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Pacific Northwest National Laboratory
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Ultrasonic Examination of Double-Shell Tank 241-AW-103 Examination Completed September 2006

AF Pardini
GJ Posakony

November 2006

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

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Pacific Northwest National Laboratory
Richland, Washington 99352

Summary

AREVA NC Inc. (AREVA), under a contract from CH2M Hill Hanford Group (CH2M Hill), has performed an ultrasonic examination of selected portions of Double-Shell Tank 241-AW-103. 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-AW-103 were to detect, characterize (identify, size, and locate), and record measurements made of any wall thinning, pitting, or cracks that might be present in the wall of the primary tank and the wall of the secondary tank. Any measurements that exceed the requirements set forth in the Engineering Task Plan (ETP), RPP-Plan-27202 (Jensen 2005) and summarized on page 1 of this document, are to be 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 electronic media and paper copies of all measurements are provided to PNNL for third-party evaluation. PNNL is responsible for preparing a report(s) that describes the results of the AREVA ultrasonic examinations.

Examination Results

The results of the examination of Tank 241-AW-103 have been evaluated by PNNL personnel. The primary tank ultrasonic examination consisted of two vertical 15-in.-wide scan paths over the entire height of the tank, the heat-affected zone (HAZ) of four vertical welds and one horizontal weld from Riser 29 and two vertical 15-in.-wide scan paths over the entire height of the tank from Riser 28. Additionally, two vertical 15-in.-wide scan paths over the entire height of the secondary tank from Riser 28 were performed. The examinations were performed to detect any wall thinning, pitting, or cracking in the primary tank wall.

Primary Tank Wall Vertical Scan Paths

Two 15-in.-wide vertical scan paths were performed on Plates #1, #2, #3, #4, and #5 from Riser 28. The plates were examined for wall thinning, pitting, and cracks oriented vertically on the primary tank wall. There were no areas of wall thinning that exceeded the reportable level of 10% of the nominal thickness. No pitting or vertical crack-like indications were detected in Plates #1, #2, #3, #4, or #5.

Two 15-in.-wide vertical scan paths were performed on Plates #1, #2, #3, #4, and #5 from Riser 29. The plates were examined for wall thinning, pitting, and cracks oriented vertically on the primary tank wall. There were no areas of wall thinning that exceeded the reportable level of 10% of the nominal thickness. No pitting or vertical crack-like indications were detected in Plates #1, #2, #3, #4, or #5.

Primary Tank Wall Weld Scan Paths

The HAZ of vertical welds in Plates #2, #3, #4, and #5 from Riser 29 were examined for wall thinning, pitting, and cracks oriented either perpendicular or parallel to the weld. 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 weld HAZ areas in Plates #2, #3, #4, and #5.

The HAZ of the horizontal weld between Plate #5 and the tank knuckle from Riser 29 was examined for wall thinning, pitting and cracks oriented either perpendicular or parallel to the weld. 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 weld HAZ areas on Plate #5 side or on the knuckle side of the horizontal weld.

Secondary Tank Wall Scan Paths

Two 15-in.-wide vertical scan paths were performed on the secondary tank wall on Plates #1, #2, #3, #4, and #5 from Riser 28. The plates were examined for wall thinning, pitting, and cracks oriented vertically 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 vertical crack-like indications were detected in Plates #1, #2, #3, #4, or #5.

Contents

Figures

1.0 Introduction

AREVA NC Inc. (AREVA), under a contract from CH2M Hill Hanford Group (CH2M Hill), has performed an ultrasonic examination (UT) of selected portions of Double-Shell Tank (DST) 241-AW-103. 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-AW-103 were to detect, characterize (identify, size, and locate), and record measurements made of any wall thinning, pitting, or cracks that might be present in the wall of the primary tank and the wall of the secondary tank. Any measurements that exceed the requirements set forth in the Engineering Task Plan (ETP), RPP-Plan-27202 (Jensen 2005), are to be 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 plate.
- Pits with depths that exceed 25% of the nominal plate thickness.
- Stress-corrosion cracks that exceed 0.10 in. (through-wall) and are detected in the inner wall of the tank, 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 electronic media and paper copies of all measurements are provided to PNNL for third-party evaluation. PNNL is responsible for preparing a report(s) that describes the results of the AREVA UT.

2.0 Qualified Personnel, Procedures, and Equipment

Under contract from CH2M Hill, 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. Personnel participating in the examinations are to be certified in accordance with American Society for Nondestructive Testing (ASNT) Recommended Practice SNT-TC-1A, 1992 Edition, and associated documentation is to be provided. The capability of the UT system is to be validated through a performance demonstration test (PDT) on a mock-up simulating the actual DST. The current procedure for the UT is to be based on requirements listed in the American Society for Mechanical Engineers (ASME), Boiler and Pressure Vessel Code Section V, Article 4, *Ultrasonic Examination Methods for Inservice Inspection*.

2.1 Personnel Qualifications

The following individuals were qualified and certified to perform UT of the Hanford DST 241-AW-103:

- **Mr. Wesley Nelson**, ASNT Level III (#LM-1874) in UT, has been identified as AREVA's UT Level III authority for this project. Mr. Nelson has been certified by AREVA as a UT Level III in accordance with AREVA procedure COGEMA-SVCP-PRC-014, latest revision which conforms to the requirements of ASNT SNT-TC-1A, 1992. Further documentation has been provided to establish his qualifications (Pardini 2000).

- **Mr. James B. Elder**, ASNT Level III (#JM-1891) in UT, has been contracted by AREVA 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 (Posakony and Pardini 1998).

- **Mr. William D. Purdy**, AREVA UT Level II limited (for P-Scan data acquisition only). Mr. Purdy has been certified in accordance with AREVA procedure COGEMA-SVCP-PRC-014, latest revision. Further documentation has been provided to establish his qualifications (Posakony 2001).

The following individuals participated in this examination and are trainees and are not qualified or certified to perform independent UT of the Hanford DST 241-AW-103:

- **Mr. Jeffery S. Pintler**, AREVA UT trainee in accordance with AREVA procedure COGEMA-SVCP-PRC-014, latest revision.

- **Ms. Laura A. Sepich**, AREVA UT trainee in accordance with AREVA procedure COGEMA-SVCP-PRC-014, latest revision.

2.2 Ultrasonic Examination Equipment

CH2M Hill has provided the UT equipment for the examination of Tank 241-AW-103. This equipment consists of a Force Institute P-Scan ultrasonic test instrument and Force Institute AWS-5D remote-controlled, magnetic-wheel crawler for examining the primary and secondary tank walls. Ultrasonic transducers used for the examinations are commercially available. The P-Scan ultrasonic system has been qualified through a PDT administered by PNNL. (Posakony and Pardini 1998)

2.3 Ultrasonic Examination Procedure

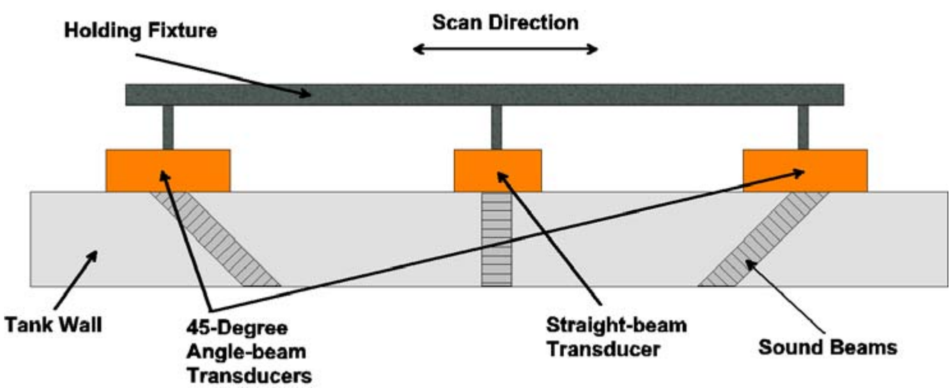
AREVA has provided the UT procedure for the examination of Tank 241-AW-103. This procedure, COGEMA-SVUT-INS-007.3, Revision 3, outlines the type of UT and mechanical equipment that are to be used as well as the types of transducers. Both straight-beam and angle-beam transducers are used for the examination of the primary and secondary tank walls. 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 identifies the specific transducers used and the sensitivity adjustments needed to perform the inspection. The AREVA UT procedure has been qualified through a PDT (Posakony and Pardini 1998).

3.0 Ultrasonic Examination Configuration

AREVA 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-AW-103 included UT of the primary and secondary tank walls and the HAZ of selected welds in the primary tank wall.

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 AREVA 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 primary 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 UT inspector) as the assembly is scanned across a line. At the end of each scan line the fixture is indexed 0.035-in. (or as set by the UT inspector) and the scan is repeated. The mechanical scanning fixture is designed to scan a maximum of approximately 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:

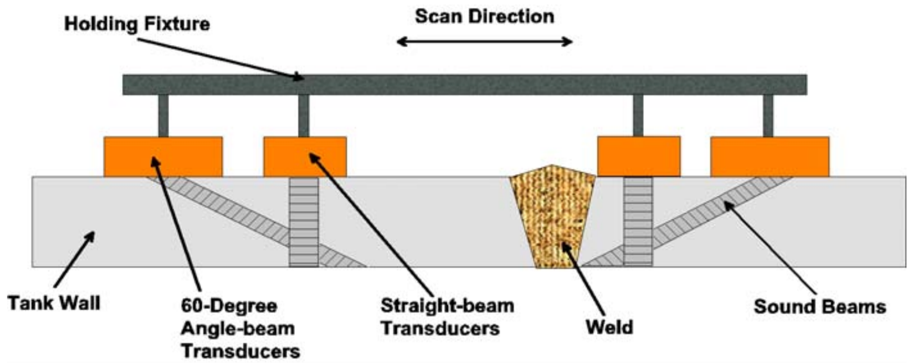
Angle-Beam
Type: MWB-45 04E
Frequency: 4 MHz
Size: 8 X 9 mm
Manufacturer: Krautkramer

Straight-Beam
Type: MSEB 5B
Frequency: 5 MHz
Size: Dual - 9 X 2 mm
Manufacturer: Krautkramer

Figure 3.1. Transducer Configuration for Examining the Primary and Secondary Tank Walls

3.2 Weld Zone Transducer Configuration

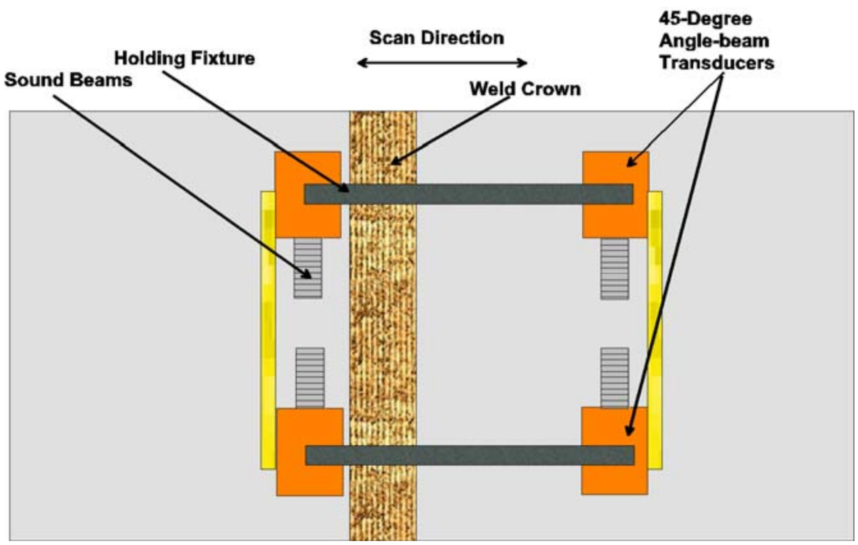
Figure 3.2 is a functional sketch that shows the configurations for examination of the weld zone. The area of interest (HAZ of the weld) is shown as lying adjacent to the weld. Both cracks and pitting may occur in this region. The “A” portion of this sketch shows the 60-degree angle-beam transducers used for detecting cracks parallel to the weld. The straight-beam transducers in this sketch are used for detecting and recording any pitting or wall thinning that may be present. All transducers are ganged together. The scanning distance traveled is limited to a total of approximately 5.0-in. The sketch titled “B” shows the arrangement for detecting cracks that may lie perpendicular to the weld. Four 45-degree, angle-beam transducers are used for this inspection. Again the transducers are ganged together but the scan is limited to a total of approximately 4.0-in. The weld zone requirements are shown in Figure 3.3. The scan protocol, data capture, and index parameters are the same for examining other weld areas in the tank.



A. Configuration for pitting and cracks parallel to weld

Transducer Specifications:
Angle-Beam
Type: MWB-60 04E
Frequency: 4 MHz
Size: 8 X 9 mm
Manufacturer: Krautkramer

Straight-Beam
Type: MSEB 5B
Frequency: 5 MHz
Size: Dual - 9 X 2 mm
Manufacturer: Krautkramer



B. Configuration for cracks perpendicular to weld

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

Figure 3.2. Transducer Configurations for Examination of Weld Zone in the Primary Tank Wall

In the HAZ, the requirement for characterizing cracks that lie perpendicular or parallel to welds in the primary tank wall is described in Figure 3.3. The HAZs are located on either side of the weld and defined as being within 1-in. of the toe of the weld and on the inner three-quarters of the thickness (3/4T) of the plate. These zones are considered most likely to experience stress-corrosion cracking.

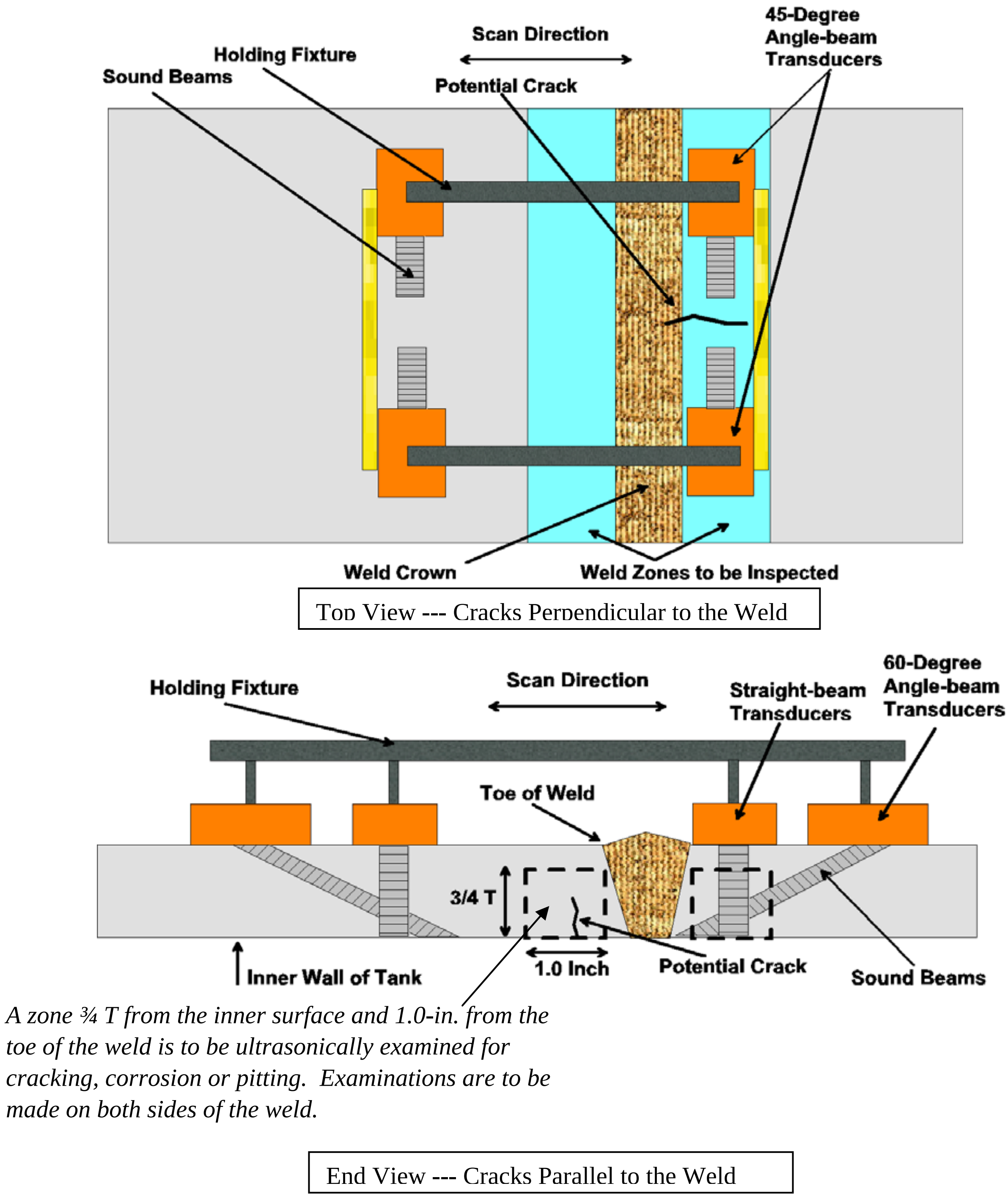


Figure 3.3. Views of the Weld Zone to be Ultrasonically Examined in the Primary Tank Wall

4.0 Ultrasonic Examination Location

Tank 241-AW-103 is located in the Hanford 200 East area in AW Tank Farm. The crawler and associated scanner that hold the transducers were lowered into the 24-in. risers located on the east side (Riser 28) and on the west side (Riser 29) of 241-AW-103. Figure 4.1 provides a graphic of the location of the risers.

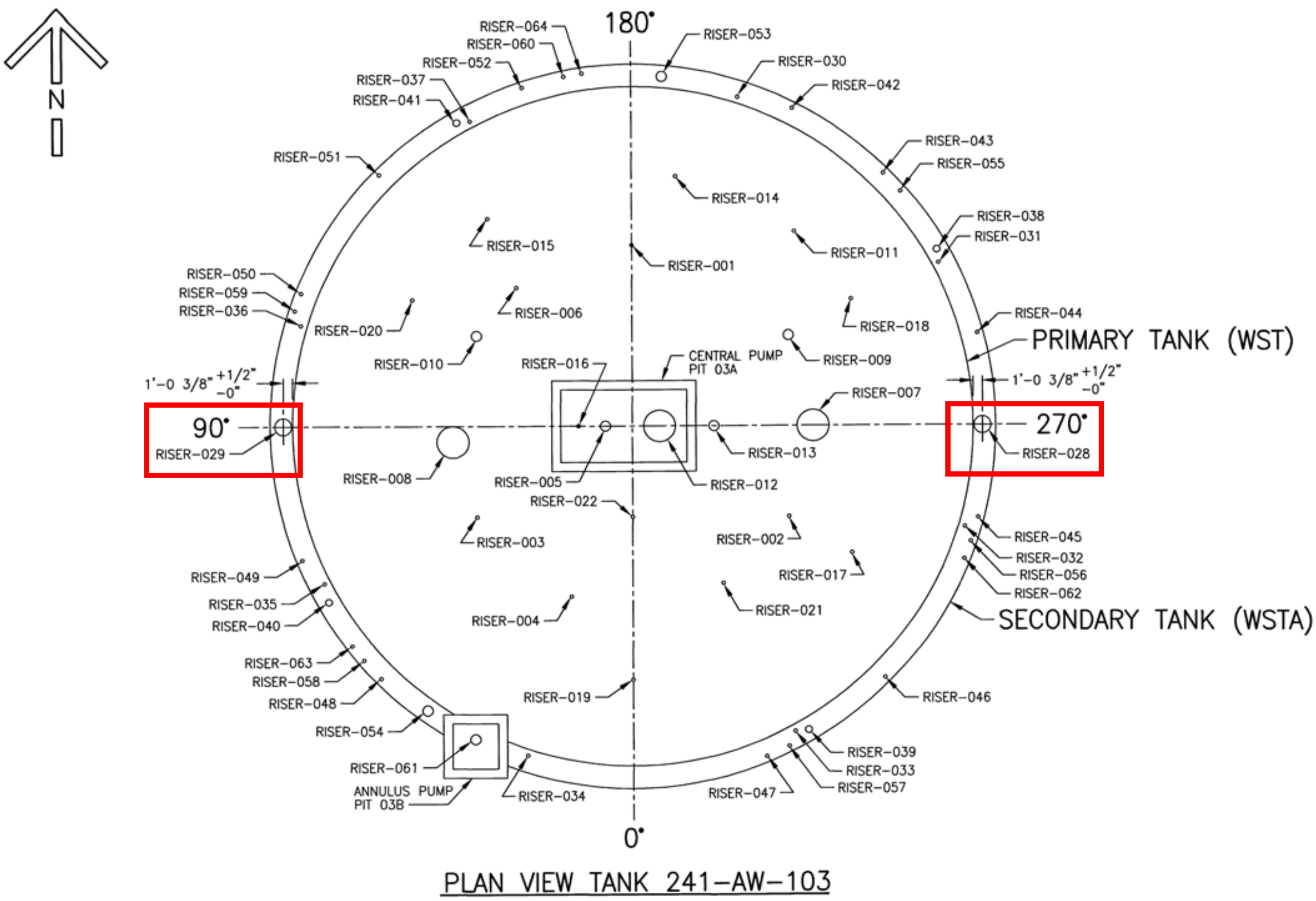


Figure 4.1. UT of Tank 241-AW-103 Riser 28 and Riser 29

Figure 4.2 describes the areas on the primary wall of Tank 241-AW-103 that were ultrasonically examined from Riser 28 located on the east side of the tank. Two 15-in.-wide vertical scan paths were performed on Plates #1, #2, #3, #4, and #5 below the entrance to Riser 28.

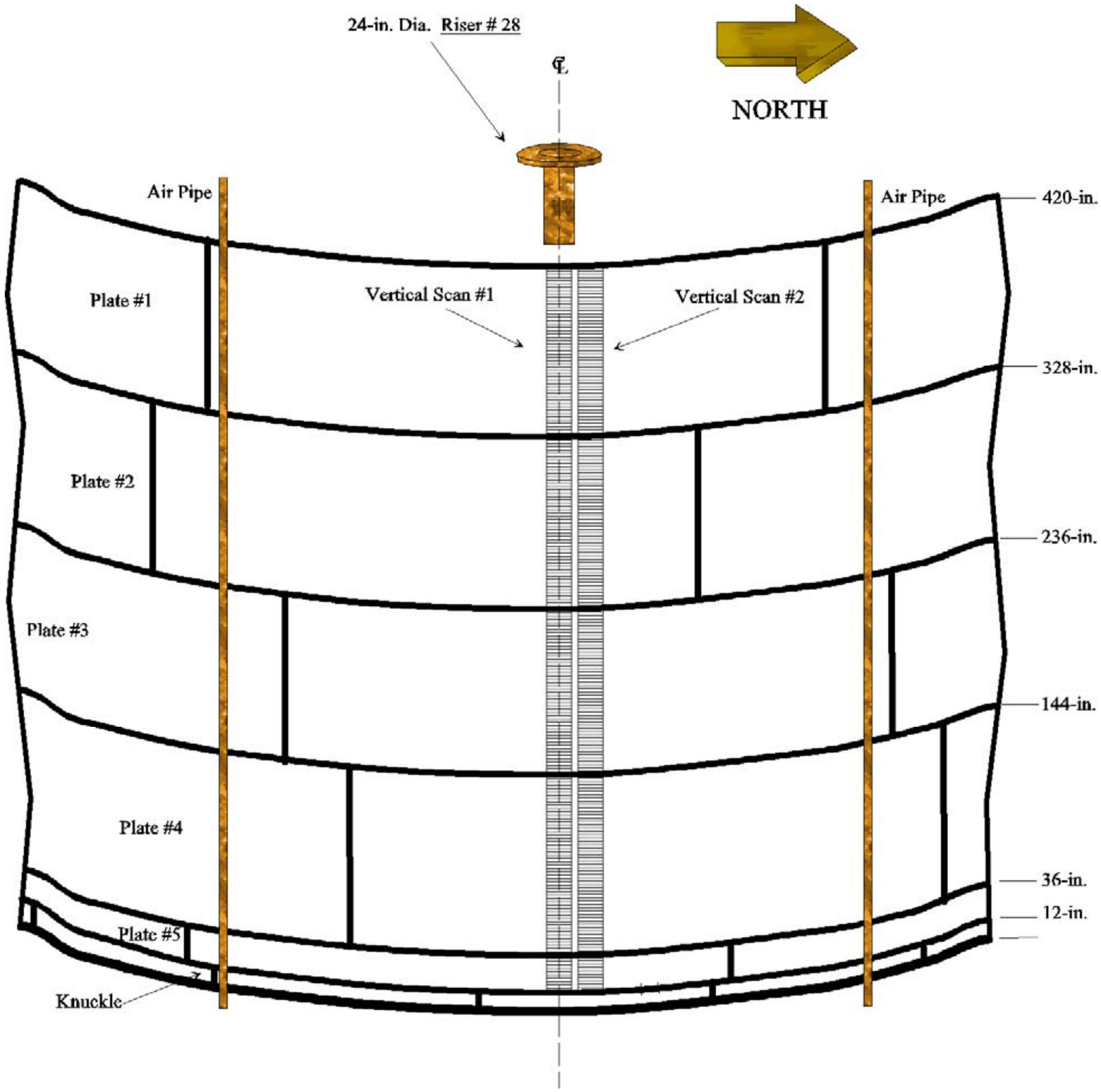


Figure 4.2. Sketch of Scan Paths on 241-AW-103 Primary Tank from Riser 28

Figure 4.3 describes the areas on the primary wall of Tank 241-AW-103 that were ultrasonically examined from Riser 29 located on the west side of the tank. Two 15-in.-wide vertical scan paths were performed on Plates #1, #2, #3, #4, and #5 below the entrance to Riser 29. Vertical weld HAZ examinations were done on Plates #2, #3, #4, and #5, and the horizontal weld HAZ examination was done on the transition Plate #5 to knuckle weld.

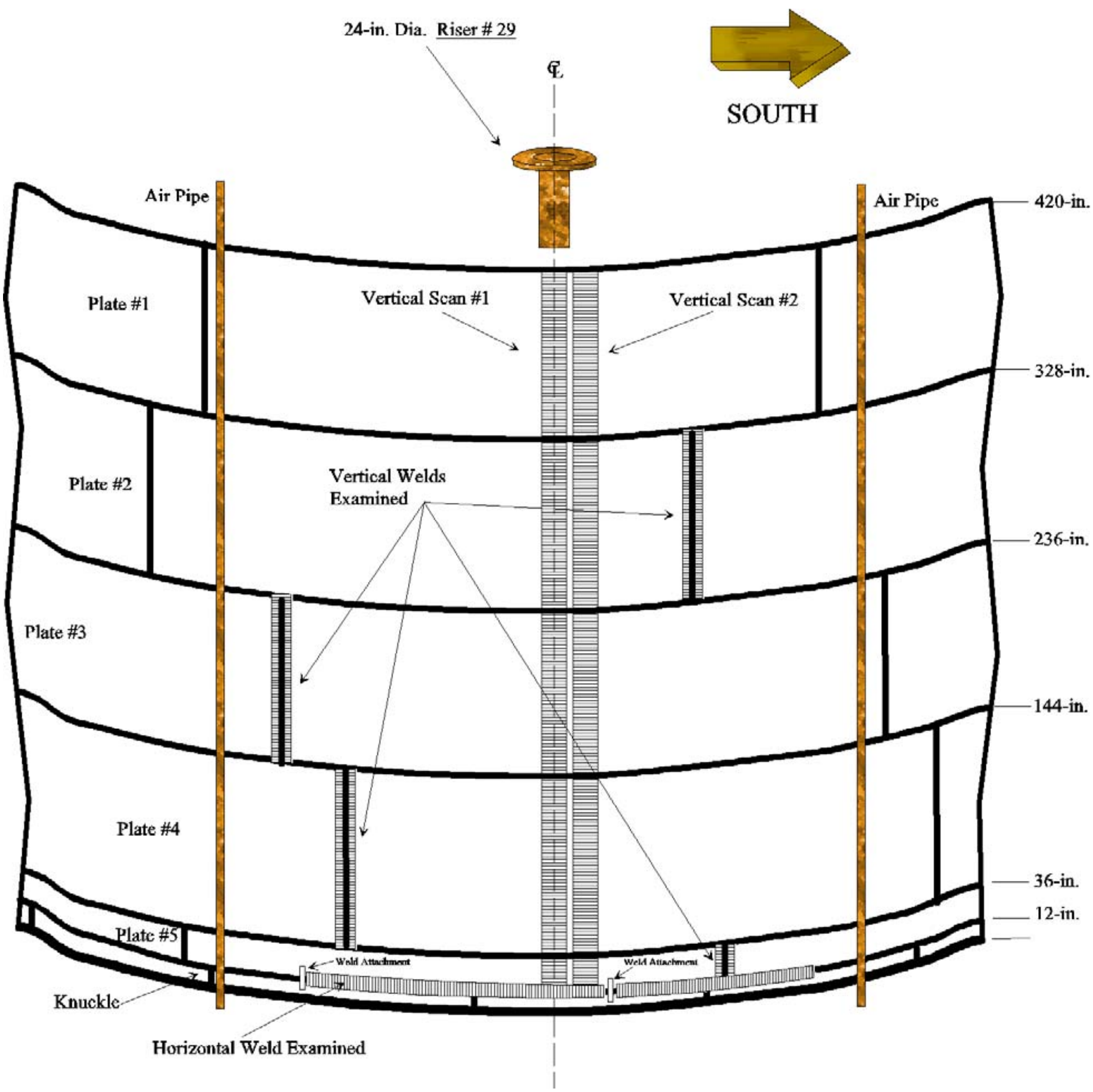


Figure 4.3. Sketch of Scan Paths on Tank 241-AW-103 Primary Tank from Riser 29

Figure 4.4 describes the areas on the secondary wall of Tank 241-AW-103 that were ultrasonically examined from Riser 28 located on the east side of the tank. Two 15-in.-wide vertical scan paths were performed on Plates #1, #2, #3, #4, and #5 below the entrance to Riser 28.

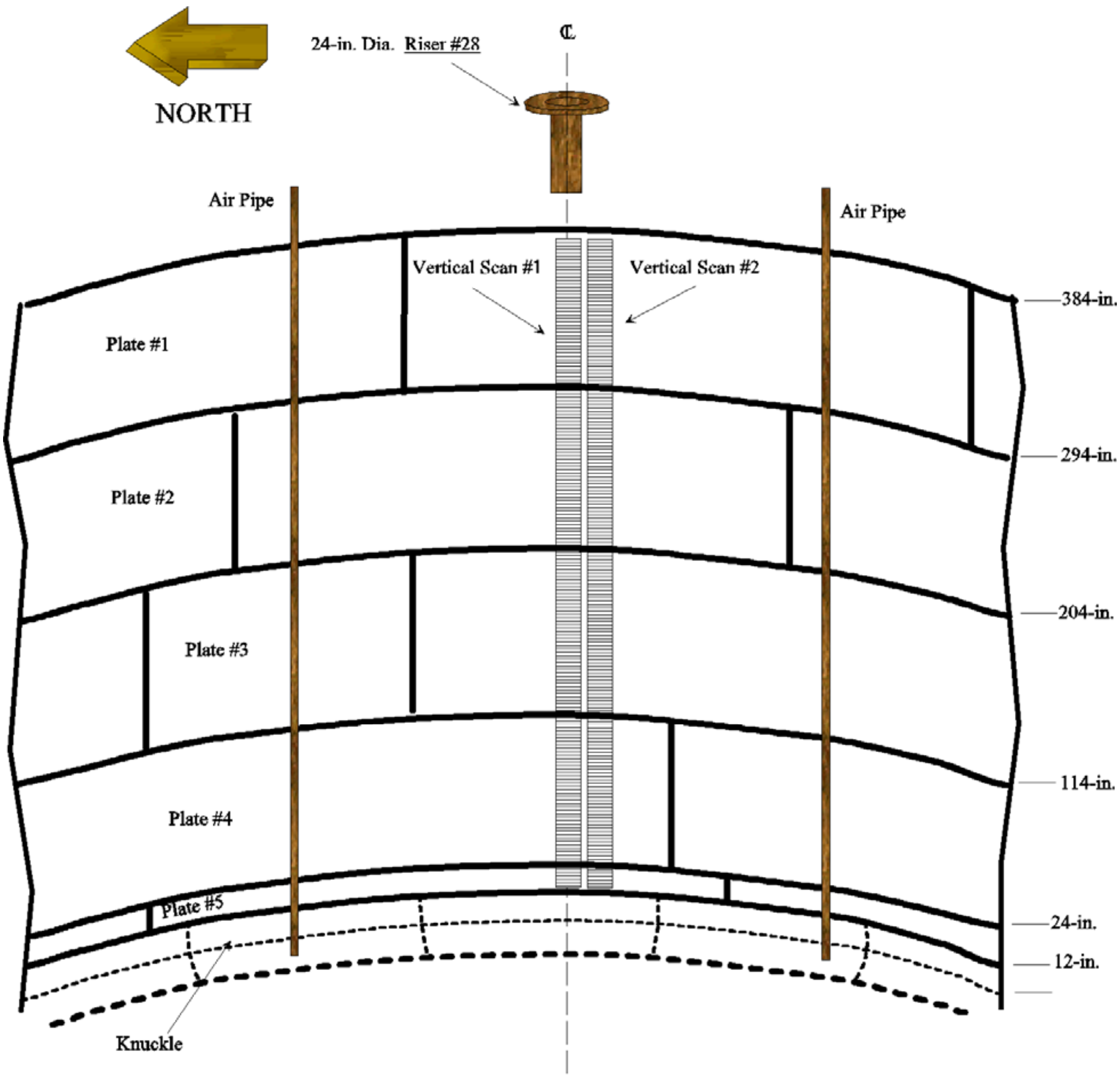


Figure 4.4. Sketch of Scan Paths on Tank 241-AW-103 Secondary Tank from Riser 28

5.0 Ultrasonic Examination Results

AREVA 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 AREVA Level III Mr. Wes Nelson, and peer reviewed by JBNDT Level III Mr. Jim Elder. The results of the examination of Tank 241-AW-103 are presented in Figures 5.1 through 5.6.

Figures 5.1 and 5.2 show the wall thickness examination results for the primary tank wall from Riser 28. The examination consisted of two vertical paths beneath the 24-in. diameter riser. Vertical scan #1 was 15-in.-wide on Plates #1, #2, #3, #4, and #5 near the centerline of the 24-in. riser. Vertical scan #2 was adjacent to vertical scan #1 and was also 15-in.-wide on Plates #1, #2, #3, #4, and #5. Vertical scans were conducted in the downward direction. Figures 5.1 and 5.2 display the minimum readings taken in each 15-in.-wide by 12-in.-long area of the scan.

Figures 5.3 and 5.4 show the wall thickness examination results for the primary tank wall and the HAZs of both vertical and horizontal welds from Riser 29. The examination consisted of two vertical paths beneath the 24-in. diameter riser. Vertical scan #1 was 15-in.-wide on Plate #1, #2, #3, #4, and #5 near the centerline of the 24-in. riser. Vertical scan #2 was adjacent to vertical scan #1 and was also 15-in.-wide on Plates #1, #2, #3, #4, and #5. Vertical scans were conducted in the downward direction. The HAZs of vertical welds in Plates #2, #3, #4, and #5 were examined and the HAZ in the horizontal weld between Plate #5 and the knuckle section was also examined. Weld area exams include approximately 5-in. on each side of the weld. Areas in the figures that show two measurements in the same box are the result of the vertical scan paths overlapping the horizontal scan paths. Figures 5.3 and 5.4 display the minimum readings taken in each 15-in.-wide by 12-in.-long area of the scan. In the overlapping areas, both minimum readings from each vertical and horizontal scan paths are given.

Figures 5.5 and 5.6 show the wall thickness examination results for the secondary tank wall from Riser 28. The examination consisted of two vertical paths beneath the 24-in. diameter riser. Vertical scan #1 was 15-in.-wide on Plates #1, #2, #3, #4, and #5 near the centerline of the 24-in. riser. Vertical scan #2 was adjacent to vertical scan #1 and was also 15-in.-wide on Plates #1, #2, #3, #4, and #5. Vertical scans were conducted in the downward direction. Figures 5.1 and 5.2 display the minimum readings taken in each 15-in.-wide by 12-in.-long area of the scan.

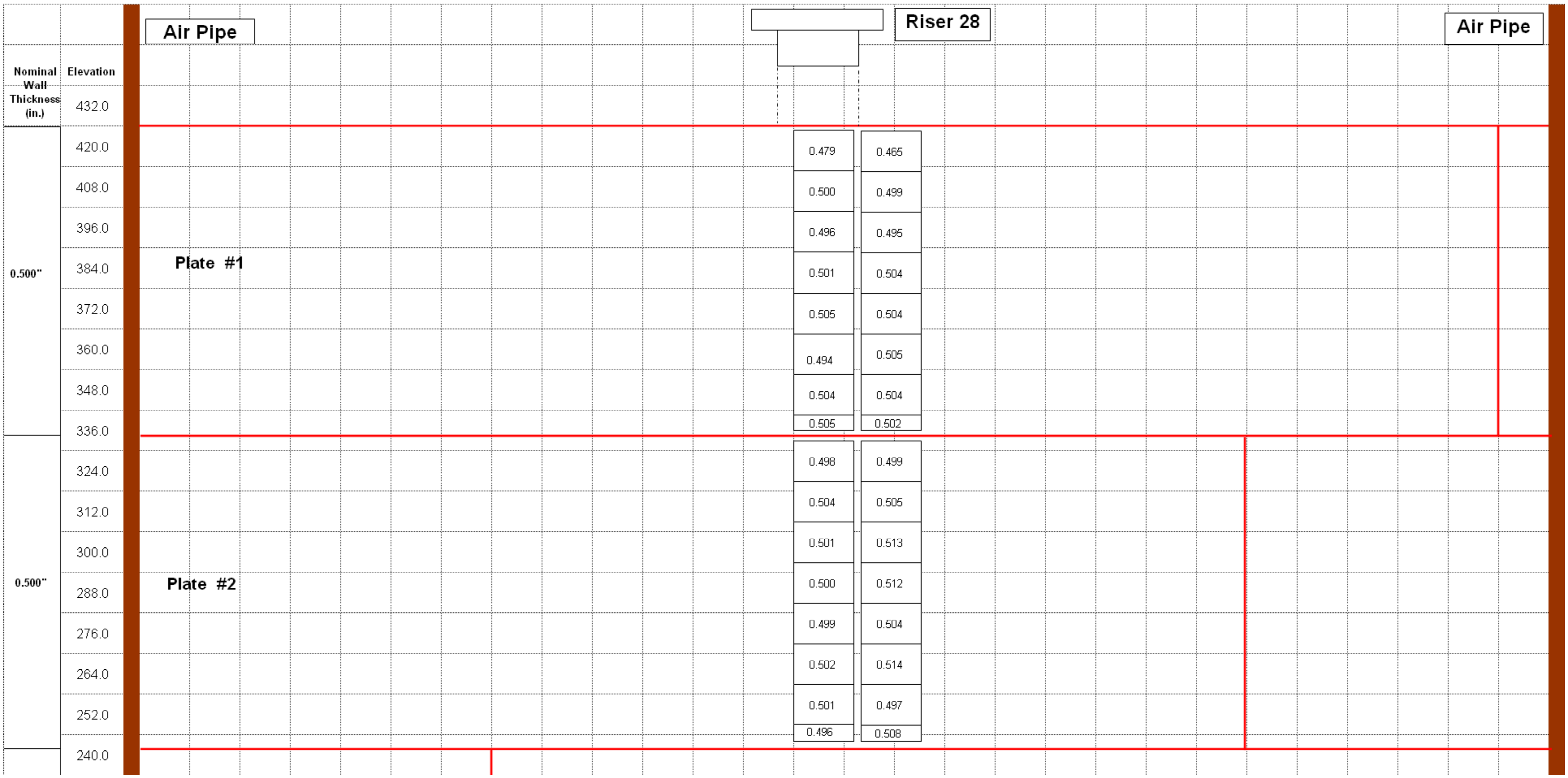


Figure 5.1. UT Data from Tank 241-AW-103 Primary Tank Riser 28

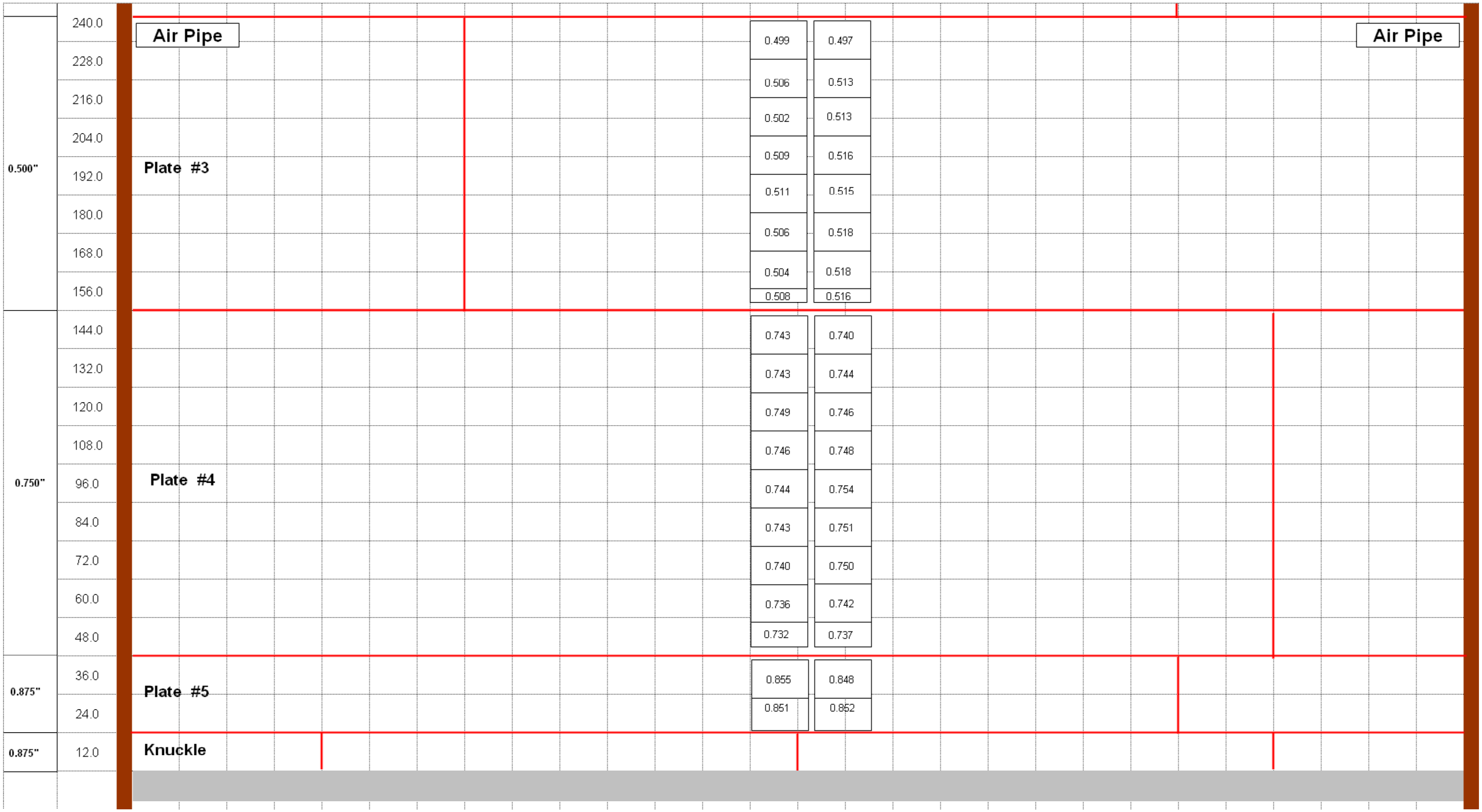


Figure 5.2. UT Data from Tank 241-AW-103 Primary Tank Riser 28 cont.

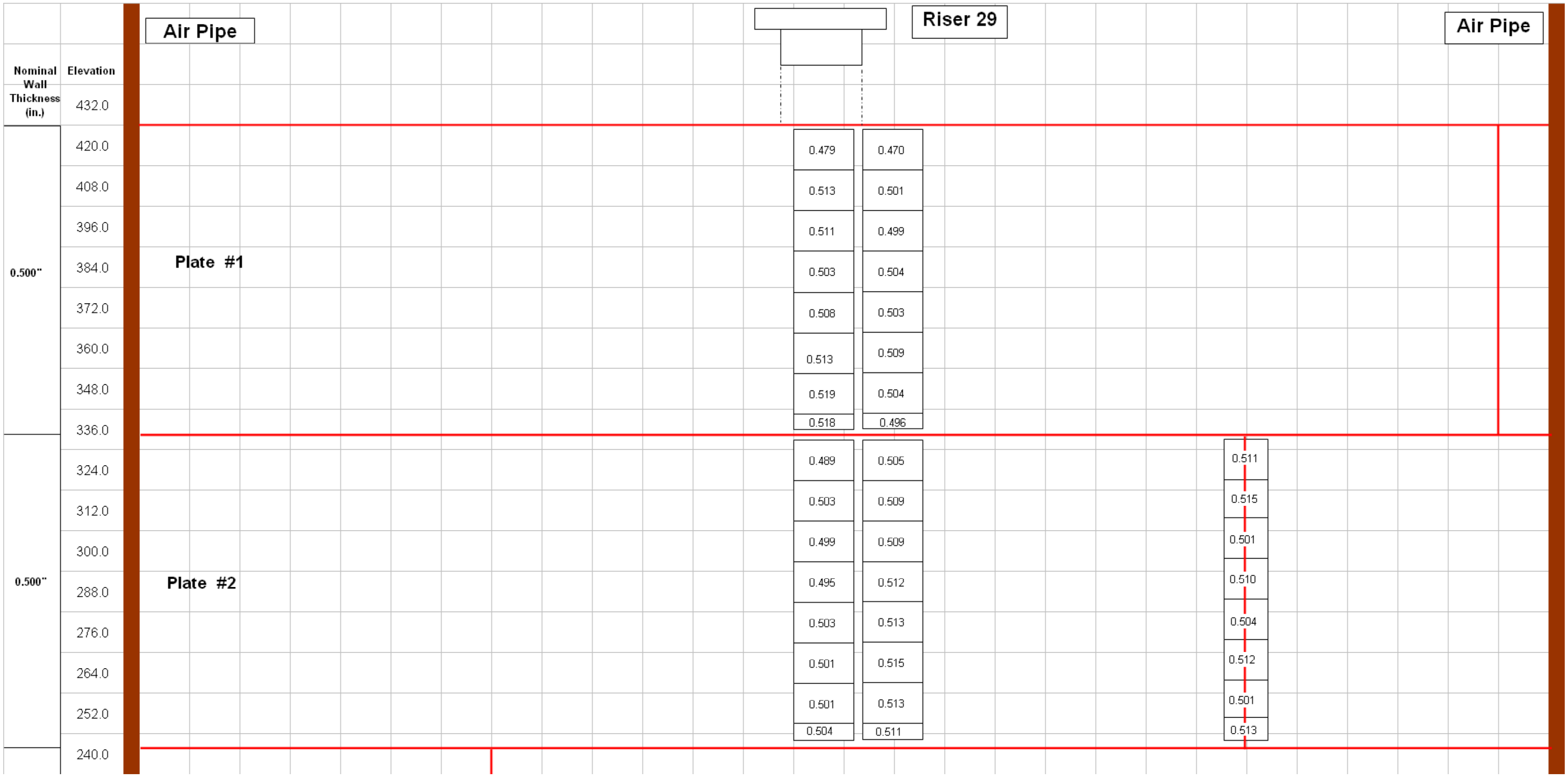


Figure 5.3. UT Data from Tank 241-AW-103 Primary Tank Riser 29

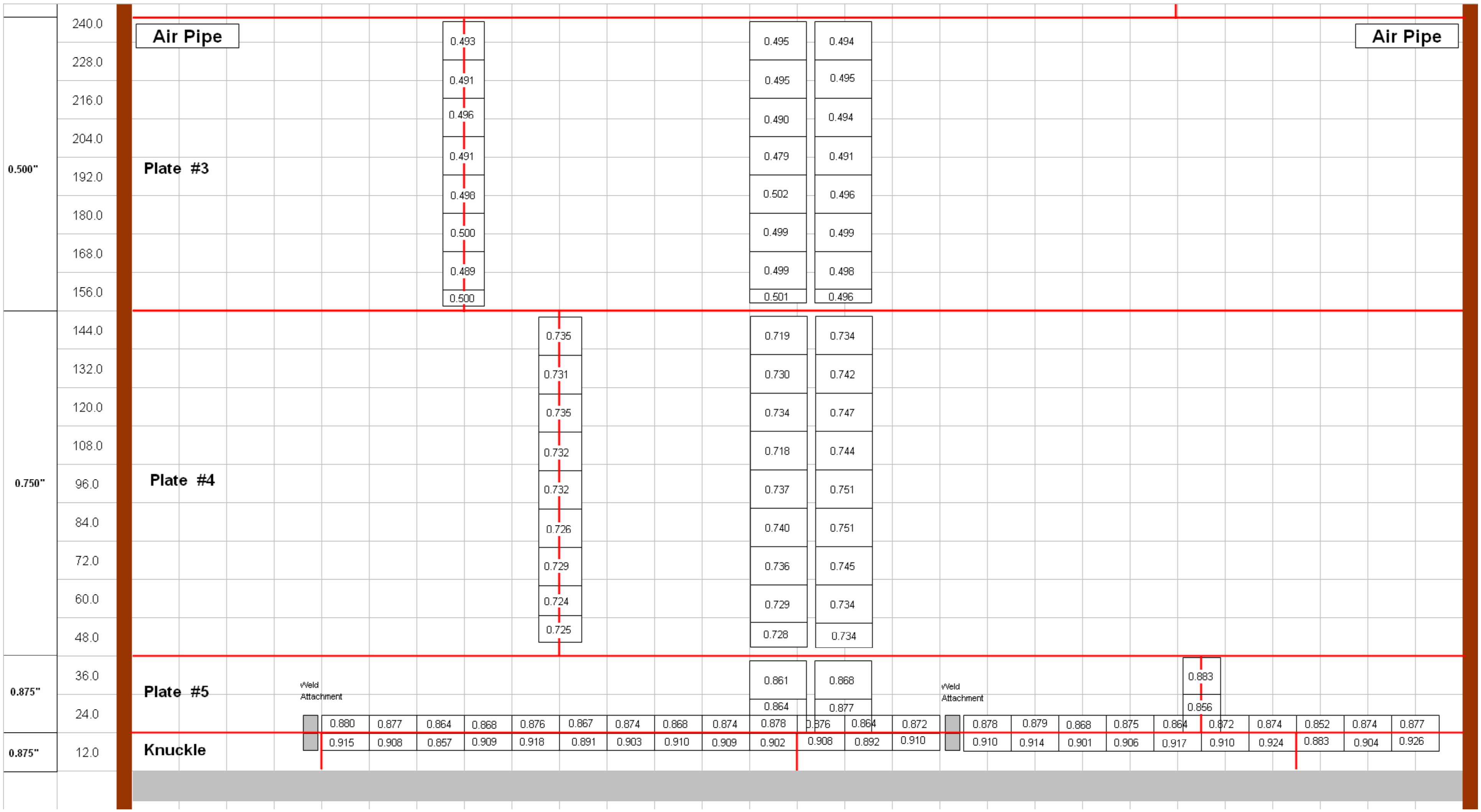


Figure 5.4. UT Data from Tank 241-AW-103 Primary Tank Riser 29 cont.

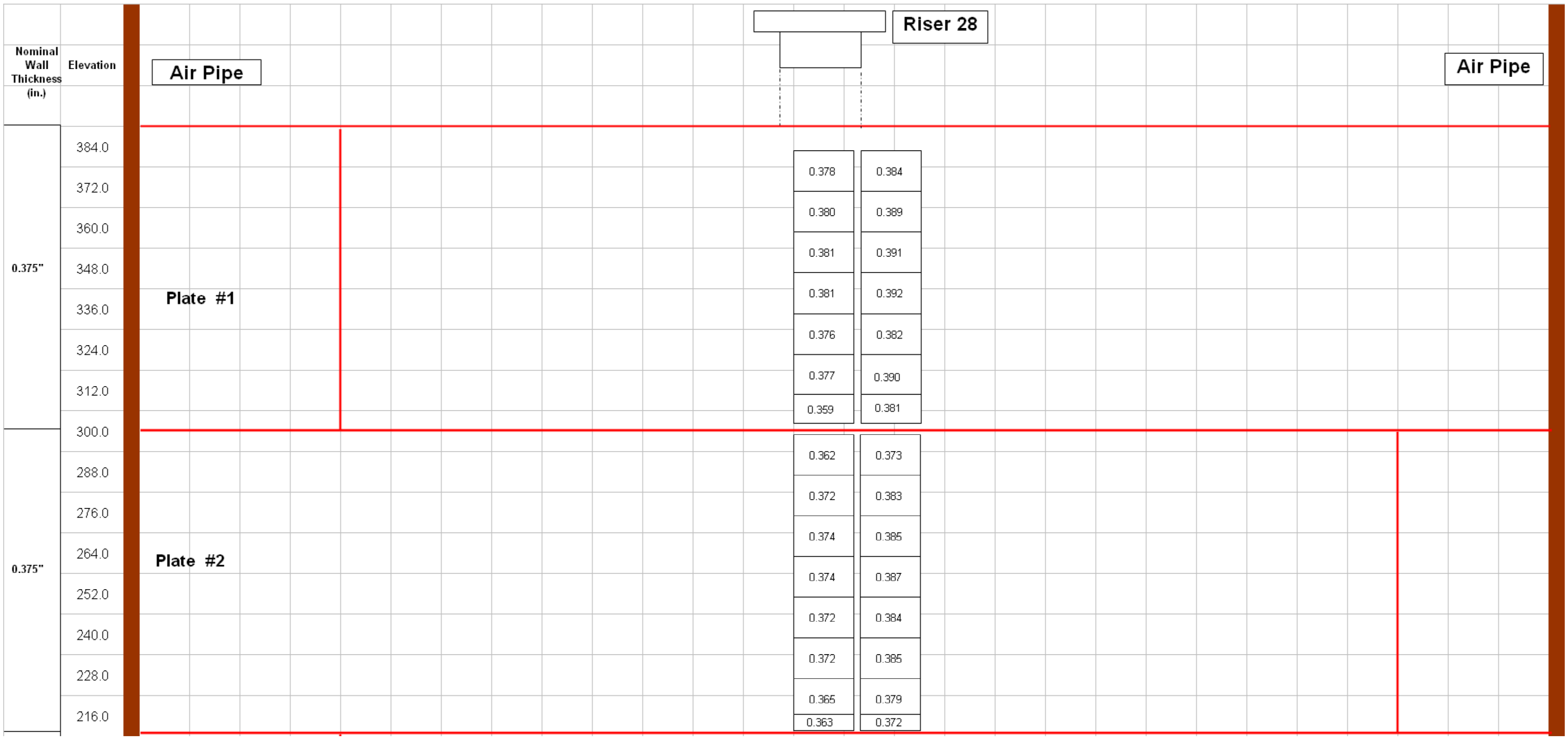


Figure 5.5. UT Data from Tank 241-AW-103 Secondary Tank Riser 28

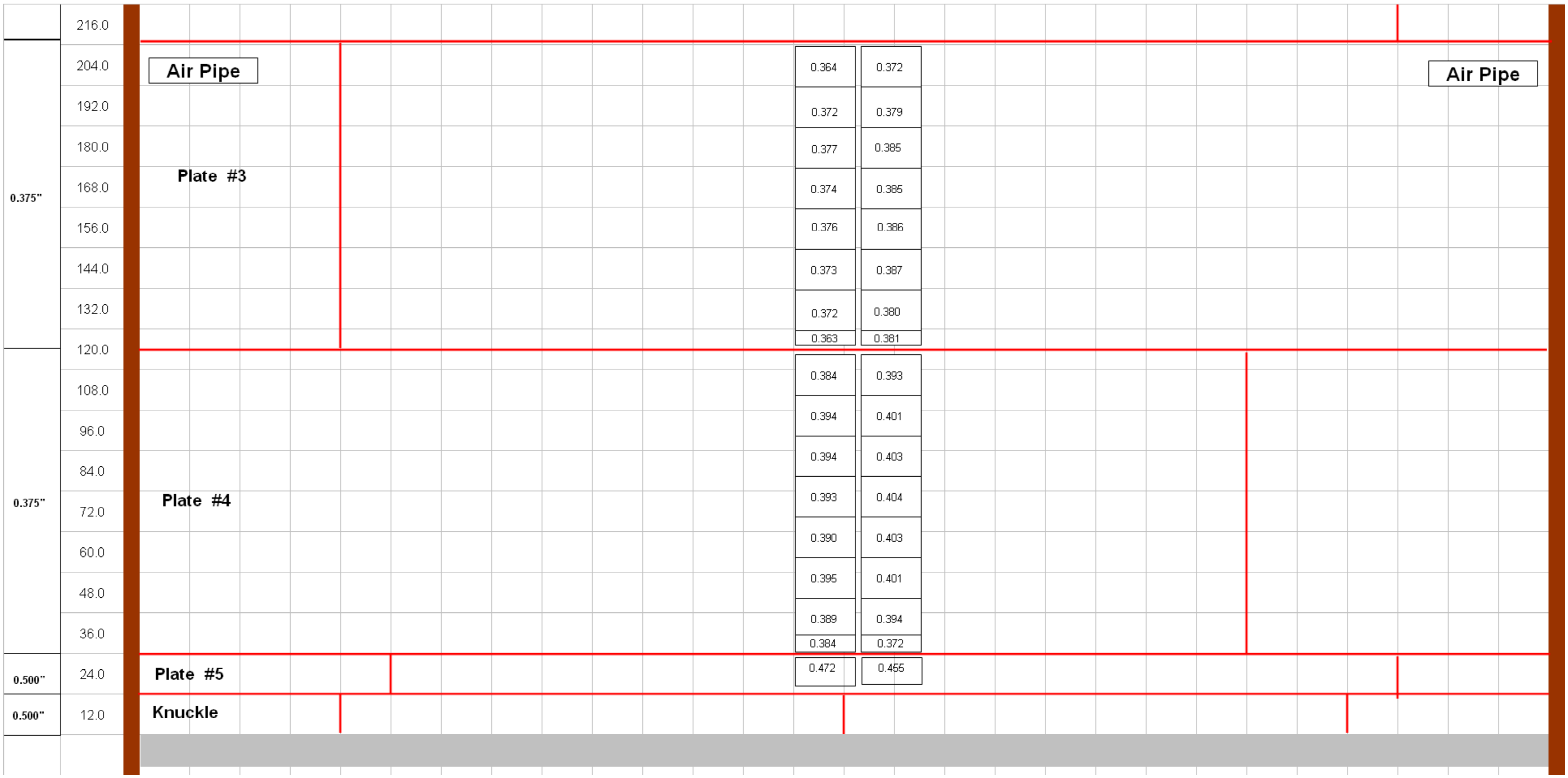


Figure 5.6. UT Data from Tank 241-AW-103 Secondary Tank Riser 28 cont.

6.0 Conclusions

The results of the examination of Tank 241-AW-103 have been evaluated by PNNL personnel. The primary tank ultrasonic examination consisted of two vertical 15-in.-wide scan paths over the entire height of the tank, the heat-affected zone (HAZ) of four vertical welds and one horizontal weld from Riser 29 and two vertical 15-in.-wide scan paths over the entire height of the tank from Riser 28. Additionally, two vertical 15-in.-wide scan paths over the entire height of the secondary tank from Riser 28 were performed. The examinations were performed to detect any wall thinning, pitting, or cracking in the primary tank wall.

6.1 Primary Tank Wall Vertical Scan Paths

Two 15-in.-wide vertical scan paths were performed on Plates #1, #2, #3, #4, and #5 from Riser 28. The plates were examined for wall thinning, pitting, and cracks oriented vertically on the primary tank wall. The results indicated that the minimum thicknesses in the areas that were scanned with nominal thickness of 0.500-in. are as follows; Plate #1 was 0.465-in., Plate #2 was 0.496-in., and Plate #3 was 0.497-in. The nominal thickness in Plate #4 is 0.750-in. and the minimum thickness in this area was 0.732-in. The nominal thickness in Plate #5 is 0.875-in. and the minimum thickness in this area was 0.848-in. There were no areas of wall thinning that exceeded the reportable level of 10% of the nominal thickness. No pitting or vertical crack-like indications were detected in Plates #1, #2, #3, #4, or #5.

Two 15-in.-wide vertical scan paths were performed on Plates #1, #2, #3, #4, and #5 from Riser 29. The plates were examined for wall thinning, pitting, and cracks oriented vertically on the primary tank wall. The results indicated that the minimum thicknesses in the areas that were scanned with nominal thickness of 0.500-in. are as follows; Plate #1 was 0.470-in., Plate #2 was 0.489-in., and Plate #3 was 0.479-in. The nominal thickness in Plate #4 is 0.750-in. and the minimum thickness in this area was 0.718-in. The nominal thickness in Plate #5 is 0.875-in. and the minimum thickness in this area was 0.861-in. There were no areas of wall thinning that exceeded the reportable level of 10% of the nominal thickness. No pitting or vertical crack-like indications were detected in Plates #1, #2, #3, #4, or #5.

6.2 Primary Tank Wall Weld Scan Paths

The HAZ of vertical welds in Plates #2, #3, #4, and #5 from Riser 29 were examined for wall thinning, pitting and cracks oriented either perpendicular or parallel to the weld. The results indicated that the minimum thicknesses in the weld areas that were scanned are as follows: The nominal thickness of Plate #2 is 0.500-in. and the minimum thickness in this weld area was 0.501-in. The nominal thickness in Plate #3 is 0.500-in. and the minimum thickness in this weld area was 0.491-in. The nominal thickness in Plate #4 is 0.750-in. and the minimum thickness in this weld area was 0.724-in. The nominal thickness in Plate #5 is 0.875-in. and the minimum thickness in this weld area was 0.856-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 in the weld areas in Plates #2, #3, #4, and #5.

The HAZ of the horizontal weld between Plate #5 and the tank knuckle from Riser 29 was examined for wall thinning, pitting and cracks oriented either perpendicular or parallel to the weld. The results indicated that the minimum thickness in the weld area with nominal thickness of 0.875-in. on Plate #5 was 0.852-in. The minimum thickness in the weld area with nominal thickness of 0.875-in. on the knuckle was 0.857-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 in the weld areas on Plate #5 side or on the knuckle side of the horizontal weld.

6.3 Secondary Tank Wall Vertical Scan Paths

Two 15-in.-wide vertical scan paths were performed on the secondary tank wall on Plates #1, #2, #3, #4, and #5 from Riser 28. The plates were examined for wall thinning, pitting, and cracks oriented vertically on the secondary tank wall. The results indicated that the minimum thicknesses in the areas that were scanned with nominal thickness of 0.375-in. are as follows; Plate #1 was 0.359-in., Plate #2 was 0.362-in., Plate #3 was 0.363-in., and Plate #4 was 0.372-in. The nominal thickness in Plate #5 is 0.500-in. and the minimum thickness in this area was 0.455-in. There were no areas of wall thinning that exceeded the reportable level of 10% of the nominal thickness. No pitting or vertical crack-like indications were detected in Plates #1, #2, #3, #4, or #5.

7.0 References

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G. J. Posakony to C.E. Jensen dated October 5, 2001, Letter *Purdy Performance Demonstration Test (PDT) Report*. Copy on file in the PNNL DST Project Records.

Jensen, C. E., 2005, *Engineering Task Plan for the Ultrasonic Inspection of Hanford Double-Shell Tanks FY2006 and FY2007*, RPP-PLAN-27202, Rev 0, October 2005, CH2M Hill Hanford Group, Inc., Richland, Washington.

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