.3, Revision 2, outlines the type of UT and mechanical equipment that are to be used as well as the types of transducers. Both straight-beam and angle-beam transducers are used for the examination of the primary and secondary tank wall. The examination procedures include full documentation on methods for calibration, examination, and reporting. Hard copies of the T-Scan (thickness) and P-Scan (projection or angle beam) views of all areas scanned are made available for analysis. The UT procedure requires the use of specific UT transducers for the different examinations. A calibration performed before and after the examinations ensures that each transducer used in the inspection is adjusted and that the entire system is performing correctly. The COGEMA UT procedure has been qualified through a PDT. Revisions to the procedure are reviewed to determine if a further PDT is required. Reference: PNNL-11971, *Final Report - Ultrasonic Examination of Double-Shell Tank 241-AN-107*.

3.0 Ultrasonic Examination Configuration

COGEMA is required to inspect selected portions of the DSTs which may include the primary and secondary tank walls, the HAZ of the primary tank vertical and horizontal welds, and the tank knuckle and bottoms. The P-Scan system has been configured to perform these examinations and has been performance tested. The examination of Tank 241-AP-104 included UT of the primary tank wall in the upper knuckle region, and the wall of the secondary tank in the lower knuckle region.

3.1 Primary and Secondary Tank Wall Transducer Configuration

Figure 3.1 provides an example of the scanning configuration generally used during an examination of the primary and secondary tank walls. However, other configurations can be used at the discretion of the COGEMA UT Level III (i.e., 45-degree transducers can be removed for simple wall thickness measurements). The functional diagram in Figure 3.1 shows one straight-beam and two angle-beam transducers ganged together for examining the tank wall. The straight beam is designed to detect and record wall thinning and pits, and the angle beams are designed to detect and record any cracking that may be present. These transducers are attached to the scanning bridge and they all move together. Information is captured every 0.035-in. (or as set by the NDE inspector) as the assembly is scanned across a line. At the end of each scan the fixture is indexed 0.035-in. (or as set by the NDE inspector) and the scan is repeated. The mechanical scanning fixture is designed to scan a maximum of 15-in. and then index for the next scan. The hard copy provides a permanent record that is used for the subsequent analysis.



Transducer Specifications:

Straight-Beam
Type: SDC-5
Frequency: 5 MHz
Size: Dual - 4 X 8 mm
Manufacturer: Sigma

Straight-Beam
Type: MSEB 5B
Frequency: 5 MHz
Size: Dual - 2 X 8 mm
Manufacturer: Krautkramer

Angle-Beam
Type: MWB-45 04E
Frequency: 4 MHz
Size: 8 X 9 mm
Manufacturer: Krautkramer

Figure 3.1. Transducer Configuration for Examining the Tank Wall

3.2 Primary Tank Upper Knuckle Examination

Examination of the upper knuckle region of the primary tank utilized a modified scanning bridge known as the Y-arm scanner. The Y-arm provides scanning of the transducers directly on the upper knuckle region. The Y-arm is a special fixture that attaches to the AWS-5D magnetic wheel crawler. Its purpose is to extend the reach of the transducer assembly. This extension allows the transducer assembly to follow the curve of the portion of the upper knuckle above shell course #1. It is designed to hold the dual 0-degree or two 45-degree transducers in the same configuration as used for the examination of the tank wall. The transducer configuration used in this upper knuckle examination was a dual 0-degree transducer.

Figure 3.2 shows the area of the section of the upper knuckle examined using the Y-arm fixture. With the transducer positioned 1-in. above the shell course #1 to knuckle weld, the scanning bridge was set to scan the transducer upward a distance of approximately 12-in. in 0.035-in steps (or as set by the operator). Upon completion of the scan, the crawler was indexed circumferentially 0.035-in. (or as set by the operator) and the scan upward is repeated to obtain a pixel size 0.035-in. x 0.035-in. (or as set by the operator). Approximately 15-ft. was scanned in the circumferential direction for this 1st scan. The crawler and scanner were repositioned to scan an additional 12-in. above the first scan. This 2nd scan was also approximately 15-ft. in the circumferential direction.

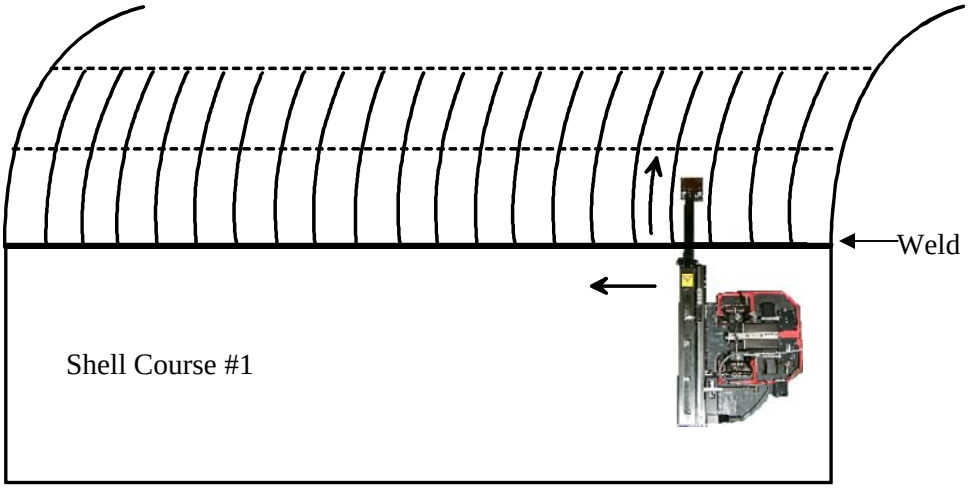


Figure 3.2. Scanning of the Primary Tank Upper Knuckle

3.3 Secondary Tank Lower Knuckle Examination

Examination of the lower knuckle region of the secondary tank utilized the same Y-arm scanner that was used on the upper knuckle examination of the primary tank. The Y-arm provides scanning of the transducers directly on the lower knuckle region. The Y-arm is a special fixture that attaches to the AWS-5D magnetic wheel crawler. Its purpose is to extend the reach of the transducer assembly. This extension allows the transducer assembly to follow the curve of the portion of the lower knuckle below shell course #5. It is designed to hold the dual 0-degree or two 45-degree transducers in the same

configuration as used for the examination of the tank wall. The transducer configuration used in the examination of the secondary tank lower knuckle region for wall thinning and pits was a single dual-element straight beam transducer. The transducer configuration used for crack detection in this examination was two opposing 45-degree angle-beam transducers that were rotated 90-degrees from the orientation used for the wall crack inspection. This configuration is designed to detect cracks that are in a circumferential direction with respect to the axis of the tank.

Figure 3.3 shows the area of the section of the lower knuckle examined using the Y-arm fixture. With the transducer positioned 1-in. below the shell course #5 to knuckle weld, the scanning bridge was set to scan the transducer downward a distance of approximately 12-in. in 0.035-in steps (or as set by the operator). Upon completion of the scan, the crawler was indexed circumferentially 0.035-in. (or as set by the operator) and the scan downward is repeated to obtain a pixel size 0.035-in. x 0.035-in. (or as set by the operator). Approximately 20-ft. was scanned in the circumferential direction. It should be noted that the Y-arm fixture was designed to examine the primary tank knuckle and is made with a spring steel arm which is curved for the primary knuckle. Application on the secondary knuckle bends the spring steel arm away from its normal operational angle creating a slight error in radial position. This radial position error was accounted for in the UT data report.

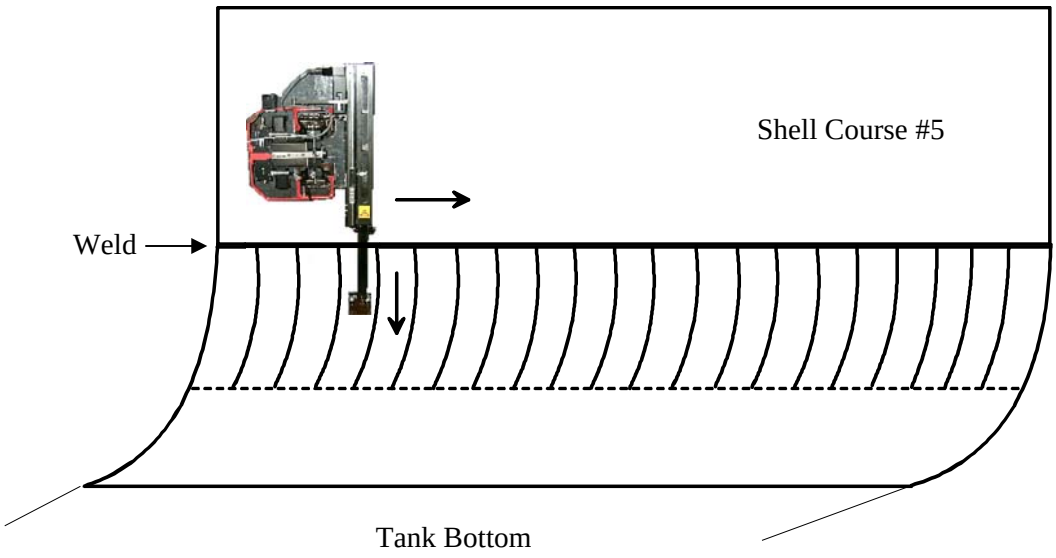


Figure 3.3. Scanning of the Secondary Tank Lower Knuckle

4.0 Ultrasonic Examination Location

Tank 241-AP-104 is located in the Hanford 200 East area in AP Tank Farm. The crawler and associated scanner that hold the transducers were lowered into the 24-in. riser located on the east side of 241-AP-104 and designated as Riser 30. Figure 4.1 provides a graphic of the location of this riser.

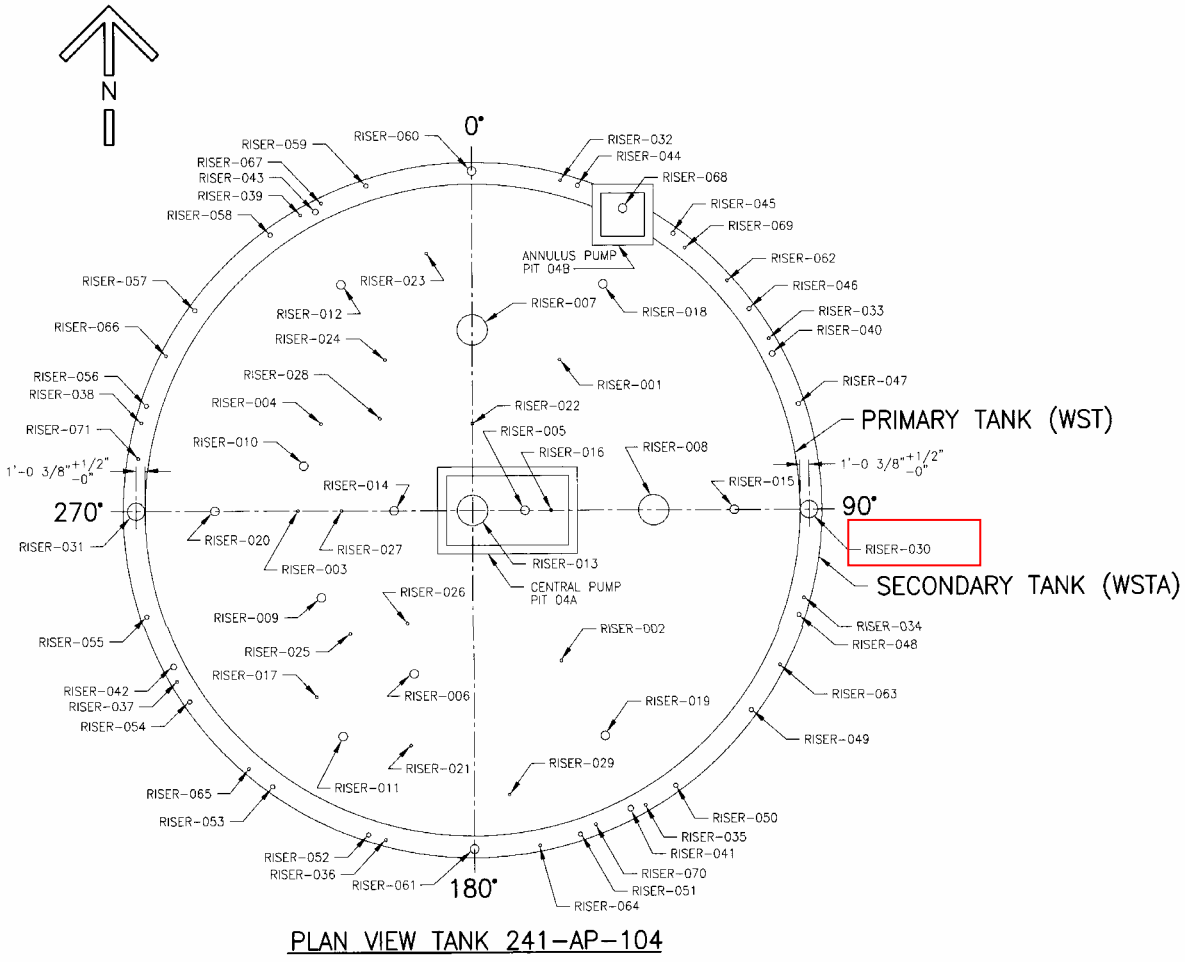


Figure 4.1. UT of 241-AP-104 from Riser 30

Figures 4.2 and 4.3 describe the areas on the primary and secondary walls of Tank 241-AP-104 that were ultrasonically examined. Two approximately 12-in.-wide by 15-ft.-long circumferential scan paths (one above the other) were performed on the upper knuckle of the primary tank near Riser 30. One approximately 12-in.-wide by 20-ft.-long circumferential scan path was performed on the lower knuckle of the secondary tank below Riser 30.

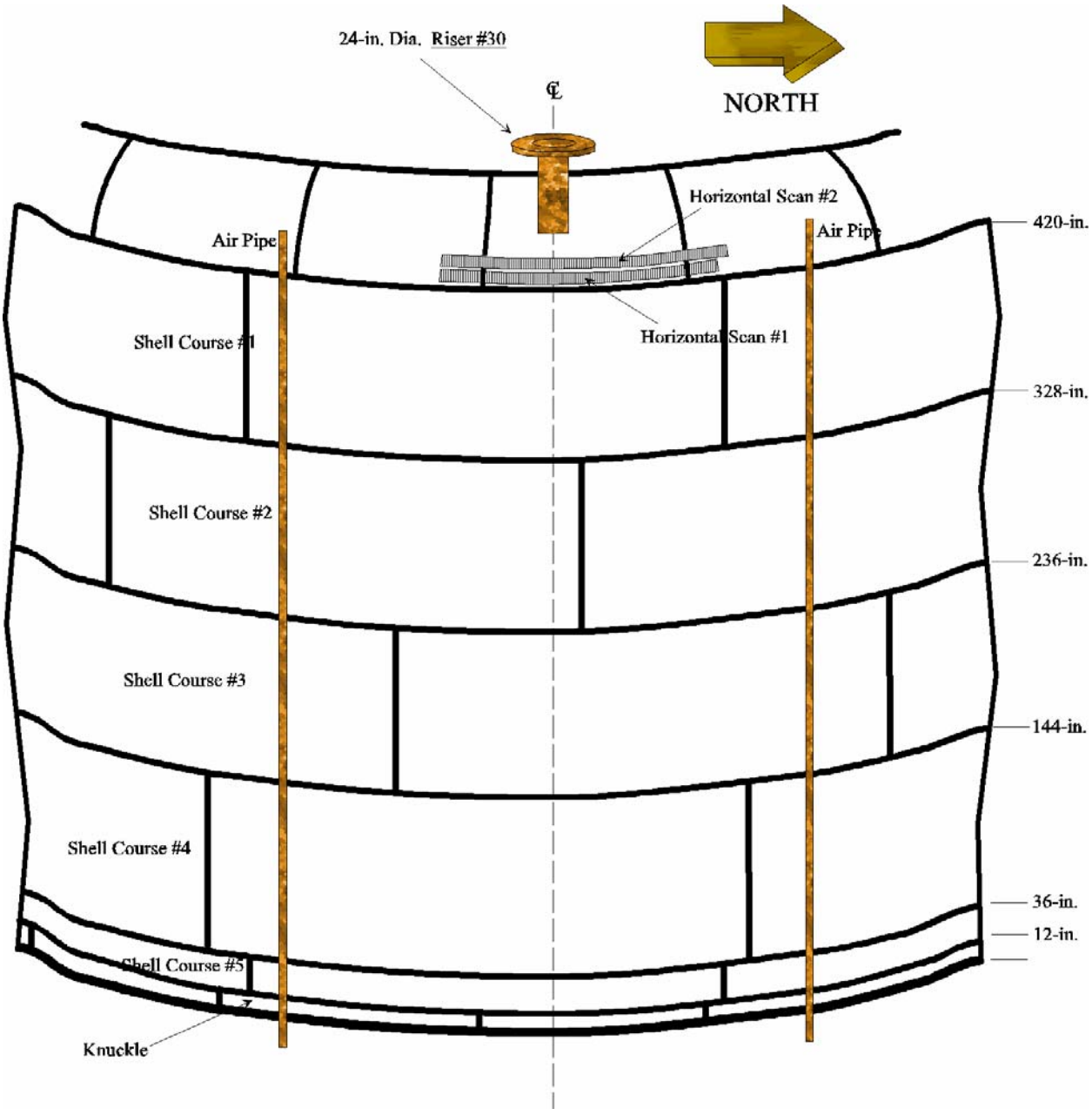


Figure 4.2. Sketch of Scan Paths on Tank 241-AP-104 Primary Tank Upper Knuckle

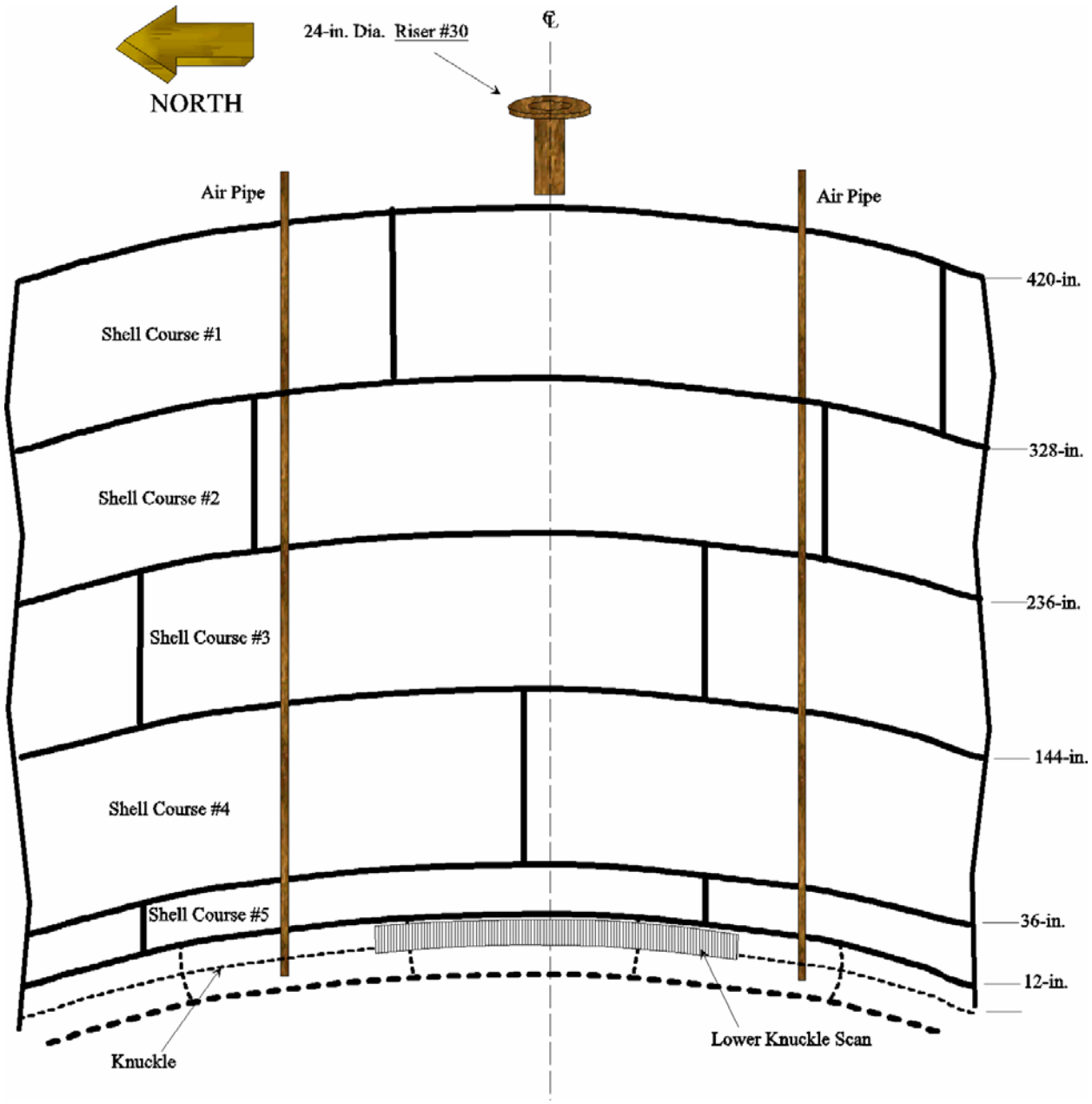


Figure 4.3. Sketch of Scan Paths on Tank 241-AP-104 Secondary Tank Lower Knuckle

5.0 Ultrasonic Examination Results

COGEMA has provided detailed reports including T-Scan and P-Scan hard copies of all areas that were ultrasonically examined to PNNL for third-party review. The data was analyzed by COGEMA Level III Mr. Wes Nelson and peer reviewed by JBNDT Level III Mr. Jim Elder. The results of the examination of Tank 241-AP-104 are presented in Figures 5.1 and 5.2.

Figure 5.1 shows the wall thickness examination results for the primary tank wall upper knuckle region. The examination consisted of two horizontal scan paths near the 24-in. diameter entrance riser #30. Horizontal scan #1 was approximately 12-in. wide beginning approximately 1-in. above the shell course #1 to upper knuckle weld. Horizontal scan #2 was approximately 12-in. wide beginning approximately 11-in. above the shell course #1 to upper knuckle weld.

Figure 5.2 shows the wall thickness examination results for the secondary tank wall lower knuckle region. The examination consisted of one horizontal scan path below the 24-in. diameter entrance riser #30. The horizontal scan was approximately 12-in. wide beginning approximately 1-in. below the shell course #5 to lower knuckle weld.

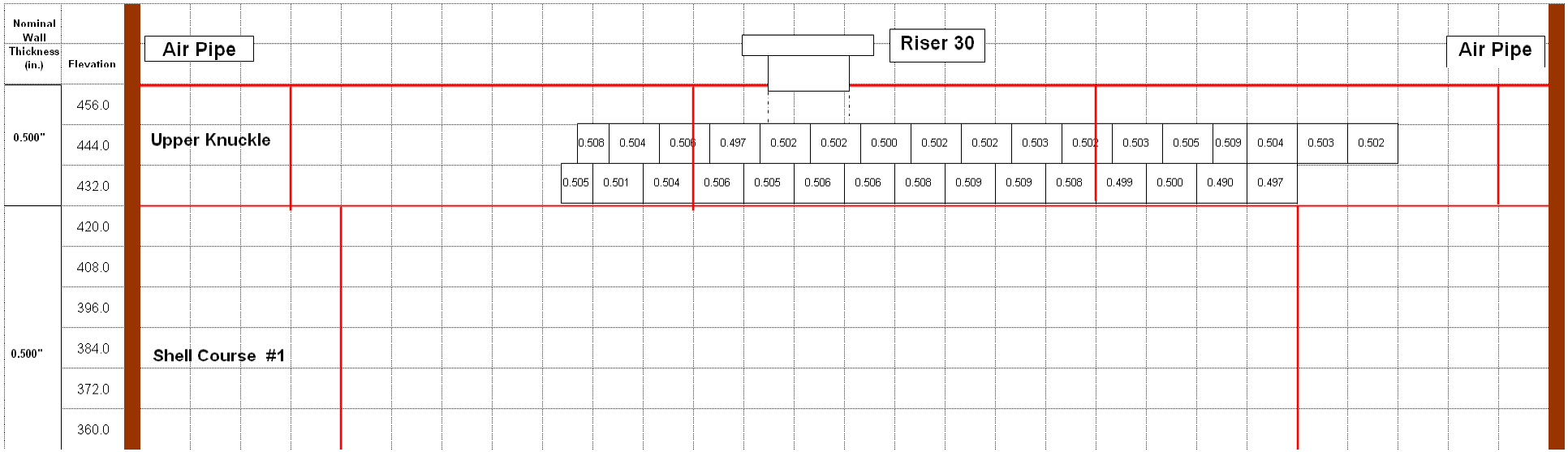


Figure 5.1. UT Data from Tank 241-AP-104 Primary Tank Upper Knuckle Region

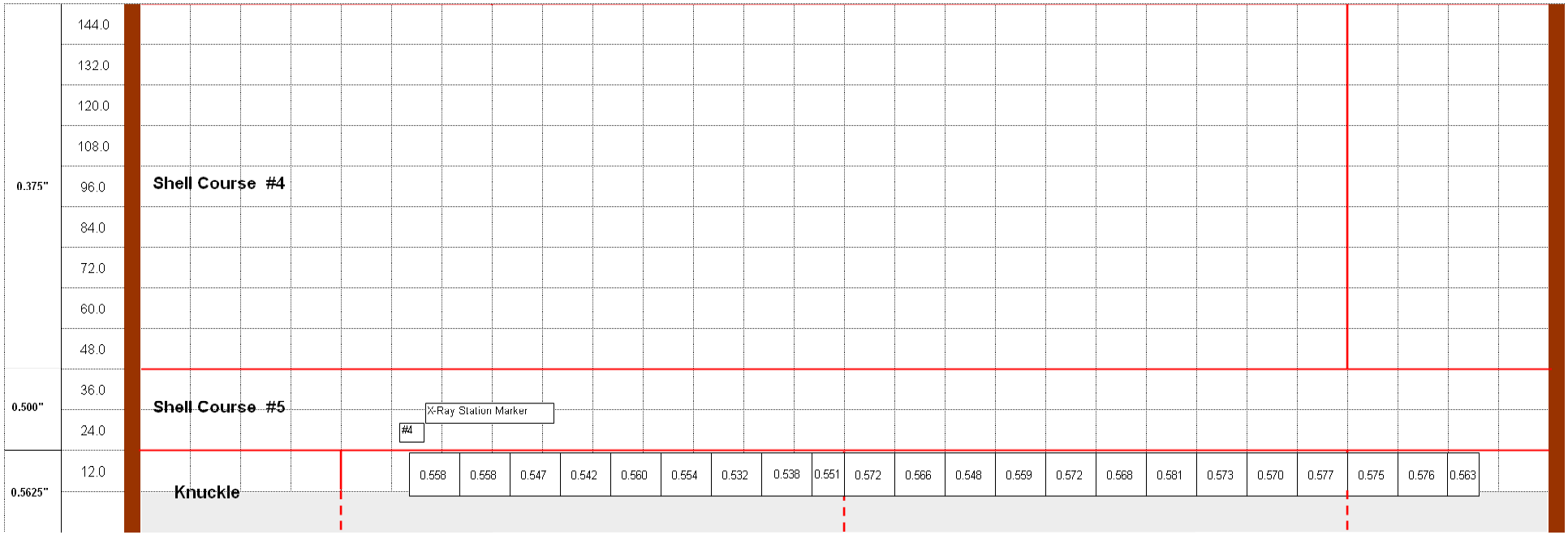


Figure 5.2 UT Data from Tank 241-AP-104 Secondary Tank Lower Knuckle Region

6.0 Conclusions

The results of the examination of Tank 241-AP-104 have been evaluated by PNNL personnel. The examination consisted of two approximately 12-in. wide horizontal scans on the upper knuckle of the primary tank and one horizontal scan on the lower knuckle of the secondary tank. The examination was performed to detect any wall thinning on the primary tank wall upper knuckle and to detect any wall thinning, pitting, or cracking in the secondary tank wall lower knuckle.

6.1 Primary Tank Wall Upper Knuckle Scan Path

Two approximately 12-in.-wide scan paths were performed on the upper knuckle of the primary tank above shell course #1. The upper knuckle was examined for wall thinning. The nominal thickness of the upper knuckle of the primary tank is 0.500-in. The results indicated that the minimum thickness in horizontal scan #1 was 0.490-in. The results indicated that the minimum thickness in horizontal scan #2 was 0.497-in. There were no areas of wall thinning that exceeded the reportable level of 10% of the nominal thickness.

6.2 Secondary Tank Wall Lower Knuckle Scan Path

One approximately 12-in.-wide scan path was performed on the lower knuckle of the secondary tank below shell course #5. The lower knuckle was examined for wall thinning, pitting, and cracks oriented circumferentially. The nominal thickness of the lower knuckle of the secondary tank is 0.5625-in. The results indicated that the minimum thickness in the horizontal scan was 0.532-in. There were no areas of wall thinning that exceeded the reportable level of 10% of the nominal thickness. No pitting or crack-like indications were detected.

7.0 References

Jensen, C. E., 2004, *Engineering Task Plan for the Ultrasonic Inspection of Hanford Double-Shell Tanks FY2005*, RPP-22571, Rev 0, September 2004, CH2M Hill Hanford Group, Inc., Richland, Washington.

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