241-SY Tank Farm Construction Extent of Condition Review for Tank Integrity

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Abstract: This report provides the results of an extent of condition construction history review for tanks 241-SY-101, 241-SY-102, and 241-SY-103. The construction history of the 241-SY tank farm has been reviewed to identify issues similar to those experienced during tank 241-AY-102 construction. Those issues and others impacting integrity are discussed based on information found in available construction records, using tank 241-AY-102 as the comparison benchmark. In the 241-SY tank farm, the third DST farm constructed, refractory quality and stress relief were improved, while similar tank and liner fabrication issues remained.

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EXECUTIVE SUMMARY

The construction history of the 241-SY tank farm has been reviewed to identify any concerns for the long-term integrity of the tanks. This initial review was prompted by construction issues identified during the formal leak assessment for tank 241-AY-102 (AY-102), RPP-ASMT-53793, *Tank 241-AY-102 Leak Assessment Report.* In tank AY-102, bulges in the secondary liner, deterioration of refractory during post-weld stress relieving (post-weld heat treatment), and primary tank floor plate welding rework during construction left residual stresses in the tank that may have accelerated corrosion and contributed to the primary tank failure. The main purpose of this review was to determine whether the construction methods adopted after completion of the 241-AY Farm either improved the quality and integrity of the third double-shell tank farm built (241-SY tank farm) or produced similar reduced margins.

During construction of the 241-SY tank farm, weld rejection rates for the tanks were similar to the weld rejection rate in tank AY-102. The secondary liner bottom thickness was increased to 3/8 in. from 1/4 in. and the primary tank bottom was increased from 3/8 in. to 1/2 in. The plate material was also changed from American Society for Testing and Materials (ASTM) A515-65 carbon steel in the 241-AY tank farm to ASTM A516-72 carbon steel in the 241-SY tank farm.

The construction of 241-SY tank farm showed improvement in refractory placement and post-weld heat treatment. Minor issues were noted for refractory installation and weather protection, but no significant refractory repairs were required. The post-weld stress relieving process was more disciplined and effective in the 241-SY tank farm. All tanks were successfully post-weld stress relieved with no deficiencies noted.

The most significant deficiency found in the 241-SY tank farm was the presence of bulging in the primary and secondary bottoms. The maximum root to crown slope was found in tank SY-103 secondary bottom and had a slope of 1 in. per ft. Structural analysis and strain gauge testing of the bulge was conducted and results indicated the stresses in the tank to be less than the yield strength of the material. Bulging in tank SY-101 was similar in size, shape, and location to the bulge in SY-103. However, it was decided to grout the area underneath two bulges to support the primary tank in those locations.

Various other issues related to difficulties in liner fabrication were noted. All of these issues were evaluated and accepted “as-is” with no stated impact on structural tank integrity.

The 241-SY tank farm had improved construction practices in some areas as compared to tank AY-102, yet many of the construction issues experienced by tank AY-102 re-emerged. Overall, the condition of the tank liners in the 241-SY tank farm are considered to be similar to tank AY-102. Factors thought to have caused unsupported areas in the primary tank bottom and the potential for areas of high residual stress in tank AY-102 are also present in all of the 241-SY tank farm tanks.

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Abbreviations and Acronyms

AEC	Atomic Energy Commission
ARHCO	Atlantic Richfield Hanford Company
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
BNWL	Battelle Northwest Laboratory
CBI	Chicago Bridge and Iron Company
DST	Double-Shell Tank
ECN	Engineering Change Notice
Exxon	Exxon Nuclear Company
LDP	Leak Detection Pit
LW50	Lite Wate 50 castable refractory
NCR	Non-Conformance Report
NDE	Non-Destructive Examination
PUREX	Plutonium Uranium Extraction Process
TOC	Tank Operations Contractor
WRPS	Washington River Protections Solutions LLC
WST	Waste Storage Tank

Units

ft	Feet
in	Inch
h	Hour
lb	Pound
Mgal	Million Gallons

TRADEMARK DISCLOSURE

1.0 INTRODUCTION

This document provides an overview of the construction history noting any difficulties encountered for 241-AZ tank farm, the second double-shell tank (DST) farm constructed. In October 2012, it was determined that the primary tank of DST 241-AY-102 (AY-102) was leaking (RPP-ASMT-53793, Rev. 0, *Tank 241-AY-102 Leak Assessment Report*). Bulges in the secondary liner, deterioration of refractory during post-weld stress relieving, and primary tank floor plate welding rework during construction compromised the intended robustness and corrosion resistance of the tank AY-102 design and probably contributed to the primary tank's failure.

Following identification of the tank AY-102 probable leak cause, an Extent of Condition (EOC) evaluation was prepared using U.S. Department of Energy's Energy Facilities Contractors Group (EFCOG) *Guidance for Extent of Conditions Evaluations*. The EFCOG process was used to identify other DSTs with construction, waste storage, or thermal histories similar to that of tank AY-102 (WRPS-1204931, *Double-Shell Tank 241-AY-102 Primary Tank Leak Extent of Condition Evaluation and Recommended Annulus Visual Inspection Intervals*). The EOC evaluation identified six tanks with similar construction and operating histories for additional evaluation which include: 241-AY-101, 241-AZ-101, 241-AZ-102, 241-SY-101, 241-SY-102, and 241-SY-103. One of the identified evaluations was to identify any similarities in construction that could be a precursor for accelerated corrosion and premature failure.

1.1 PURPOSE

The construction history of the 241-SY tank farm has been reviewed to identify issues similar to those experienced during tank AY-102 construction. In this document, those issues and others impacting integrity are discussed based on information found in available construction records, using tank AY-102 as the comparison benchmark.

1.2 OVERVIEW

Six double-shell tank (DST) farms were constructed over a period of roughly 18 years (from 1968 to 1986), with a presumed design life of 20 to 50 years. The 241-SY tank farm was the third farm to be constructed and is the focus of this report. Table 1-1, "Double-Shell Construction and Age as of 2013," provides the construction dates, year of initial service, and the expected service life for the DSTs.

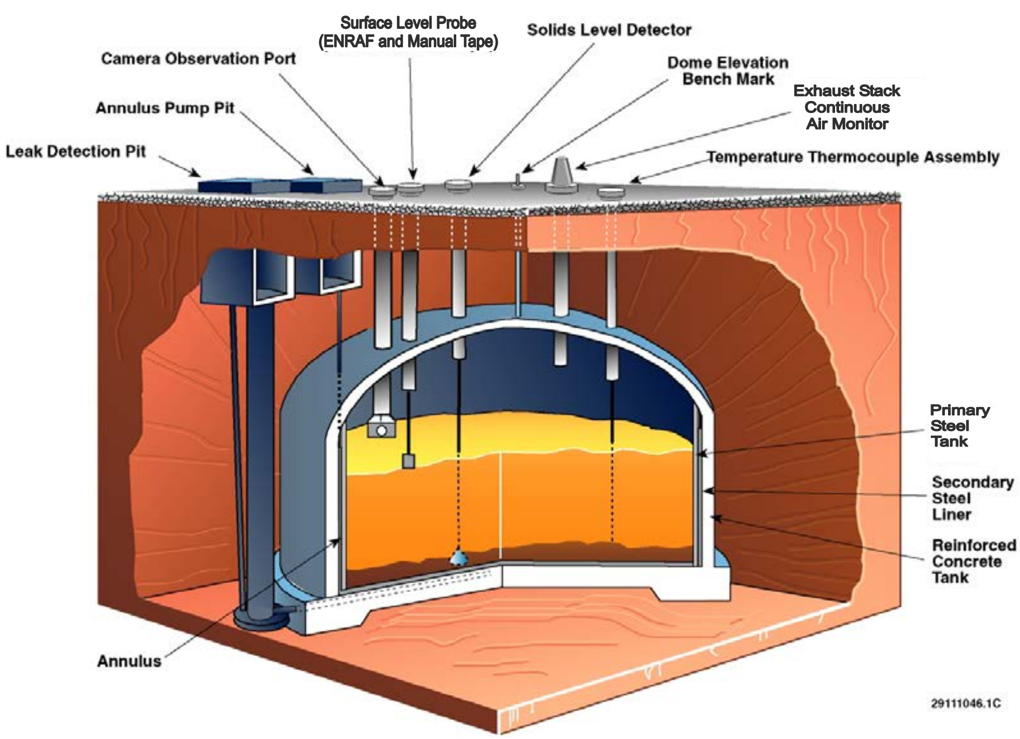
Table 1-1. Double-Shell Construction and Age as of 2013

Tank Farm	Number of Tanks	Construction Period	Construction Project	Initial Operation	Service Life	Current Age
241-AY	2	1968 – 1970	IAP-614	1971	40	42
241-AZ	2	1970 – 1974	HAP-647	1976	20	37
241-SY	3	1974 – 1977	B-101	1977	50	36
241-AW	6	1976 – 1979	B-120	1980	50	33
241-AN	7	1977 – 1980	B-130, B-170	1981	50	32
241-AP	8	1982 – 1986	B-340	1986	50	27
Total	28					

1.3 DOUBLE-SHELL TANK DESCRIPTION

Each DST consists of a primary carbon steel tank inside of a secondary carbon steel liner, which is surrounded by a reinforced-concrete shell. The primary steel tank rests atop an eight inch insulating concrete slab, separating it from the secondary steel liner, and providing for air circulation/leak detection channels under the primary tank bottom plate. An annular space of 2.5 feet exists between the secondary liners and primary tanks, allowing for visual examination of the tank wall and secondary liner annular surfaces. The annular space also allows for ultrasonic volumetric inspections of the primary tank walls and secondary liners.

Figure 1-1. Double-Shell Tank Construction



Each tank in the 241-SY tank farm has 58 risers penetrating the dome, providing access for video cameras, ultrasonic inspection devices, waste sampling devices, mixer pumps, and other equipment requiring access to either the primary tank interior or annular space (H-14-010531, Sheets 1, 2, and 3, *Dome Penetration Schedules WST/WSTA*). Tanks SY-101 and SY-103 each have two pits while tank SY-102 has four pits (H-14-010531, Sheets 1,2, and 3) extending from grade to varying depths, which house valves and pumps. This equipment allows transfer of liquid waste and sludge from SSTs to DSTs, from DSTs to other DSTs, or from DSTs to other facilities (e.g., Waste Treatment and Immobilization Plant).

2.0 241-SY TANK FARM CONSTRUCTION INFORMATION

The 241-SY tank farm was constructed between 1974 and 1977. It was designated as Project B-101, *Saltcake Storage*. The Atlantic Richfield Hanford Company (ARHCO) built the tank farm for the Atomic Energy Commission (AEC). The 241-SY tank farm contained three tanks and ancillary equipment. The Chicago Bridge and Iron (CBI) Company was contracted to build the farm. The Pittsburgh Des Moines Steel Company, built the first two double-shell tank (DST) farms. Construction management was provided by Vitro Engineering.

The 241-SY tank farm was built according to ARH-2930, *Functional Design Criteria Salt Cake Storage Facilities 241-SY Tank Farm*, and the following construction specifications:

- B-101-C1, *Specifications for Primary and Secondary Steel Tanks*
- B-101-C2, *Specifications for Excavation and Tank Foundations*
- B-101-C3, *Construction Specifications for Completion of 241-SY Tank Farm Project B-101*

To obtain information about the construction history, the Record Holding Area (RHA) and Integrated Data Management System (IDMS) were queried for boxes containing files from the Project B-101 Salt Cake Storage.

This information includes:

1. Radiographic Test Diagrams
2. Materials Certifications
3. Non-conformance reports
4. Quality Assurance construction logbooks
5. Project reports, correspondence, and meeting minutes

Daily logbook entries, which describe key construction events and issues, are summarized in Appendix A. The following sections provide an aggregation of the information collected, highlighting important events and information relevant to leak integrity. The resulting quality of construction and any issues or difficulties noted are discussed in this document.

3.0 MATERIALS OF CONSTRUCTION

The materials of construction evolved from the construction of 241-AY tank farm to the construction of the 241-SY tank farm. The primary change in material selection was to use American Society for Testing and Materials (ASTM[1]) A516-72, *Pressure Vessel Plates, Carbon Steel, for Moderate and Lower Temperature Service*, Grade 65 for construction of the primary and secondary liner instead of ASTM A515, *Pressure Vessel Plates, Carbon Steel, for Intermediate and Higher Temperature Service*, Grade 60, used in the 241-AY tank farm. Also, the thickness of the secondary liner bottom plates was increased starting with the 241-AZ tank farm, from 1/4 in. to 3/8 in. for the secondary bottom sections. The primary bottom was increased from 3/8 in. to 1/2 in. sections. The refractory material was changed from Kaolite[2] 2200LI castable refractory to Lite Wate 50 castable refractory (LW50). In addition, the refractory pour pattern was modified. Table 3-1 provides a comparison of the construction materials used in the 241-AY and 241-SY tank farms.

Table 3-1. Material Comparison Between the 241-AY and 241-SY Tank Farms.

Material	Tank Farm	
	241-AY	241-SY
Concrete	3000 psi Type V for the walls Type III for the upper haunch and dome	4500 psi Type II for the walls Type III for the upper haunch and dome
Reinforcing Bar	A432	A615-60
Steel Plate	ASTM A515 65	ASTM A516 72
Refractory	Kaolite 2200LI	Lite Wate 50

3.1 CONCRETE

The structural concrete used in the 241-SY tank farm construction required a 4,500 psi, 28-day compressive strength. Concrete samples were taken and tested at 7 days and 28 days to confirm the compressive strength. The cement for structural concrete conformed to Federal Specification SS-C-192 Type II, except that for the haunch and dome sections of the storage tanks which conformed to Type III (B-101-C3). In the 241-AY tank farm, HWS-7791, *Specification for Side Walls and Dome Nuclear Waste Storage Tank Project IAP-614 Purex Tank Expansion*, specifies Type V concrete for the tank walls and Type III cement for haunch and dome portions of the tank. From ASTM C150, *Standard Specification for Portland Cement*, Type II cement is for general use with moderate sulfate resistance and moderate heat of hydration. Type III cement is high early strength cement, and Type V cement is high sulfate resistant cement.

[1] ASTM is a registered trademark of American Society for Testing and Materials
[2] Kaolite is a registered trademark of Babcock & Wilcox Company

3.2 REINFORCING BAR

The tank foundation was reinforced with ASTM A615, Grade 60, specifications with a minimum yield strength of 60,000 psi. #5, #6, and #7 rebar was utilized to reinforce the tank foundation (see H-2-37704, *Structural Concrete Tank Foundation Plan and Details*, for details) while #4, #6, #8, and #9 rebar was utilized to reinforce the concrete walls and dome sections (see H-2-37706, *Concrete Tank Section and Haunch Reinforcement*, for details).

3.3 STEEL PLATE

All primary tank and secondary liner plates used in the 241-SY tank farm were shipped from the United States Steel Corporation and were manufactured to ASTM A516-72, Grade 65, standard. The selection of ASTM A516 was a change from ASTM A515 used in the 241-AY tank farm. ASTM A516 is a fine grain size metal produced for moderate and lower temperature service, while ASTM A515 is a coarse grain size metal produced for moderate and higher temperature service. The smaller grain size in ASTM A516 increases the notch toughness and resistance to stress corrosion cracking over ASTM A515. The 241-SY tank farm tanks were erected using the American Society of Mechanical Engineers (ASME[3]), *Boiler and Pressure Vessel Code*, 1971 through 1973 Editions and Addenda of the code.

3.3.1 Secondary Plate

The secondary liner plates consisted of 3/8 in. and 1/2 in. sections (see H-2-37772, *Tank Cross Section 241-SY tank farm*, for details). The 1/2 in. plate was used in the lower knuckle of the liner. The 3/8 in. plate was used for the liner floor, walls and upper haunch, an increase over the 1/4 in. plate used in the 241-AY tank farm.

3.3.2 Primary Plate

The primary tank bottom utilizes primarily 1/2 in. carbon steel plates, except that a 4 ft. diameter by 1 in. thick carbon steel plate is located at the center of the primary tank bottom, and a 7/8 in. carbon steel plate is used for the primary bottom knuckle. The primary tank wall thickness varies from 7/8 in. thick carbon steel at the bottom knuckle to 3/8 in. thick at the top transition plate. The first course is 3/4 in. thick, and the next two courses are 1/2 in. thick. The top transition plate is welded to a 3/8 in. thick top knuckle (see H-2-37772 for details). The dome of the tank was constructed of 3/8 in. plate welded to the top knuckle and after post-weld stress relieving closed with a 6 ft. diameter 1/2 in. thick top dollar plate. Figure 3-1 shows the configuration of the primary tank wall and the thickness of each course.

[3] ASME is a registered trademark of American Society of Mechanical Engineers

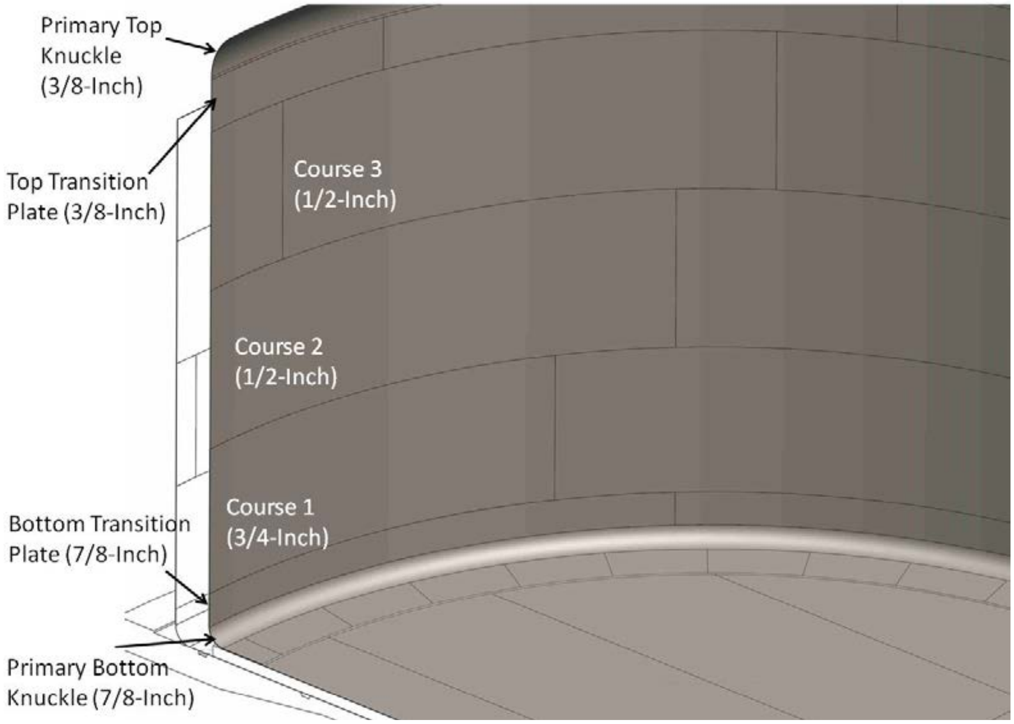


Figure 3-1. Primary Tank Wall Configuration and Thickness

3.3.3 Material Certification

Material certifications and chemical and physical test reports were required for each steel plate containing the heat and slab number. Material certifications contained yield strength and tensile strength information along with percent elongation for each specific heat and slab number. The chemical and physical test reports identify the percent of each element (i.e., carbon, manganese, phosphorus, etc.) contained within a sample of the material as well as properties such as, yield point, tensile strength, percent elongation, and information gathered from bend test results.

3.4 REFRACTORY

The refractory was required to limit the structural concrete base slab to a maximum temperature of 500 °F during the post-weld stress relief. The material had to have a minimum compressive strength of 130 psi after heating, either wet or dry. In addition, the material had to be compatible with the chemicals found in the tank waste. The 241-AY tank farm used Kaolite 2200-LI castable refractory, while LW50 was used in the 241-SY tank farm. The effects of freezing LW50 as well as saturating it with water were lab tested. The results can be found in RPP-19097, *Evaluation of Insulating Concrete in Hanford Double-Shell Tanks*, Attachment 9.

3.5 PIPING

All pipe used for permanent risers was manufactured to ASTM A53, Grade B, Type S or ASTM A106, Grade A or B specifications. Flanges conform to ASTM A181, Grade I or II specifications. Coal tar enamel wrapped in kraft paper or coal tar tape was used on carbon steel pipe exposed to earth.

4.0 CONSTRUCTION SEQUENCE

Construction of the three 241-SY tanks was awarded to CBI. Excavation began in 1974 and the project was completed in 1977. Vitro Engineering acted as construction management for the project. The site preparation included excavation work and shoring. The shoring was necessary because of the proximity of the 241-S tank farm.

The tanks were constructed simultaneously with SY-102 being built first, followed by SY-101, and with SY-103 following last. A listing of the construction sequence follows:

1. Install concrete foundation on which the secondary liner bottom rests. The foundation has a tertiary leak detection system, which includes a waffle grid in the structural concrete, collection pipes, and the leak detection pit.
2. Install cribbing and jack stands for secondary liner bottom fabrication.
3. Fabricate secondary liner bottom on top of cribbing and jack stands.
4. Inspect secondary liner bottom.
5. Remove jack stands and then cribbing.
6. Lower the secondary liner bottom onto the concrete foundation.
7. Install thermocouple conduits, to be embedded in the tank bottom refractory as well as the retainer ring used as a form for the perimeter of the refractory.
8. Pour the refractory in twelve pour sections.
9. Install the air supply piping with refractory poured around the pipes separately.
10. Install heating matrix, protective covering for refractory and, cribbing and jack stands for primary tank bottom fabrication.
11. Fabricate primary tank bottom on top of cribbing and jack stands.
12. Inspect primary tank bottom.
13. Weld the first plate course (skirts) to the primary tank and secondary liner.
14. Weld second plate course (initial plate course) to primary tank.
15. Remove jack stands and then the cribbing.
16. Lower the primary tank bottom onto the refractory.
17. Install center support post to support dome sections.
18. Continue construction of the primary and secondary liner walls.
19. Fabricate and visually inspect the primary tank dome and dome penetrations.
20. Remove center support post.
21. Place the concrete shell.
22. Start backfilling the tank farm area.
23. Insulate and provide post-weld stress relief for stress relief of the primary tank.
24. Conduct hydrostatic test of the primary tank.
25. Install upper haunch plates for the secondary liner.
26. Tack-weld the flashing to cover the gap between the secondary liner and primary tank to prevent concrete from entering the annulus.
27. Install reinforcing steel and pour concrete over the upper haunch area and tank dome.
28. Install appurtenances (thermocouple trees, pumps, etc.).
29. Backfill to top of the domes.
30. Install the waste transfer system of piping, pump pits, and valve pits.
31. Complete backfill.

4.1 CONCRETE FOUNDATION

The structurally reinforced concrete foundation is 89 ft-6 in. in diameter and is designed to distribute all weight loads uniformly. The circular center portion of the foundation is 6 ft. in diameter and 2 ft. thick. From the circular center portion, the foundation decreases to about 1 ft. thick, and then increases to a thickness of 2 ft. at the outer edge. The structural foundation contains slots to direct any leakage to drain lines which empty to a leak detection pit (LDP). The foundation is composed of reinforced concrete requiring a 4500 psi, 28 day compressive strength (see B-101-C3). Figure 4-1 shows the construction progress of concrete foundations for the 241-SY tank farm. The concrete has been poured for tanks SY-101 (in the foreground) and SY-102. The reinforcing bar has been placed for tank SY-103. In the background are the shoring piles that were driven to prevent the soil from slumping and exposing the tanks in the adjacent 241-S tank farm.

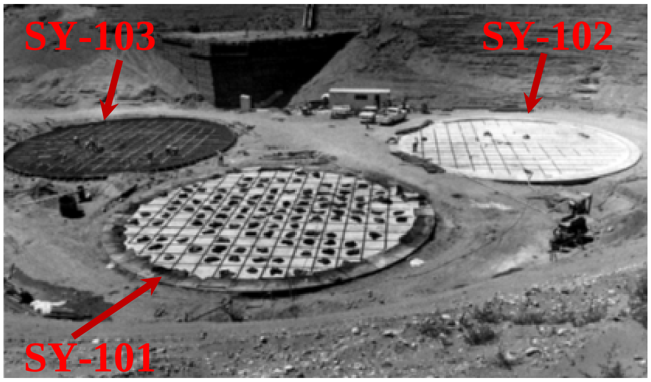


Figure 4-1. 241-SY-Farm Structural Concrete

4.2 SECONDARY LINER BOTTOM

The secondary liner bottom has an 80 ft. diameter, and the primary tank is 75 ft. in diameter, which results in a 2 1/2 ft. wide annular space between the primary tank and secondary liner. The secondary liner bottom was constructed onsite on jack stands and cribbing over the foundation. A protective cover of plywood and sand was placed over the foundation to minimize damage to the concrete. The secondary liner bottom knuckles were fabricated in sections at an offsite location by CBI and then shipped to the worksite to join them to the bottom plates. The secondary liner bottom plates are 3/8 in. thick carbon steel and the bottom knuckles are made of 1/2 in. thick carbon steel. This is an increase in thickness over the 1/4 in. plate used in the 241-AY tank farm tanks. See Table 5-4, in Section 5.1, for weld NDE information.

Figure 4-2. Crews Fabricating Secondary Liner Bottom (Photo 64775-12) (Taken 9-23-74)

Figure 4-2 shows the construction progress of the secondary liner for the 241-SY tank farm. Tanks SY-101 and SY-103 are resting on supports while tank SY-102 has been lowered onto the foundation. The individual plates were installed using fit-up tools to secure the plates within allowable tolerance for proper welding. Once completed and inspected, the secondary liner bottom was lowered onto the foundation using a series of eight hydraulic jacks around the perimeter of the tank bottom. A metal lip was installed around the upper edge of the bottom knuckle, which gave the hydraulic jacks a surface to use to lift and lower the tank bottom. Figure 4-3 shows the hydraulic jack and metal lip used as a lifting platform to lower the secondary liner onto the foundation. The liner welds were liquid-dye penetrant tested before and after lowering the secondary liner.

Figure 4-3. Lowering of Secondary Liner Bottom Using Hydraulic Jacks (Photo 66898-3) (Taken 12-9-1974)

Figure 4-4 shows a view of the tank SY-101 secondary liner lower knuckle construction. In the background, tank SY-102 is up on cribbing. The secondary liner bottoms for tanks SY-101 and SY-102 are resting on jack stands and cribbing, which were used to support the liner above ground level, allowing access to weld and inspect the underside of the liner bottoms. The 241-SY tank farm used strong backs to support the liner bottoms when they were being lowered.

Figure 4-4. Secondary Liner Lower Knuckle Section for Tank 241-SY-101 (Photo 64516-8) (Taken 8-20-74)

The 241-AY tank farm used a superstructure to support the lowering operation, which provided more support[4]. For the 241-SY tank farm, additional strong backs were added to the lowering operations to limit deflections in the steel plates.

4.3 REFRACTORY

The refractory design used for the three 241-SY tank farm tanks specified a nominal 8 in. thick layer of LW50 castable refractory material to be located between the primary tank and secondary liner bottoms, manufactured by Pryor-Giggey. The primary purpose of the refractory was to act as an insulating barrier between the primary tank and the concrete foundation during the post-weld stress relief process where temperatures of up to 1100 °F were required in the primary tank. Its use was to prevent the structural concrete temperature from rising above 500 °F.

Figure 4-5. Tank SY-102 with Refractory Cut Out Over Air Ventilation Supply Pipes and Air Channels Cut into Refractory (Taken 10-21-74)

The refractory pad housed air ventilation piping, thermocouple conduit, and air distribution slots. The air distribution slots allowed airflow to cool the primary tank bottom and to direct potential leaks to the tank annulus where leak detectors were located (see H-2- 37705, *Structural Insulating Concrete Plan and Details*). The four ventilation pipes terminate at the center of the tank at an air distribution ring. Air is drawn through this ventilation piping and out through the air distribution slots in the refractory.

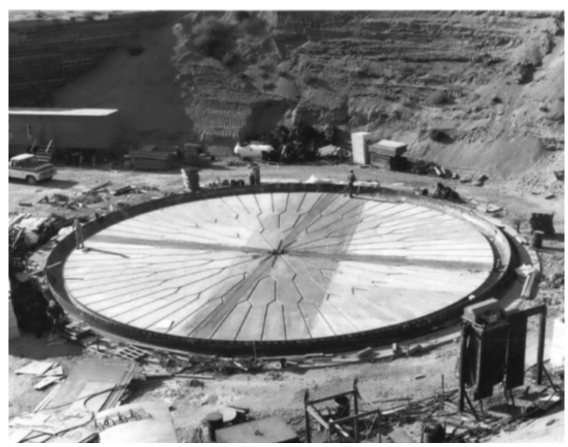


Figure 4-6. Tank 241-SY-102 with Refractory Filled in Over Air Ventilation Supply Pipes and Air Channels Cut into Refractory (Photo 66542-6) (Taken 10-22-74)

Prior to pouring the refractory a 7 in. x 3/4 in. carbon steel stiffener ring was installed around the perimeter of the pour and thermocouple conduits were installed. The stiffener ring was used as a form for the refractory and to contain spalling from the perimeter. The thermocouples allowed temperature monitoring of the refractory and primary tank bottom during post weld stress relief. The refractory was poured in twelve

[4] The Pittsburgh Des Moines Steel Company used a more substantial superstructure for the construction of the 241-AZ tank farm than the one they used for 241-AY tank farm. (refer to RPP-RPT-54818 *241-AZ Tank Farm Construction Extent of Condition Review for Tank Integrity)*

sections with channels left for the installation of the air supply pipes separately. The air distribution channels were cut into the refractory as opposed to the use of forms to shape the air channels in the 241-AY tank farm.

Following the installation of the ventilation piping and the center air distribution ring, refractory was poured into the pipe channels and air distribution channels were cut in these refractory sections. Figure 4-5 shows the refractory with the air ventilation supply pipe channel still open. Figure 4-6 shows the completed refractory of tank SY-102.

The refractory for tanks SY-101 and SY-102 was poured prior to the winter of 1974-75 and heated by a temporary electrical heating grid to prevent freezing. Installation of the refractory for tank SY-103 was postponed until March 1975 to avoid cold weather conditions. The primary tank and secondary liner construction continued during that time. A port was cut into the side of the secondary liner to support placement of the refractory in SY-103. Figure 4-7 shows the protective layer installed over tanks SY-101 and SY-102.

Figure 4-7. Protective Layer Installed Over Refractory for 241-SY-101 and 241-SY-102. (Photo 66534-1) (Taken 10-21-74)

4.4 PRIMARY TANK BOTTOM

Following completion of the refractory pouring and cutting the air distribution channels, the primary tank bottom was fabricated using a similar sequence as the secondary liner bottom. A protective cover was installed over the refractory to prevent damage during primary tank bottom fabrication. The bottom plates were installed on jack stands and cribbing over the refractory using fit-up tools to allow proper welding. Once the top and bottom sides of the primary tank bottom were completely welded, the first plate course (skirt) was welded on to the primary bottom and secondary liner. The primary tank was then lowered onto the refractory.

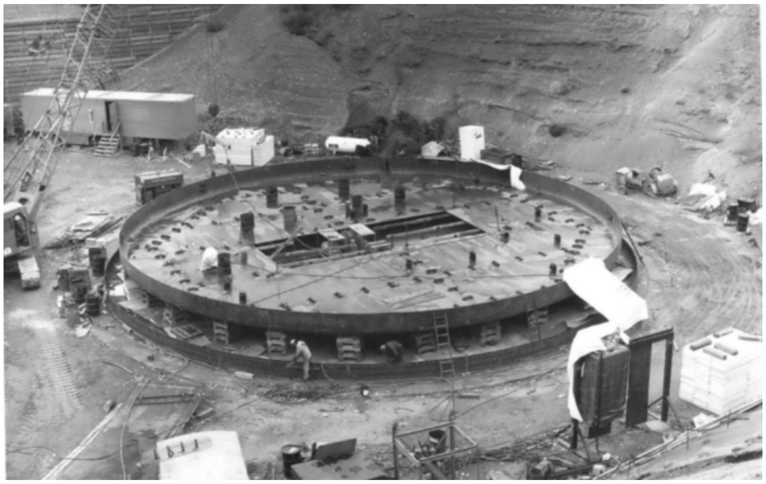


Figure 4-8. Crews Fabricating Primary Tank Bottom (Photo 66771-26) (Taken 11-21-74)

The tank primary bottom is composed of primarily 1/2 in. plate, increased from 3/8 in. used in the 241-AY tank farm, with the exceptions of the center 4 ft. diameter which is composed of 1 in. thick steel plate, and a 7/8 in. thick plate used for the bottom knuckle. See Table 5-4, in Section 5.1, for weld NDE information. Figure 4-8 shows the construction progress of the primary tank bottom for 241-SY tank farm on November 21, 1974. Crews are fabricating the primary bottom using jack stands and cribbing to gain access to the bottom side.

Figure 4-9. Fabricators Welding the Tank Dome Sub-Assemblies (Photo 67722-39) (Taken 3-20-75)

4.5 PRIMARY TANK WALL AND TANK DOME

The primary tank measures 75 feet in diameter to the center of the vertical plate. While the vertical wall of the secondary liner is all 3/8 in. thick steel, the primary tank plate thickness varies from 7/8 in. thick carbon steel at the bottom knuckle to 3/8 in. thick at the top transition plate and top knuckle. Above the bottom knuckle and bottom transition plates, there are three courses of plates that make up the majority of the primary tank wall as seen in Figure 3-1. The first of these courses is 3/4 in. thick. The next two courses are 1/2 in. thick. Above the third course is a 3/8 in. thick plate referred to as the top transition. This top transition plate is butt welded to a 3/8 in. thick primary top knuckle, which begins the elliptical shape of the steel tank dome. See Table 5-4, in Section 5.1, for weld NDE information.

To facilitate the installation of tank dome plates, a temporary center support post was installed. This post provided a resting place for the tank dome plates for proper fit-up and welding. Several smaller dome sections were welded together on supports at grade level, before being lifted by a crane and weld in place. Welders can be seen welding tank dome sub-assemblies in Figure 4-9. Figure 4-10 shows the dome support column.

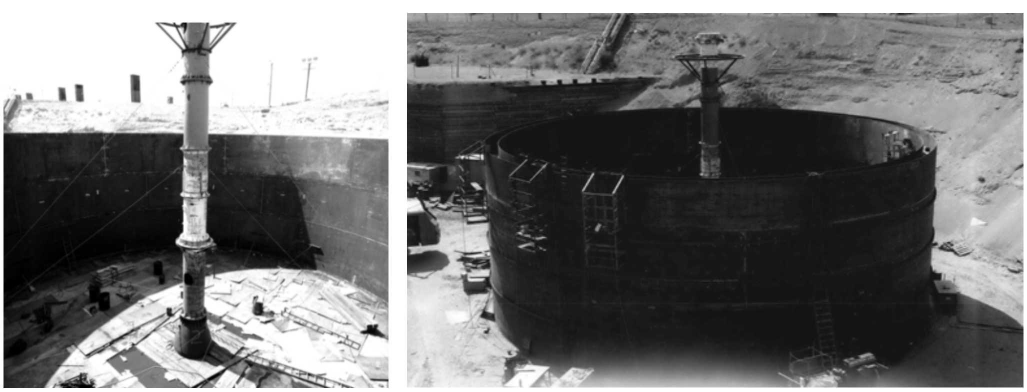


Figure 4-10. Tank Dome Support (Photo 68847-35 and 68847-38) (Taken 4/18/75)

After installation of the dome plates, the riser penetration holes were cut and pipes were welded to the tank dome plates. These penetrations served as access points for the remainder of construction and they support the installation of permanent and temporary equipment during operation. Figure 4-11 shows the construction progress of tank SY-103 primary and secondary liner wall.

Figure 4-11. Secondary Liner Wall Fabrication and Primary Tank Wall (Photo 68847-37) (Taken 4-18-75)

4.6 SECONDARY LINER WALL AND CONCRETE SHELL

The secondary liner wall is made up of a four plate course, seen in Figure 4-12 similar to the primary tank wall. The 3/8 in. thick secondary liner wall was welded up to the elevation just below the secondary top knuckle. The top knuckle of the secondary liner was not installed until after weld inspections, stress relieving, and hydrostatic testing of the primary tank were completed to allow access into the annulus.

The concrete shell, poured directly against the secondary liner (i.e., the secondary liner was used as a casting form for the concrete shell), is 1-1/2 ft. thick and has an outside diameter of 83 ft. The vertical concrete wall rests on a steel bearing plate that sits in a groove cast in the foundation. The vertical wall of the concrete shell was poured in three courses. Figure 4-13 shows the construction progress of the concrete vertical wall for the 241-SY tank farm on June 19, 1975. Two courses of concrete have been poured. Backfilling to the top of the concrete, hydrostatic testing, and post-weld stress relieving were completed prior to the final course and tank dome concrete being poured.

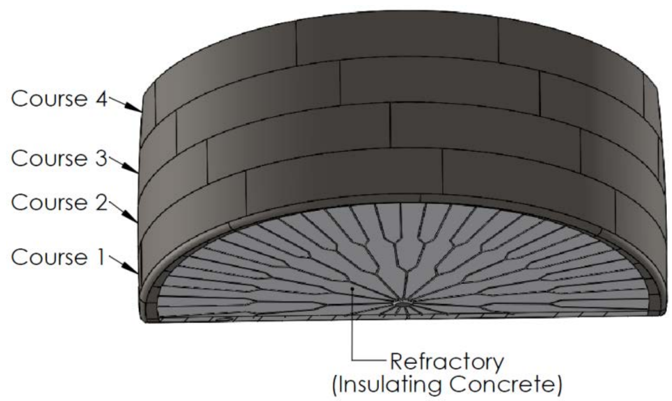


Figure 4-12. Cross-Section of Primary Tank and Refractory

4.7 PRIMARY TANK STRESS RELIEVING

After installation of the risers, and removal of the center post, the primary tanks were post-weld stress relieved. Insulation was installed over the primary tank and in the annulus to protect the concrete from high temperatures and to help regulate the heating of the primary tank. The refractory installed between the secondary liner bottom and the primary tank bottom protected the concrete foundation from high temperatures. In Figure 4-14, the crew is preparing for post-weld stress relieving. The insulation used to retain heat and protect the concrete can be seen wrapped around the primary tank of SY-102 on June 19, 1975.

The requirements for stress relieving were in accordance with ASME Code, Section VIII (1971), which specified a holding temperature of 1100 °F for 1 hour for each inch of steel. In addition, the difference between the maximum and minimum temperatures in the tank was required to be less than 200 °F. Thermocouples were attached to the primary tank to measure the temperature. The thermocouples installed during the insulating refractory pour were used to monitor the progress of the tank post-weld stress relieving temperatures in the primary bottom. The post-weld stress relieving specification from B-101-C1 is as follows:

Figure 4-13. Two Courses of Concrete Have Been Poured (Photo 69402-38) (Taken 6-19-75)

a. *"Primary tanks are to be fully stress relieved following completion of all high temperature work such as welding, cutting, burning, gouging, etc. Tanks are to be heated internally and indicating and recording temperature devices shall be used to aid in control and maintenance of a uniform distribution of temperature in the tank walls. Tanks shall be insulated for the stress relieving operation; insulation shall be removed after completion of stress relieving.*

b. *Stress relieving shall be in accordance with Paragraph UCS-56, Section VIII, of the ASME Boiler and Pressure Vessel Code, except that:*

   (1) *With reference to Note 1, Table UCS-56 tabulation, the minimum allowable holding temperature shall be 1000 F.*

   (2) *The rate of temperature rise and reduction between 600 F and 1000 F shall be no more than 100 F, per hour.*

   (3) *The period of heating from 600 F to 1100 F shall consume no more than 12 hours.*

   (4) *During the heating-up period, above 600 F, the temperature of all parts of the tank being heated shall be uniform with a maximum temperature differential at any time, between the highest and lowest temperature, of 200 F"*

Figure 4-14. Insulation Covering the Primary Tank of SY-102 Prior to Stress Relieving (Photo 69402-39) (Taken 6-19-75)

The heating occurred in two phases; the tank was first heated to 600°F and held for 2 hours to complete the curing process on the refractory. This curing was done to dehydrate the refractory and effectively turn it into a ceramic material. After the 2 hour hold, the temperature was to be slowly increased to 1100°F where it was held for 1 hour.

The tanks were cooled to 600°F at a rate of no more than 100°F per hour. At that point the, the stress relieving was deemed complete and the recorders documenting the heating and cooling were turned off. Table 4-1 shows a summary of the stress relieving of the tanks in the 241-SY tank farm.

Table 4-1. Post Weld Stress Relieving in 241-SY Tank Farm

Event	SY-101	SY-102	SY-103
Burners Turned On	2:00 p.m. July 10, 1975	5:00 p.m. June 21, 1975	10:00 a.m. August 1, 1975
Completed Initial Hold Time to Cure Refractory	5:30 a.m. July 11, 1975	3:30 p.m. June 22, 1975	10:00 p.m. August 1, 1975
Completed Final Hold Time for Post-Weld Stress Relief	12:10 a.m. July 12, 1975	11:42 a.m. June 23, 1975	3:00 p.m. August 2, 1975
	Three Hour Hold at 1000°F	One Hour Hold at 1100°F	One Hour Hold at 1100°F
All Thermocouples Reading Below 600°F, Reorders Turned Off.	8:10 a.m. July 12, 1975	7:30 p.m. June 24, 1974	11:20 p.m. August 2, 1974

The post-weld stress relieving process for tank SY-101, the second tank constructed in 241-SY tank farm, was started at 2:00 p.m. on 7/10/1975. An initial holding temperature of 600°F was reached at 3:30 a.m. on 7/11/1975, and completed 2 hours later at 5:30 a.m. The final hold temperature for tank SY-101 was 1000°F and it was reached at 9:10 p.m. on 7/11/1975. It should be noted that the temperature increase from 600°F to 1100°F should have taken no more than 12 hours (see B-101-C1). In this case it took approximately 15.5 hours. There was no mention of this issue in the QA logs and no NCR's or deficiency reports were located. The temperature was held at 1000°F for 3 hours before the heat was reduced and finally turned off. Post-weld stress relieving in tanks SY-101 was completed at 8:10 a.m. on 7/12/1975. At this time, all of the thermocouples had cooled below 600°F.

Official startup of stress relieving on tank SY-102 was at 3:00 p.m. on 6/21/1975; all burners were turned on at 5:00 p.m. A 2 hour hold at 600°F occurred at approximately 3:30 p.m. on 6/22/1975. A temperature of 1100°F was reached at 10:42 a.m. on 6/23/1975 and held for 1 hour. It took approximately 19 hours to heat tank SY-102 from 600°F to 1100°F, or 7 hours longer than specified in specification B-101-C1. There was no mention of this issue in the QA logs, and no NCR's or deficiency reports were located. After the 1 hour hold, the temperature was slowly reduced until the recorders were shut off at 7:30 a.m. on 6/24/1975 because all of the thermocouples were below 600 °F.

Official startup of stress relieving on tank SY-103 was at 10:05 a.m. on 8/1/1975. The 600°F curing temperature was reached at 8:00 p.m. and held for 2 hours. The stress relieving temperature of 1100°F was reached at 2:00 p.m. on 8/2/1975 and the hold was completed 1 hour later at 3:00 p.m. The temperature increase from 600°F to 1100°F took 16 hours, which is longer than the 12 hours specified in specification B-101-C1. There was no mention of this issue in the QA logs, and no NCR's or deficiency reports were located. The temperature was slowly reduced until the recorders were shut off at 11:30 p.m. on 8/2/1975.

Stress relieving was successful in all tanks, and there were no difficulties with the stress relieving process or equipment noted in the QA logs. Tank SY-101 was stress relieved at only 1000°F for 3 hours. There is no supplemental information or documentation on why it was stress relieved for 3 hours at 1000°F and not at 1100°F for 1 hour. All tanks in the 241-SY tank farm took longer than the 12 hours allowed in the specification for heating from 600°F to 1100°F. There was no mention of this issue in the QA logs, and there were no NCR's or deficiency reports located.

4.8 PRIMARY TANK HYDROSTATIC TEST

After completion of stress relieving, the heating equipment and temporary insulation were removed. The primary tank was then subjected to hydrostatic testing. Section 16, "Hydrostatic Test," of B-101-C1, provided the following direction for hydrostatic testing:

a. *"After the tank has been stress relieved, a full hydrostatic test shall be applied to the primary tanks by filling with water to a depth of 39 feet from the bottom of the tank ± 1 inch. One of the vertical risers near the center of the tank dome shall be used for introduction of water. Air bleed ports shall be provided to evacuate air within from the other vertical risers during the test. All accessible welded joints below the water level shall be coated with blue chalk. A preliminary hydrostatic test may be made, before stress relieving, at the contractor's option*

Figure 4-15. Partial Backfill of Tank SY-103 (Photo 69620-44) (Taken 7-22-75)

b. *The hydrostatic pressure shall be maintained for 24 hours.*

c. *Leak detection shall be by visual inspection of each welded joint previously coated with a solution of blue chalk and water or alcohol."*

Official startup of hydrostatic testing on tank SY-101 was on 7/24/1975 with the start of tank filling and covering weld seams with chalk. Testing was completed on 7/25/1975 with no leaks noted.

Official startup of hydrostatic testing on tank SY-102 was on 7/9/1975 with the start of tank filling. Progression of hydrostatic testing was slowed by the stress relieving effort in tank SY-101. Testing was completed on 7/15/1975 with no leaks noted.

Official startup of hydrostatic testing on tank SY-103 was on 8/8/1975 with the start of tank filling and covering weld seams with chalk. Progression of hydrostatic testing was slowed by the attempted strain gauge testing on the primary bottom of tank SY-103. Testing was completed on 8/11/1975 with no leaks noted. Additional hydrostatic testing was performed on this tank to support the strain gauge and acoustic testing of the stress from the bulge in tank bottom (see section 5.2.2.3).

After the completion of stress relieving and hydrostatic testing, the tanks were backfilled to the top of the already-poured concrete shell.

Figure 4-15 shows the construction progress for tank SY-103 on July 22, 1975. Post-weld stress relieving and partial backfill are complete. The secondary liner top knuckles are spread around the tank and ready to be lifted into place and welded to the secondary liner vertical wall.

4.9 COMPLETE SECONDARY LINER WALL AND TANK PENETRATIONS

Once the hydrostatic test was completed, the need for further access into all portions of the annulus was limited. The secondary top knuckle was installed and welded to the secondary liner vertical wall section. The secondary top knuckle is not welded to the primary tank. By design, a 1 in. maximum gap exists between the primary

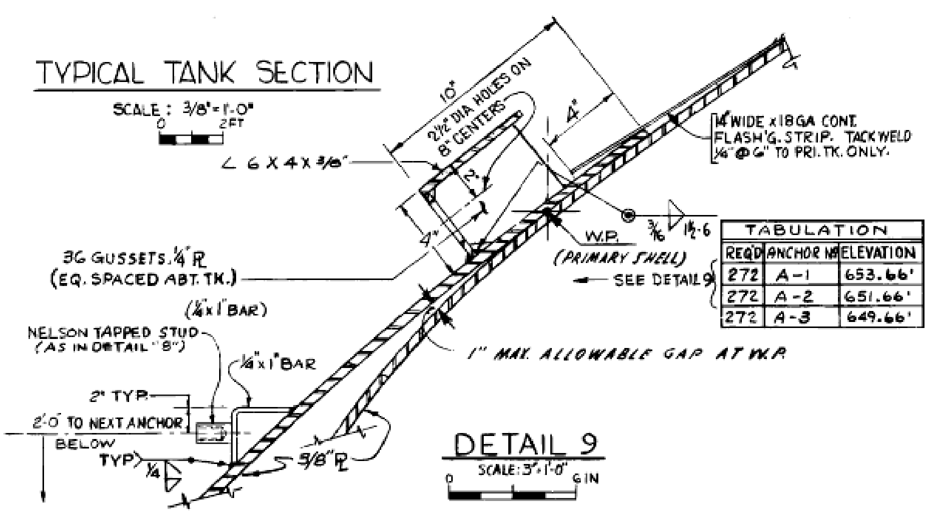


Figure 4-16. Detail 9 From H-2-37772, Showing the Intersection Between the Secondary Liner and Primary Tank Dome

tank dome and termination of the secondary liner. To prevent the collection of debris or concrete during the remaining construction, metal flashing was installed over the outside of the secondary top knuckle by tack welding to the outside of the primary tank as shown in drawing H-2-37772, Detail #9 in Figure 4-16.

4.10 CONCRETE DOME POUR

Section 17 "Support of Tanks During Concreting" of B-101-C1, provided the following direction to support concrete pours:

a. *"Tank supports shall be provided by the contractor to maintain the tanks in the geometric shape shown on the drawings during the period while the wall and dome concrete is being placed. The secondary tanks will be used as the inside form for the concrete walls.*

b. *Supports for placement of dome concrete shall be so located that steel tank dome does not deflect more than 1" between supports or exceed a stress of 20,000 psi at any point. Placement of dome concrete shall not impose any additional load on the primary tank shell.*

c. *Concrete and concrete reinforcing steel will be furnished and placed by another contractor. Placement of concrete will be limited to a rate of not more than 2 feet in elevation per hour from the bottom of the wall to a point 2 feet above the tangent line of the dome. Concrete in the haunch area, to the construction joint approximately 9 feet in from the outer wall form, will be placed at a rate not greater than one foot in elevation per hour. After concrete in the haunch area has cured a minimum of 3 days, concrete in remainder of the dome will be placed in one continuous pour. The following are the wet concrete live loads to be imposed on the tank:*

Within Radius of Tank Center (ft)	*Load (Lbs. per Sq. Ft.)*
0' - 25'	*375*
25' - 37'	*450*
37' - 40'	*450 at 37' radius to 1,100 at 40' radius*
Tank Wall	*600*

d. *High-early-strength cement will be used in concrete above the tangent line of the tank domes to permit earlier access to tank interiors and completion of tank appurtenances. Concrete will have a slump of not more than 4 inches at the time of placement and a minimum compressive strength of 3000 psi in 28 days.*

e. *Shoring or external support shall be of such design and construction, that when the dome concrete is placed, no additional load will be placed on the shell of the primary tank.*

f. *Tank dome supports shall remain in place a minimum of 7 days after completion of the final placement of concrete in the tank dome, except that the center support shall remain in place 14 days.*

g. *The floor of the primary tank shall be covered with 5/8 inch plywood or one inch thick lumber to prevent the accidental reconcentration* (sic) *of stresses removed during stress relief. Dome support columns shall be designed to rest on blocks or heavy timbers which will aid in distributing the load.*

Figure 4-17. Crews Installing Rebar Prior to Concrete Dome Pour (Photo 70273-26) (Taken 10-22-75)

A significant amount of rebar was installed around the tank prior to pouring the concrete. The rebar was used to reinforce the concrete. In Figure 4-17, the crew is installing rebar in the dome region while concrete forms are in place just below the tank haunch.

The dome was poured in two sections joined using a keyed construction joint. The first section poured includes the rest of the vertical wall and haunch. The tank haunch is the transition between the vertical concrete shell and tank dome. The second section was the remainder of the dome.

Figure 4-18 shows the construction progress of the concrete pour for the 241-SY tank farm on October 22, 1975. The last three sections of concrete have been poured and the concrete shell is completed.

Figure 4-18. Completion of Tank Dome Concrete (Photo 70273) (Taken 10-22-75)

4.11 TANK APPURTENANCES

After completing the concrete pours, the tank dome support structures were disassembled and removed in pieces through the existing 42 in. diameter riser penetrations. The equipment to be placed in the interior of the tank was then installed, including thermocouples, dry wells, and annulus pump pit, leak detection pump pit drains, and an air lift circulator in tank SY-102. These pieces of equipment were welded to the existing penetrations that had previously been installed on the tank dome prior to the tank stress relief.

5.0 CONSTRUCTION ISSUES

This section provides a detailed view of the construction issues identified during the fabrication of tanks SY-101, SY-102, and SY-103. This information has been compiled from a review of the Quality Assurance (QA) Construction daily logbooks (QA log), inspection sheets, memos, drawings, photos, construction records, and post-construction reports. The most important construction deficiencies are listed in Table 5-1 below. As noted in Section 4.0, tank SY-102 was built first, followed by SY-101, and with SY-103 last. The secondary and primary tank bottom fabrication/testing, post-weld stress relief and the refractory condition were the focus of this review.

Table 5-1. 241-SY Tank Farm Major Non-Conformance/Deficiency Report List

Non-Conformance or Design Change	Date	Tank	Description
NCR: B-101-20-2307-6	9/20/1974	SY-102	In several areas of the tank SY-102 secondary bottom, the root to crown slope exceeds the 3/8 inches per foot allowable. Thus the tank bottom presently exhibits slopes in localized areas up to 5/8 inches per foot.
NCR: B-101-21-2307-7	9/20/1974	SY-102	In two areas of the tank SY-102 secondary bottom distortions exist within the tangent point of the knuckle curvature.
NCR: B-101-22-2307-8	10/1/1974	SY-101	In several areas of the tank SY-101 secondary bottom, the root to crown slope exceeds the 3/8 inches per foot allowable. Thus, the tank bottom presently exhibits slopes in localized areas up to 13/16 inches per foot.
NCR: B-101-24-2307-9	12/13/1974	SY-103	In several areas of the tank SY-103 secondary bottom, the root to crown slope exceeds the 3/8 inches per foot allowable. Thus, the tank bottom presently exhibits localized areas up to 1 inch per foot.
NCR: B-101-34-2307-19	3/20/1975	SY-103	In several areas of the tank SY-103 primary bottom, the root to crown slope exceeds the 3/8 inches per foot allowable. Thus, the tank bottom presently exhibits slopes in localized areas up 13/16 inch per foot.
Design Change: B-101-128	1/31/1977	SY-101	Grout out-of-tolerance bumps in the primary tank bottom of the SY-101 tank. Locations at approximately 0° and 180° (North and South) on the tank.

5.1 WELD REJECTION AND NON-DESTRUCTIVE EXAMINATION

A quantitative comparison of welding success on tanks SY-101, SY-102, and SY-103 is shown in Table 5-2. A similar comparison was completed and included within RPP-ASMT-53793, *Tank 241-AY-102 Leak Assessment Report*, for the 241-AY tank farm. Analysis of the tank AY-101 and tank AY-102 primary bottom radiographic test diagrams (weld maps) was completed for a second time as a part of this extent of condition effort to ensure accuracy and consistency. The results are provided in Table 5-3, “241-AY Tank Farm Primary Tank Bottom Weld Comparison.” They are nearly identical to those previously tabulated with some minor discrepancies resulting from omission of the center dollar plate in the primary tank bottom in RPP-ASMT-53793.

Table 5-2. 241-SY Tank Farm Primary Tank Bottom Weld Comparison

	Tank SY-101			Tank SY-102			Tank SY-103		
	Feet of Weld (ft)	Reject Rate (%) per Repair Cycle	Total Reject Rate (%)	Feet of Weld (ft)	Reject Rate (%) per Repair Cycle	Total Reject Rate (%)	Feet of Weld (ft)	Reject Rate (%) per Repair Cycle	Total Reject Rate (%)
Weld prior inspection	655	N/A	N/A	625	N/A	N/A	647	N/A	N/A
Weld rejected after original weld	189	28.9%	28.9%	130	20.8%	20.8%	184	28.4%	28.4%
Weld rejected after first repair	71	37.6%	30.8%	30	23.1%	21.2%	29	15.8%	25.6%
Weld rejected after second repair	21	29.6%	30.7%	11	36.7%	21.8%	8	27.6%	25.7%
Weld rejected after third repair	1	4.8%	30.1%	4	36.4%	22.0%	1	12.5%	25.6%
Weld rejected after fourth repair	0	0.0%	30.1%	0	0.0%	22.0%	1	100.0%	25.7%
Weld rejected after fifth repair	0	N/A	N/A	0	N/A	N/A	1	100.0%	25.7%
Weld rejected after sixth repair	0	N/A	N/A	0	N/A	N/A	0	0%	25.7%
Total weld rejections	**282**			**175**			**224**		
Total weld	**937**			**800**			**871**		
Overall weld rejection rate	**30.1%**			**22.0%**			**25.7%**		

Table 5-3. 241-AY Tank Farm Primary Tank Bottom Weld Comparison

	Tank AY-101			Tank AY-102		
	Feet of Weld (ft)	Reject Rate (%) per Repair Cycle	Total Reject Rate (%)	Feet of Weld (ft)	Reject Rate (%) per Repair Cycle	Total Reject Rate (%)
Weld prior inspection	672	N/A	N/A	673	N/A	N/A
Weld rejected after original weld	67	10.0%	10.0%	229	34.0%	34.0%
Weld rejected after first repair	7	10.4%	10.0%	86	37.6%	34.9%
Weld rejected after second repair	1	14.3%	10.1%	27	31.4%	34.6%
Weld rejected after third repair	1	100.0%	10.2%	1	3.7%	33.8%
Weld rejected after fourth repair	0	N/A	N/A	0	N/A	N/A
Total weld rejections	**76**			**343**		
Total weld	**748**			**1016**		
Overall weld rejection rate	**10.2%**			**33.8%**		

The overall weld rejection[5] rates for SY-101, SY-102, and SY-103 were 30.1%, 21.9% and 25.7% respectively. In comparison, tank AY-102 had a similar rejection rate at 33.8%. The maximum number of times a weld section was repaired during 241-AY tank farm construction was four, with one weld section in tank AY-101 and one weld section in tank AY-102. During 241-SY tank farm construction, one weld section in tank SY-103 was repaired six times. (Weld rejections were a noted issue in RPP-RPT-53793.) Weld rejection in the 241-SY tank farm is an issue that likely contributed to the bulging seen in the primary tanks and secondary liners of the 241-SY tank farm. It was noted in NCR B-101-34-2307-19 (see Appendix C, App Figure C-2) that re-working welds created added distortions. It is likely that weld rejection and repair was a contributor to tank bottom bulging discussed later in Section 5.2. All welds were examined and accepted using the methods described hereafter, and all welds were stress relieved during the post-weld stress relieving process.

Welds were rejected or accepted based on non-destructive examination (NDE) methods. All NDE was performed by American Society for Nondestructive Testing (ASNT[6]) SNT-TC-1A certified level II NDE personnel. The level of NDE varied between the primary tank and secondary liner as well as with elevation of the tank. The change in NDE due to elevation was based on the planned use of the tank to contain waste up to a specific elevation. Table 5-4, "241-SY Tank Farm Non-Destructive Examinations Used During Construction," provides a summary of the NDE used to ensure the pedigree of the primary tank and secondary liner.

[5] Surface defects on the plate steel accounted for 8 to 10% of the weld rejection (see Appendix C, App Figure C-1)
[6] ASNT is a registered trademark of American Society for Nondestructive Testing

All welding was performed in accordance with Hanford Standard Specification HPS-220-W with approved procedures qualified in accordance with Section IX, ASME Code, by welders certified in accordance with Hanford Standard Specification HPS-210-W. On 7/31/1974 in the QA log it was noted that an unapproved weld procedure was used to begin welding on the tank SY-102 secondary liner. The weld procedure was later approved and all welds were inspected and accepted using the same methods and procedures.

Table 5-4. 241-SY Tank Farm Non-Destructive Examinations Used During Construction[7]

	Primary Tank Inspections	Secondary Liner Inspections
Tank Bottom	• 100% radiography • Magnetic particle • Liquid penetrant • 100% visual • Hydrostatic leak test	• 100% radiography • Liquid penetrant • 100% visual
Bottom Knuckle	• 100% radiography • Magnetic particle • Liquid penetrant • 100% visual • Hydrostatic leak test	• 100% radiography • Liquid penetrant • 100% visual
Vertical Wall	• 100% radiography up to 422 inches, not including the horizontal weld at 422 inches. (See Note 6 on Primary Shell Weld Maps in Appendix B) • Magnetic particle • 100% visual • Hydrostatic leak test	• 100% radiography up to 324 inches above floor plates. • 100% visual
Upper Knuckle and Tank Dome	• 100% visual • Hydrostatic leak test of upper knuckle and the horizontal weld connecting the dome and upper knuckle	• 100% visual

The radiography inspection on the primary tank and secondary liner bottoms was completed prior to lowering the bottom. Liquid penetrant examination was completed before and after lowering the bottoms.

An example of a primary bottom weld map is shown in Figure 5-1. Each red mark on a weld section represents a weld that was repaired at least once. The circles next to the repaired weld section have values in them such as R1, R2, etc. which represents the number of times a

[7] Tank NDE inspection reference documents: B-101-C1, H-2-37772, and Weld Maps (see Appendix B)

particular weld section was repaired. The circle around the weld repair value indicates that the weld was accepted. Welds were inspected in 1 ft. long sections; each inspected section is represented with a hash mark in the weld maps. Rejected welds were ground out, re-welded, and re-inspected. The weld maps for all 241-SY tank farm primary and secondary bottoms and side walls can be seen in Appendix B.

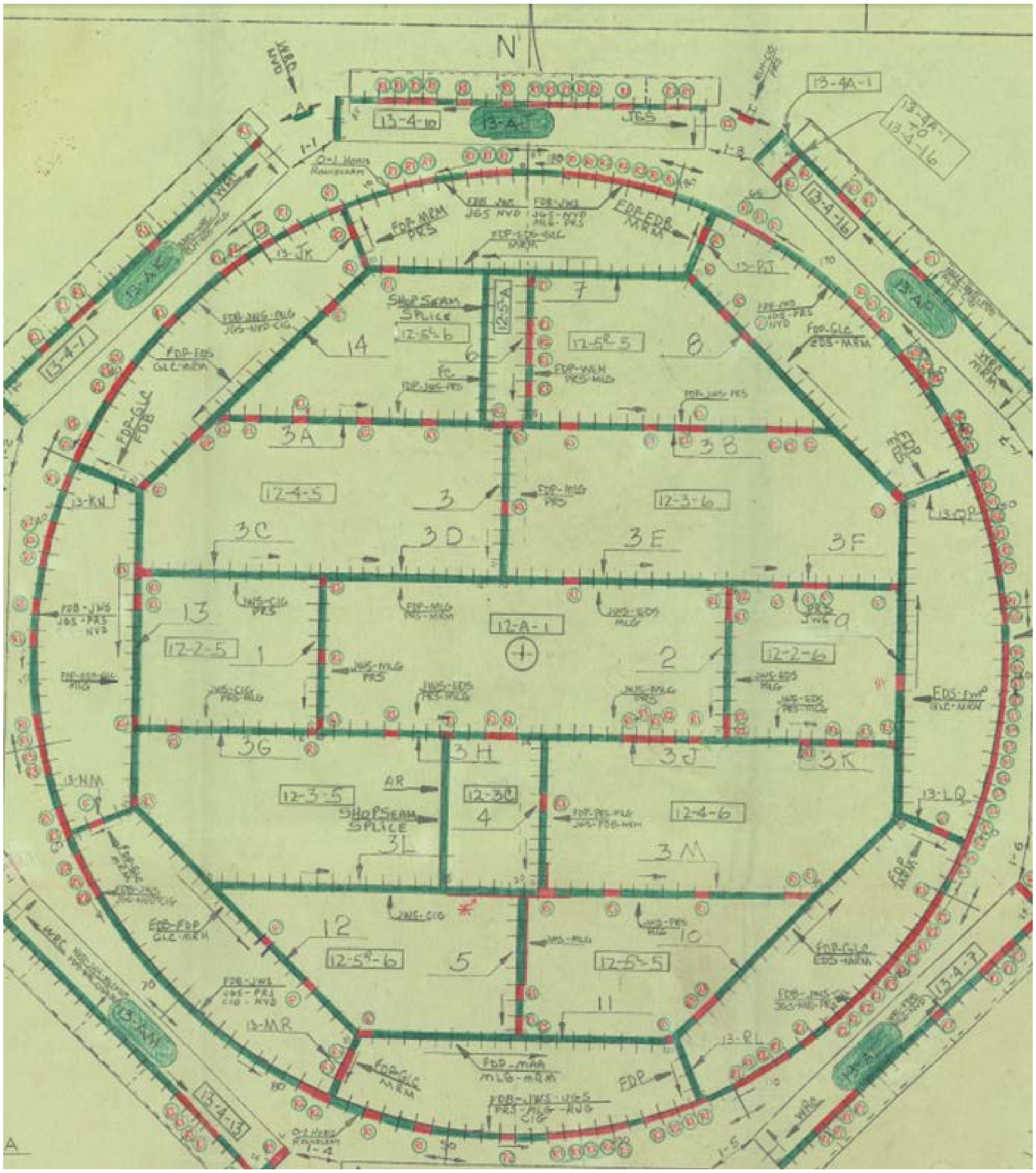


Figure 5-1. Tank SY-101 Primary Weld Map

5.2 TANK BOTTOM FLATNESS

Specification B-101-C1 specified that primary tank bottoms and secondary liner bottoms could have no root to crown slopes[8] (bulges) greater than 3/8 in. per ft. and a maximum root to crown height measuring 3 in. or less. Specification B-101-C1 also stated the following:

> *"Where flatness tolerances are not met, correction shall be by the use of 'flanging' torches, or impact tools used only with anvils or 'flatters' so that the force of the impact is distributed. All flattening operations are to be completed prior to stress relieving."*

Issues with tank bottom flatness for each tank are discussed in the following sections.

5.2.1 Secondary Liner Bottom Flatness

5.2.1.1. Tank SY-101

A survey of tank SY-101 secondary bottom liner found localized out-of- tolerance bulges. An attempt to repair the bulging by cutting seams and re-working welds was unsuccessful. After attempted repairs, there were nine out-of-tolerance bulges in the secondary bottom, the worst measuring 13/16 in. per ft. at its peak. Bulges were later accepted using the suggested disposition in NCR-B-101-22-2307-8 (Appendix C, App Figure C-3) which stated:

"*Conditionally accept provided that:*

1. *The subsequent liquid penetrant examination required after lowering is acceptable.*
2. *With load of primary tank bottom on refractory and before primary bottom is lowered, inspect and repair refractory cracks and depressions that are greater than the tolerances specified on the drawings and in the construction specifications.*

Justification:

> *The areas of out of tolerance are localized. Thus, the distribution of loadings will not affect the tank function and integrity."*

A method used to measure bulges in the 241-SY tank farm tanks can be seen in Figure 5-2. An inspector is using a level and a measuring tape to measure the root to crown height of a secondary liner bottom bulge during the refractory pour.

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[8] May also be referred to as distortions, and peak to valley slopes.

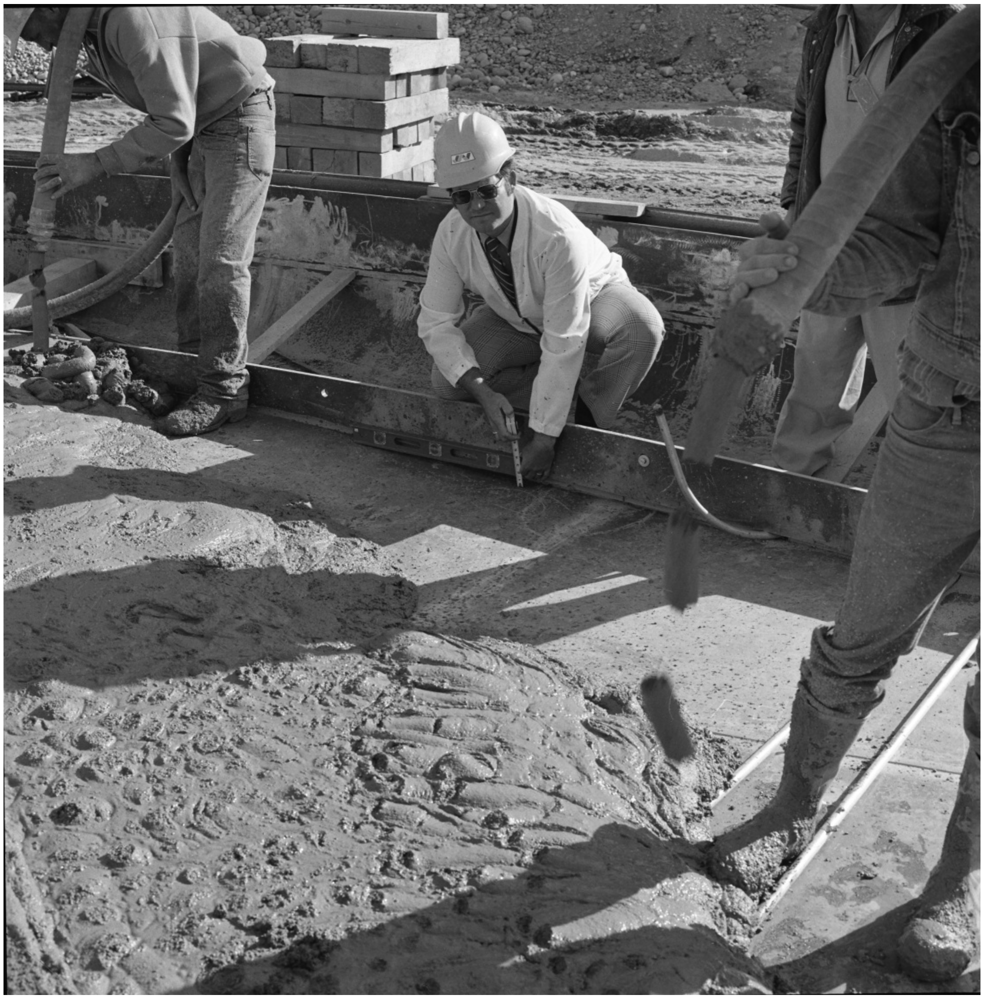

Figure 5-2. Secondary Liner Bulges During Pouring of the SY-101 Refractory (Photo 64906-8) (Taken 10-4-74)

5.2.1.2. Tank SY-102

At least two out-of-tolerance bulges were found in the tank SY-102 secondary liner bottom as noted in NCR-B-101-20-2307-6 (Appendix C, App Figure C-4), with the worst bulge being 5/8 in. per ft. The suggested disposition and justification of acceptance is identical to tank SY-101, NCR B-101-22-2307-8 above. Tank SY-102 also had two bulges within the tangent point of the knuckle curvature (NCR-B-101-21-2307-7, Appendix C, App Figure C-5).

The disposition and justification was the following:

"*Conditionally accept provided that:*

1. *The subsequent liquid penetrant examination required after lowering is acceptable.*
2. *With load of primary tank bottom on refractory and before primary bottom is lowered, inspect and repair refractory cracks and depressions that are greater than the tolerances specified on the drawings and in the construction specifications.*

Justification:

The areas of out of tolerance are localized. Thus, the distribution of loadings will not affect the tank function and integrity."

No slope was given for the two bulges. Figure 5-3 is a sketch of one of the bulges noted in NCR B-101-21-2307-7 (see Appendix C, App Figure C-5). Assuming the measurements are taken from the upper tangent point, the distance to the theoretical tank bottom is 12 in.

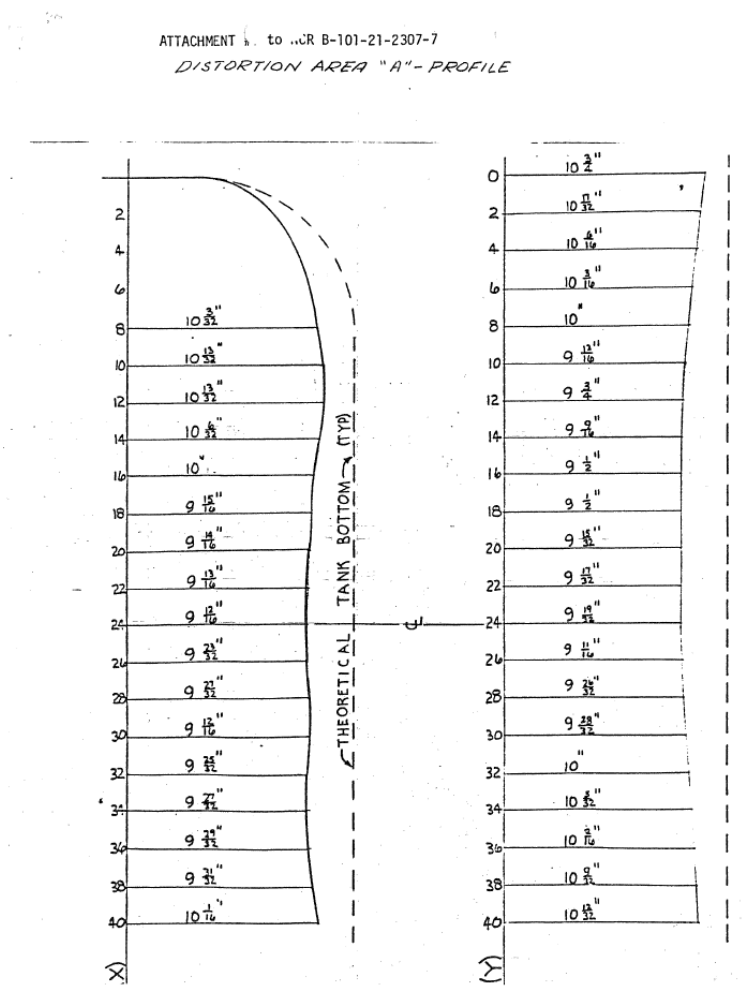

Figure 5-3. Tank SY-102 Sketch of Bulging Within the Tangent Line to the Knuckle

5.2.1.3. Tank SY-103

The welding sequence was revised prior to the secondary bottom fabrication of tank SY-103 in an attempt to correct the tolerance problem seen in the secondary liner fabrication of tanks SY-101 and SY-102. The effort was unsuccessful as bulges of up to 1 in. per ft. were noted in NCR-B-101-24-2307-9 (see Appendix C, App Figure C-6). An attempt was made to reduce the slope of the two bulges.

On 12/18/1974, it is noted in the QA log:

> *"103 Secondary – CB&I is trying to reduce the slope at 2 locations on the tank bottom. Air hammers against planishing* (sic) *hammers were used to see if the slope could be hammered down. I saw no change in the condition. Next, 6000 lbs was placed on the hump & again air hammers were used. Again no change was noted."*

The next day on 12/19/2013, the QA log states:

> *"103 Secondary Tank Bottom: A magnetic particle test was requested on the area that had been jack hammered upon yesterday (high-low area). At 2:00 PM I witnessed that test and found no questionable areas on either the weld pass or plate material itself."*

The suggested disposition in NCR B-101-24-2307-9 for tank SY-103 secondary liner bottom bulges was:

"*Conditionally accept provided that:*

1. *The subsequent liquid penetrant examination required after lowering is acceptable.*

2. *With load of primary tank bottom on refractory and before primary bottom is lowered, inspected and repair refractory cracks and depressions that are greater than the tolerances specified on the drawings and in the constriction specifications.*

Justification:

The areas out of tolerance are localized. The distortion at location '2' was rechecked and it

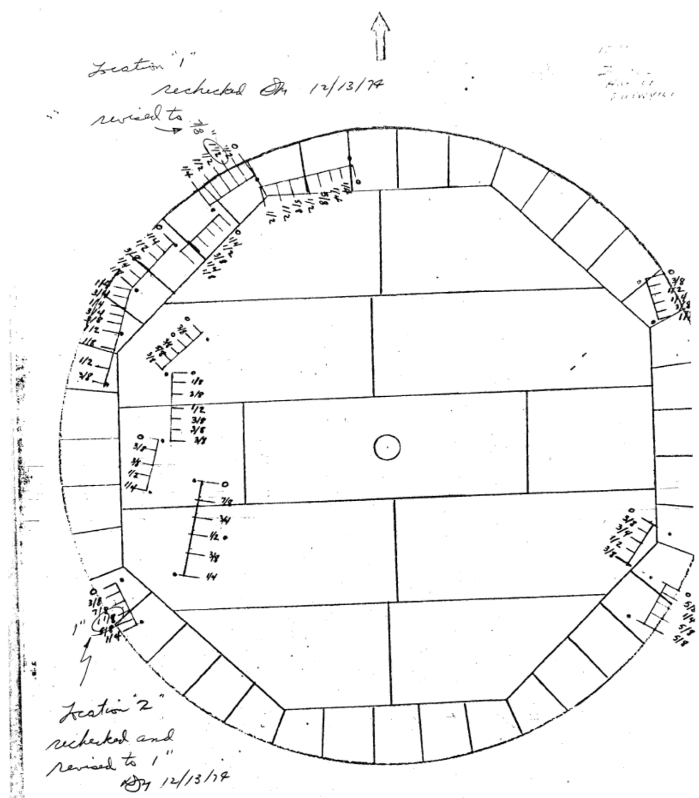

Figure 5-4. Attachment to NCR B-101-24-2307-9 Showing Location 1 and Location 2

> *was noted that the high point lies in the center of that plate material. Since the peak does not occur in the weld area, this distortion and the other distortions will not affect the tank function and integrity."*

The weld sequence was again significantly modified. An elaborate system of strongbacks was utilized for future tank bottom welding. The new weld sequence and strongbacks were first implemented on the primary tank bottom in SY-102, discussed later. Location 2 in the above quote can be seen in Figure 5-4. The primary cause listed in the NCR's for the secondary liner bulges in each tank was *"unsatisfactory weld sequence."*

5.2.2 Primary Tank Bottom Flatness

After the out-of-tolerance problem in the tank SY-103 secondary liner bottom, the weld sequence was significantly modified for a second time. A system of strongbacks was added in an effort to meet the root to crown slope specifications. The new weld sequence was used on all of the primary tank bottoms.

5.2.2.1. Tank SY-101

Primary tank SY-101 was initially accepted and declared to be within bottom flatness tolerances. In Vitro-R-389, *Strain Gage Activity (July 31 thru August 25, 1975) Relating to Primary Tank 241-SY-103*, the following observations were made:

5. *"…The bottom was fabricated and was out of tolerance. One area that was out of tolerance was determined to be a ridge distortion caused by the weld could be fixed* (sic) *by removing and rewelding three seams. This was done and that particular location came within tolerance, however new areas developed which were marginal as to being within tolerance. The bottom was then lowered and the out of tolerance areas redistributed leaving a bottom within tolerance."*

An ARHCO review of Vitro Engineering inspection reports found no documentation of a primary tank SY-101 bottom survey after lowering. It is unclear what generated the concern over bottom flatness in primary tank SY-101 after initial acceptance, but it is assumed that the lack of documentation led to an inspection of the primary tank SY-101 bottom. Primary tank SY-101 bottom flatness was questioned in an October 1, 1975 letter to J.F. Albaugh, *Documentation of Verification of SY Tank Farm Tank Bottom Flatness* (see Appendix C, App Figure C-7). A follow-up inspection of primary tank SY-101 bottom revealed at least two bulges near the lower knuckle.

It was suggested in a May 4, 1976 letter to V.D. Schrag, *Bottom Flatness Survey Tank 101-SY* (see Appendix C, App Figure C-8), that loading imposed on the knuckle during construction caused the bulge found in the primary tank SY-101 bottom after initial acceptance.

In a letter from Battelle Pacific Northwest Laboratories to J.F. Albaugh (ARHCO) on August 19, 1976 (Appendix C, App Figure C-9), it is noted that the work performed in BNWL-B-475, *Computer-Based Structural Investigation of the SY-103 Waste Storage Tank Which Contains*

Out-Of-Tolerance Bottom Bump, and in ARH-R-172, *Analysis of Underground Waste Storage Tanks 241-SY at Hanford, Washington,* has *"provided us with much insight into the tank fabrication problem and forms the basis for our present attitude on the SY-101 tank bottom question."* It is also noted in the letter that any effort to analyze the actual *"bump"* would not be cost effective and:

> *"…it is very likely to result in a conclusion that using the bumpy bottom without fixing the bumps would be unacceptably risky due to imposed, high flexural stresses during filling. Hence some stabilizing technique, like bump grouting, would be indicated to support the flexing.*
>
> *We find no difficulties associated with mechanics problems which might be imagined as a result of grouting, provided, the grout compliance and thermal properties are reasonably like that insulating concrete found under the remainder of the tank bottom (recalling that the insulating concrete has experienced thermal effects from the stress relief treatment)…"*

The analysis conducted on primary tank SY-103 (see Section 5.2.2.3) was used as the basis for determining the acceptability of the primary tank SY-101 bottom.

The solution to the bulge is found in Record of Design / Field Change B-101-128, which states the following:

> *"<u>Description</u>*
>
> - *Grout out-of-tolerance bumps in the primary tank bottom of the 241-SY-101 tank. Location approximately at 0° and 180° of the tank as shown on ES-B101-MG.*
> - *Grouting procedure per JA Jones submittal dated 7/1/76.*
> - *Structural stress supporting rationale per Vitro inputs attached.*
>
> *<u>Justification</u>*
>
> *To provide support to out-of-tolerance tank bottom to eliminate high stress potential."*

The decision was made to grout the bump areas beneath primary tank SY-101. A construction verification checklist which verifies the completion of the grouting at both 0° and 180° relative to north is found in App Figure C-10 in Appendix C.

A procedure for completing the design change is attached in Appendix C, App Figure C-9 which lists the following steps.

> *"This procedure is to outline the method used to grout under the primary tank bottom of Tank 101 in 241-SY Tank Farm. The reason for grouting is to give full support of the primary bottom in the area defined by drawing ES-B-101-M6* (sic).
>
> *(1) Assemble material and equipment.*
> *(2) Check material as being light weight – 50 or 70.*
> *(3) Layout areas to be grouted on the outside primary tank.*
> *(4) Cut out retainer band 2 to 3-feet long and remove. Cutout is to be centered on major axis of deformation.*
> *(5) Chip out existing refractory a minimum 2-feet wide 8-inches deep and 8-feet long. Remove broken refractory and vacuum all dust and particles from work area.*
> *(6) Fabricate slot forms using sheet metal and install.*
> *(7) Mix refractory per manufacture's recommendations and hand pack between existing refractory and tank bottom.*
> *(8) Re-weld retainer band in place after minimum of 48 hours cure on refractory.*
> *(9) Re-clean entire area and inspect."*

The construction verification checklist verifies that a section of steel retaining band was removed, refractory was chipped out, metal forms were installed for air distribution slots, grout was placed, the retainer band was re-welded, the area was cleaned and inspected, and no damage to the primary tank occurred during the repair. The grout used to backfill under tank had a compressive strength of 3,100 psi, which is considerably higher than the 130 psi required for the refractory. If any of the sheet metal slot forms are in contact with the tank bottom, it creates the potential for localized corrosion. A diagram of one of the two bulges in primary tank SY-101 can be seen in Appendix C, App Figure C-11.

5.2.2.2. Tank SY-102

Primary tank SY-102 bottom was the first primary tank bottom to implement the new welding sequence with added strong backs in an attempt to maintain bottom flatness tolerances. In Vitro-R-389, Appendix A, it is stated that "…*On completion of fabrication this primary bottom was out of tolerance, however after lowering the areas out of tolerance shifted and reduced so that tolerances were achieved."* Tank SY-102 primary bottom was found to fall within root to crown tolerances once the tank was lowered onto the refractory, which led to the acceptance of primary tank SY-102 bottom flatness.

5.2.2.3. Tank SY-103

The primary bottom of tank SY-103 did not achieve tolerance when the new weld procedure was used, and it was determined that re-welding would not guarantee a successful repair. The primary bottom of tank SY-103 was found to have nine bulges, the largest being a bulge with a slope of 13/16 in. per ft. which resulted in NCR B-101-34-2307-19 (see Appendix C, App Figure C-2).

The suggested disposition and justification in NCR B-101-34-2307-19 is as follows:

> "*Suggested Disposition:*
>
> *'Conditional accept' provided that the subsequent liquid penetrant examination required after lowering is acceptable.*
>
> *Justification:*
>
> *The areas out of tolerance are localized. Thus, the distribution of loadings will not affect the tank function and integrity."*

The letter attached to the NCR states, "*The results of any repairs that could be made to correct the deficient areas are questionable as to their success for the following reasons:*

1. *Deficient areas move as a result of lowering the tank bottoms and if the bottom is raised to affect a repair the same area may not be out of tolerance when raised.*
2. *Past experience on tanks 102 and 101 indicated that reworking seams creates added distortion elsewhere in the tank bottom which could result in a worse new condition than presently exists.*
3. *Since the discrepancies in the 103 primary bottom are not limited to the seam areas themselves, additional seams would be required to be added to the bottom plates.*

> *Since engineering design has examined the areas and determined that existing discrepancies will not affect the tank function or integrity and because of the inability to guarantee a successful repair, we feel that a repair cannot be justified."*

In September 1975, Vitro Engineering conducted an engineering study that was later compiled into interim report Vitro-R-350, *Tank Bottom Flatness Engineering Study*. The engineering study considered relaxing the 3/8 in. per ft. root to crown slope specification by investigating the basis for the tolerance, and by analytically testing the tolerance using a computer model. The initial results from the analytical ANSYS computer model analysis in Vitro-R-350 conclude the following:

"These models arbitrarily considered the hump to transgress the radius region of the knuckle. It is in the knuckle region where elevated stress levels were detected. There were other areas of elevated stress and these regions will be discussed under 'Validity of Results' in section D.5…. It is therefore necessary that future tank criteria maintain strict limitations on the slope and size of humps formed in the one-million-gallon tanks, and that these humps shall not be permitted to be located in close proximity to the knuckle region."

Although high stresses were found in the ANSYS tank bottom model, there were questions whether or not it represented the actual tank bottom and loading accurately, as described in Vitro-R-350 below:

> 5. *"Validity of Results:*
>
> *The ANSYS tank bottom models do not portray any existing nonconformance in any tank. The geometry attempted to match a possible discrepancy permitted by the existing construction specification (Version 2.1). Granted the boundary conditions of the model may have produced higher stress values than actuality, the results are believable when you compare these stresses to an axisymmetric model results* (sic)*… The bottom shell elements of the tank bottom model show elevated bending stresses, which may not be true in all cases because of the manner by which they were loaded… But because high stresses were found in the knuckle region where this loading condition is different, the effort and expense to nullify the artificial bending stress in the bottom shell elements were not made."*

Construction was halted on tank SY-103 to allow an in-depth review of the primary tank bottom. Halting construction allowed the annulus to remain open, providing easier access to the primary tank if it was needed.

Along with the ANSYS computer analysis described in Vitro-R-350, it was suggested that strain gauges be attached to primary tank SY-103 prior to filling the tank with water for hydrostatic testing. The data gathered from strain gauges during hydrostatic testing would be used to compare and verify the ANSYS analysis. A report of the strain gauge activity and data was recorded in Vitro-R-389, the source document covering all strain gauge activity and data pertaining to primary tank SY-103. The ANSYS computer analysis and strain gauge testing were done concurrently, and reports Vitro-R-350 and Vitro-R-389 were both released in September, 1975. A diagram of the bulge in primary tank SY-103 can be seen in Figure 5-5.

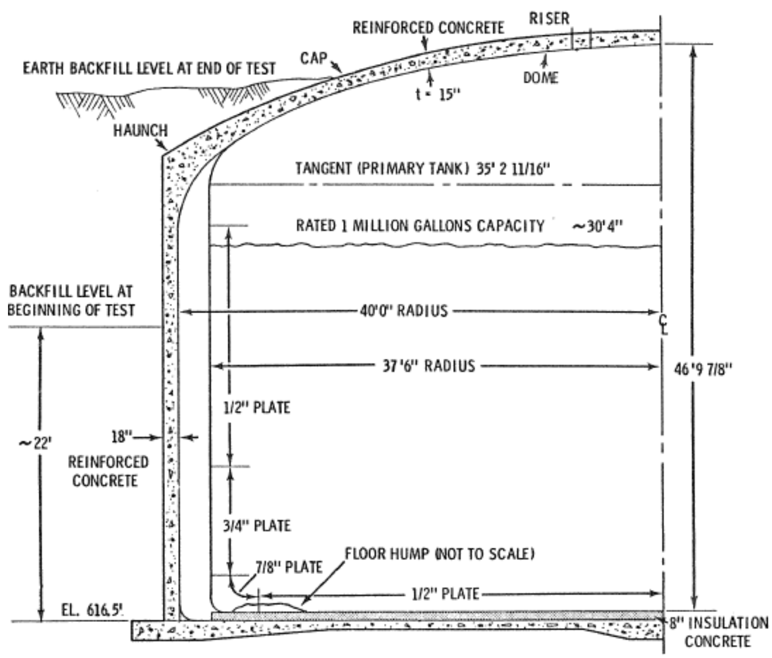

Figure 5-5. Cross-Sectional Illustration of Tank SY-103 Waste Tank

Vitro Engineering began the initial strain gauge testing by installing eleven strain gauges in the bulge region of primary tank SY-103 bottom. A baseline strain gauge reading was taken with no water present in the tank. Strain gauge readings were also taken at water levels of 15 ft.-3 in., and 39 ft.

From Vitro-R-389, initial strain gauge data analysis on August 13, 1975[9] reported the following:

> *"August 13, 1975: Preliminary analysis of strain gage* (sic) *data by Akerson, Fick, and Hecht indicated that stresses in excess of the yield strength of the material had occurred…"*

The preliminary results appeared to support the idea that tensile stresses in the bulge area were greater than the yield strength of the steel during hydrostatic testing.

The results also prompted another attempt to take strain gauge readings at a water level of 39 ft. on August 14, 1975. The results of the attempt are as follows:

> *"August 14, 1975: Because of the unexpectedly high strain indications, additional strain gage* (sic) *readings were taken by Akerson, Stratton, and Basile with water level in the tank at 39 ft…Additional readings were taken with the compensating gage and measuring gage terminal reversed…In addition, readings were taken with several gages connected in a three-wire configuration…and while the readings were different from those obtained using the two-wire method, the differences were so insignificant that this procedure was discontinued and readings were not recorded."*

After the second attempt to gather strain gauge data from tank SY-103, a decision was made to begin an overall non-destructive testing program on the primary tank. The Exxon Nuclear Company (Exxon) was asked to propose an acoustic monitoring program to be conducted during a water filling operation. The proposal was reviewed and accepted. A description of the technology, testing procedures and results can be found in XN-331, *Technical Report for NDT – Acoustics Testing of the Primary Shell of Atlantic Richfield Hanford Company Tank 103.*

The analysis from XN-331 states the following:

> "<u>Data Analysis Results</u>
>
> *Acoustic data were acquired as per XN-276.01 commencing at the 1.25 foot level and continued throughout the fill of tank 103.*
>
> *A total of 45 computer runs were conducted during and after the fill of storage tank 103. No 'significant' defects (grade 3 defects that would jeopardize the structural integrity of the tank) were found…*
>
> *…A total of eleven gradable sources were located on the tank. All eleven gradable sources were analyzed as Grade 1. Other detected acoustic sources were of such minor nature that they did not meet minimum grading criteria…"*

Battelle Pacific Northwest Laboratories (BNWL) was also contacted to monitor tank SY-103 primary tank utilizing strain gauges during the emptying of the hydro test water and second filling of the tank.

[9] The initial strain gauge test has been referenced in several reports including ARH-LD-146 *Technical Record of the 241-SY-103 Primary Tank Bottom Flatness Studies* and VITRO-R-350 *Tank Bottom Flatness Engineering Study*. However, the actual test documentation has not been found.

BNWL-B-471, *Strain Survey From a Hydrotest of the Primary Waste Tank 241-SY-103,* is the follow-on report generated by Battelle Pacific Northwest Laboratory. The results from BNWL-B-471 are summarized as follows:

> *"Tank B-103* (sic) *from tank farm 241-SY, having a non-conformance hump on the floor of the primary structure, was instrumented with strain gages* (sic) *and hydro tested. The highest compressive stress of 29,200 psi occurred on the outside surface of the knuckle region at the beginning of un-watering (water depth 43'-7"), while during subsequent filling at a maximum water level of 51'-9" the same location recorded a compressive stress of 25,400 psi.*
>
> *In general, stresses in the vicinity of the floor hump were lower than stresses on corresponding locations away from the hump. The reinforced concrete outer structure after curing appeared to reduce all stresses to a lower level."*

Figure 5-6 shows strain gauges ready to take strain measurements at the lower knuckle of primary tank SY-103 during a structural integrity study of the primary tank bottom.

Figure 5-6. Battelle Strain Gauges on Primary Tank SY-103 (Photo 756534-20) (Taken 9-12-1975)

Additionally, after a review of the procedure used by Vitro Engineering during initial strain gauge testing, it was noted in BNWL-B-471 that there was room to doubt the validity of the results for the following reasons, *"After consultation with Battelle-Northwest, analysis of the test procedure showed inadequate temperature compensation, long leads effects (two-wire readout) and possible capacitance effects caused by water surrounding the strain gage* (sic) *leads."* These factors were not accounted for during the initial strain gauge monitoring. An independent review of the structural study reported in BNWL-B-475 was conducted by an *"experienced staff member of the Engineering Technology Department. He has concluded that expected service performance of the SY-103 tank has not been compromised by the slightly out-of-tolerance bump."*

Other non-destructive testing was conducted on primary tank SY-103 during and after hydrostatic testing such as, liquid penetrant examination of the inside and outside of primary tank SY-103. Magnetic particle, and visual examinations were conducted on the outside surface of primary tank SY-103. All tests found primary tank SY-103 to be acceptable. The sequence and summary of all the non-destructive tests and the results are compiled into ARH-LD-146, *Technical Record of the 241-SY-103 Primary Tank Bottom Flatness Studies.*

5.2.3 241-SY Tank Farm Bottom Flatness Issues Summary

Tanks SY-101, SY-102, and SY-103 all had out-of-tolerance bulging in the secondary liner bottoms attributed to sequencing of the welding operation. After attempting to correct the out-of-tolerance condition, each secondary liner bottom was conditionally accepted using the criteria noted in the respective NCR written for each secondary liner. The bulging in the secondary liners of the 241-SY tank farm is very similar to the bulging noted in tank AY-102 in RPP-ASMT-53793. The principal issue with unsupported bulges in the secondary liner is that the bulges compress under the weight of a filled primary tank. The refractory may then crack due to its lack of strength in shear, leaving portions of the primary bottom unsupported.
Tanks SY-101 and SY-103 had out-of-tolerance bulging in the primary tank bottom. The refractory in tank SY-101 was chipped out in two locations and backfilled with grout to help support the bulging found in the primary bottom. Once the grouting was completed, tank SY-101 was accepted and signed off as construction complete. Extensive analysis, strain gauge, and acoustics testing were conducted on the bulge in tank SY-103. The measured stresses in the tank during hydrostatic testing were initially found to exceed the yield strength of the material. After multiple reviews by consultants and NDE contractors and further testing, the bulges in primary tank SY-103 bottom were conditionally accepted and construction continued. The primary issue with unsupported bulging in the primary tank bottom is the presence of tensile or compressive stresses along the wetted surface. This condition is thought to be a contributor to potential failure by stress corrosion. Primary tank AY-102 flatness is noted as being generally good, with very little mention of bumps or bulging during construction although voids between the primary bottom and refractory were filled with foam during refractory repair, (RPP-ASMT-53793).
Table 5-5 lists the tanks that contain bulging, and whether the bulging is located in the secondary liner bottom, primary tank bottom, or both.

Table 5-5. Bulges by Tank

Tank	SY-101	SY-102	SY-103
Secondary	Y	Y	Y
Primary	Y	N	Y

Y - Denotes tanks with out-of-tolerance root to crown distortions

N - Denotes tanks with no out-of-tolerance root to crown distortions

Overall, 241-SY tank farm bulging issues increased over those documented in RPP-ASMT-53793 for tank AY-102. Bulging occurred in all of the secondary liner bottoms as well as two of the primary tanks in the 241-SY tank farm. This creates the potential for higher tensile and/or compressive stresses along the wetted surface of the primary tank. High stresses in the wetted perimeter are thought to be a related cause of stress corrosion cracking. Regarding tank bottom construction in the 241-SY tank farm, those factors that caused unsupported areas and the potential for areas of high residual stress in tank AY-102 are present in all of the 241-SY tank farm tanks.

5.3 REFRACTORY

The original refractory specified in the 241-SY tank farm construction specification was to be either Kaolite 2200LI (used in 241-AY tank farm) or Kaolite 2000 (used in 241-AZ tank farm), although the construction specifications allowed alternate material provided that it met the specifications (B-101-C1). The contractor selected a substitute material, LW50, made by Pryor-Giggey. Mechanical properties' testing was required for the LW50 material and testing initiated by BNWL early in the project.

Minor difficulty in the testing by BNWL was mentioned in the QA log on 6/7/1974. Not enough sample was provided for testing and new mixing instructions were required to produce a pourable mixture.

The first refractory installation was initiated for tank SY-102 on 9/25/1974. The test report for LW50 was issued shortly after on 10/16/1974 as a Battelle letter, *Evaluation of Lite Wate 50 Castable Refractory*, and can be found as Attachment 9 to RPP-19097, *Evaluation of Insulating Concrete in Hanford Double-Shell Tanks*. The refractory met the required test specifications for compressive strength, but the testing showed heating too rapidly would destroy the sample. Review comments provided by the ARHCO structural expert on 11/1/1974 (also found in Attachment 9 to RPP-19097) expressed concern about this, the need for temperature control for the initial heat-up to 600°F, and the possibility that the refractory could be saturated at the start of stress relieving. He also expressed questions about test results that showed a reduction in compressive strength after radiation exposure. Revision and additional testing were suggested to understand the heating rate but there is no record that it was performed.

Resistance of the refractory to a tank waste simulant was not demonstrated by laboratory testing as was done for 241-AY and 241-AZ tank farms. The manufacturer provided a letter certifying the refractory was compatible with a list of chemicals specified in the construction specification (B-101-C1) that was similar to the simulated tank waste used in earlier testing. The letter is also found in Attachment 9 to RPP-19097 and contains an error. The solution concentrations are given in parts per million (ppm) and not molar (M) as specified in the construction specification. No reconciliation of that error could be found.

Weather protection was specified for the refractory. Drawings include the note "*Insulating concrete shall be protected from freezing at all times*". As mentioned in Section 4.3, a heating grid was installed on top of the refractory for SY-101 and SY-102 to provide protection from freezing temperatures. The grid was covered with sand, insulation and plywood. Just prior to lowering the primary bottoms for these tanks, this system would be removed. The refractory installation for tank SY-103 was postponed until the next spring, after freezing temperatures had passed.

Issues with the refractory for each specific tank are discussed in the following sections.

5.3.1 Tank SY-101

There was one refractory-related issue with tank SY-101. On 3/18/1975 the QA log notes that refractory was pumped into tank SY-101 refractory in damaged areas:

> *"Insulating concrete was pumped into the 101 tank refractory in the two damaged areas which had been chipped out…"*

No prior mention of this refractory issue in tank SY-101 prior to QA log entry 3/18/1975 could be found, and no other construction documents have been found regarding damage or repair to this refractory. Without additional documentation, it is not possible to quantify the extent of damage to the refractory. It is known that all cylinder test reports had to be accepted prior to tank operation.

5.3.2 Tank SY-102

A QA log entry dated February 7, 1975, (see entry number 89, Appendix A) notes that tank SY-102 refractory developed cracks around the cribbing supports. The QA log entry states:

> *"102 Primary bottom… Insulating concrete has cracked around some of the twelve cribbing supports. In most cases, cracking is minor. Thompson will repair the only really bad area over the weekend."*

The refractory was repaired the next day on 2/8/1975. The repair was noted in the QA log:

> *"…decided to take out an area approx. 8'-0" x 5'-0" and 2" deep, this is the area that was broken…[The contractor] started sawing…when he completed sawing it, he started breaking it out with a hammer and wood chisel. It was broken out approx. 2 1/2 inches deep. I informed the contractor that they would have to use hot water to mix the aggregate…the concrete was mixed by hand and placed at 65°F."*

The only weather related issue specifically noted was in the QA log entry on February 10, 1975 (entry number 92 in Appendix A).

> *"102 Primary Bottom – Slight frost was detected on some areas of the insulating concrete surface (temperature 30°). Areas were Hammer tested by E.S. Davis, and seemed ok. Lowering of primary bottom was commenced at 2:00 PM…"*

Little mention was found of refractory behavior during the heating from the post-weld stress relieving process. The QA log noted that during the 600°F hold, (intended to bake-out the refractory to remove any water and form a ceramic material), that some steaming may have been observed. On 6/22/1975 it was noted that,

> *"At 3:30 pm, contractor is still in the process of baking out steam from the insulating concrete."*

This time was 22.5 hours from the start of the stress relieving process and by 10:42 a.m. on 6/23/1975 (just over 19 hours later) the lowest temperature recorded on the primary was above 1100 °F. By comparison, in tank AY-102, over two days of heating were required to remove the water from the refractory and increase the tank bottom to a temperature over 210°F, with escaping steam evidenced for an extended period. An additional two days of heating in AY-102 was required to approach temperatures required for stress relieving. Excessive rain water in the refractory was attributed to long delay in the stress-relieving process and the resulting badly damaged refractory seen in both 241-AY tanks.

Later in construction, after the post-weld stress relieving, the tank SY-102 refractory was inspected and only minor damage was reported. In Figure 5-7 is a diagram from a report titled, *Report on Field Investigation of the Tank 102-SY Insulating Concrete Around Tank Perimeter After Primary Tank Stress Relief,* dated 7/25/1975, which was ten days after the hydrostatic testing was completed on this tank. A copy of the report is in Appendix C as App Figure C-12. The report refers to three perimeter areas where degraded refractory was noted. None were noted as penetrating past the knuckle tangent point. One indicated friable layers between 1/8 in. and 1 1/4 in thick over an area 8 in. by 6 in. Another area noted was a crack 1/8 in. wide. The third area was a friable layer 1/2 in. thick by 2 ft. wide approaching the knuckle area. It was also noted that approximately 50% of the perimeter had friable material between 1/8 in. and 3/16 in. thick. Apparently no repair was made to the friable material, and the refractory was left as is.

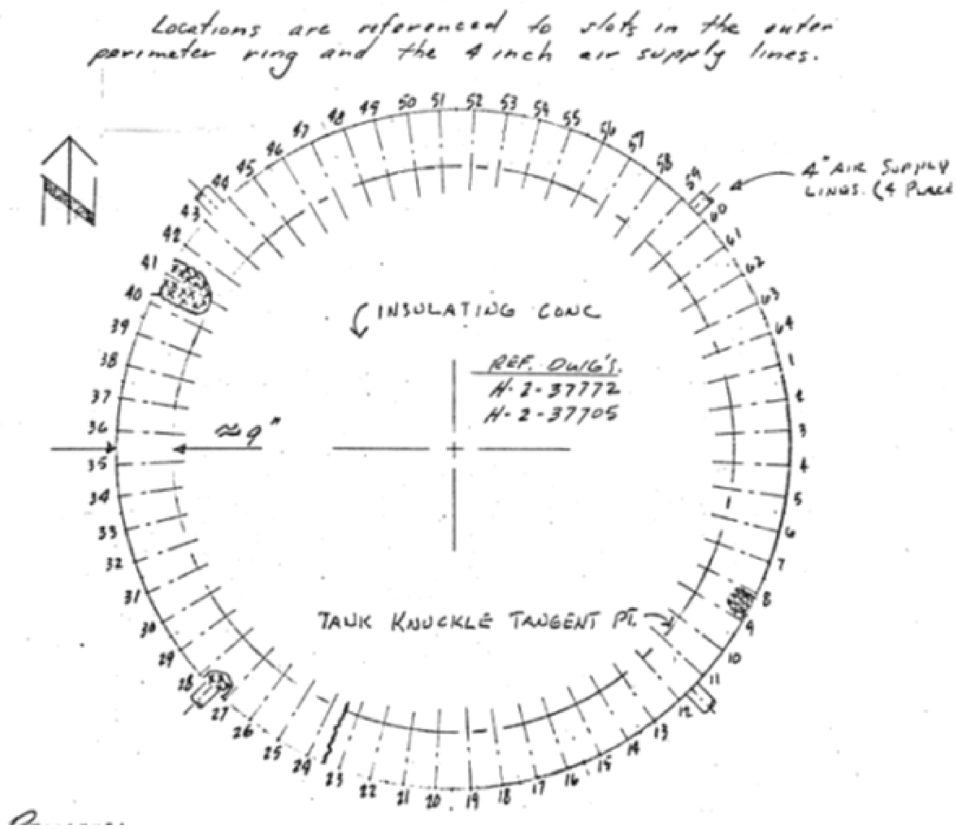

Figure 5-7. Diagram from Report on Field Investigation of the Tank 102-SY Insulating Concrete Around Tank Perimeter After Primary Tank Stress Relieving

This was the first tank constructed in 241-SY tank farm and the only one where a specific refractory inspection report was found after stress-relief and hydrostatic test. The damage was minor. No mention or record of refractory repair to the minor damage seen in tank SY-102 was located. It is assumed the minor damage was accepted as is. No record of similar post-hydrostatic test refractory inspection was found for the other 241-SY tank farm tanks.

5.3.3 Tank SY-103

No specific deficiencies were found in the logbooks for tank SY-103. An NCR was located documenting that the refractory was not level and did not meet the ± 1/4 inch specification (NCR B-101-32-2307-17). A survey of the insulating slab identified it was as much as 0.95 inches below and 0.82 inches above the specified base elevation. The cause was attributed to the limited access making form resetting difficult. The corrective action was to install the refractory before primary tank fabrication to avoid the access issues. The justification to accept the non-conforming condition" as-is" was that the refractory thickness was still adequate and the tank design and function were not affected. A copy of the NCR is included in Appendix C, App Figure C-13.

5.3.4 241- SY Tank Farm Refractory Issues Summary

Issues noted in this report pertaining to the 241-SY tank farm refractory were relatively minor. The refractory used met compressive strength specifications when tested, but it was apparently never tested for exposure to simulated caustic tank waste solutions. Weather/freeze protection was specifically requested during construction and provided by the use of a heating grid system or cold weather prohibition. Minor freeze damage was noted on tank SY-102. Repairs were minor when compared to the extensive refractory repairs to tank AY-102 described in RPP-ASMT-53793. Minor steaming was mentioned during the stress relieving step on the tank SY-102. Overall, the refractory construction in 241-SY tank farm was improved over the refractory construction in the 241-AY tank farm.

5.4 ISSUES UNIQUE TO 241-SY TANK FARM

5.4.1 Deformation of Tank SY-102 Secondary Liner

During the lowering process of the tank SY-102 secondary bottom, eight hydraulic jacks were set up around the perimeter of the tank bottom as seen in Figure 5-8. Four hydraulic jacks were operated off each of two manifolds, using one operator per manifold. A lack of hydraulic jack control led to distortions of up to 18 in. when four of the jacks were lowered 8 in. relative to the other four jacks. NCR B-101-19-2307-5 was generated and can be found along with the attachments depicting the tank bottom distortion in Appendix C, App Figure C-14.

The suggested disposition and justification from the NCR are as follows:

> "*Conditional accept provided that:*
>
> 1. *The subsequent liquid penetrant examination required after lowering is acceptable.*
> 2. *There are no unacceptable permanent distortions.*
> 3. *With load of primary tank bottom on refractory and before primary bottom is lowered, inspect and repair refractory cracks and depressions that are greater than the tolerances specified on the drawings and in the construction specifications.*"

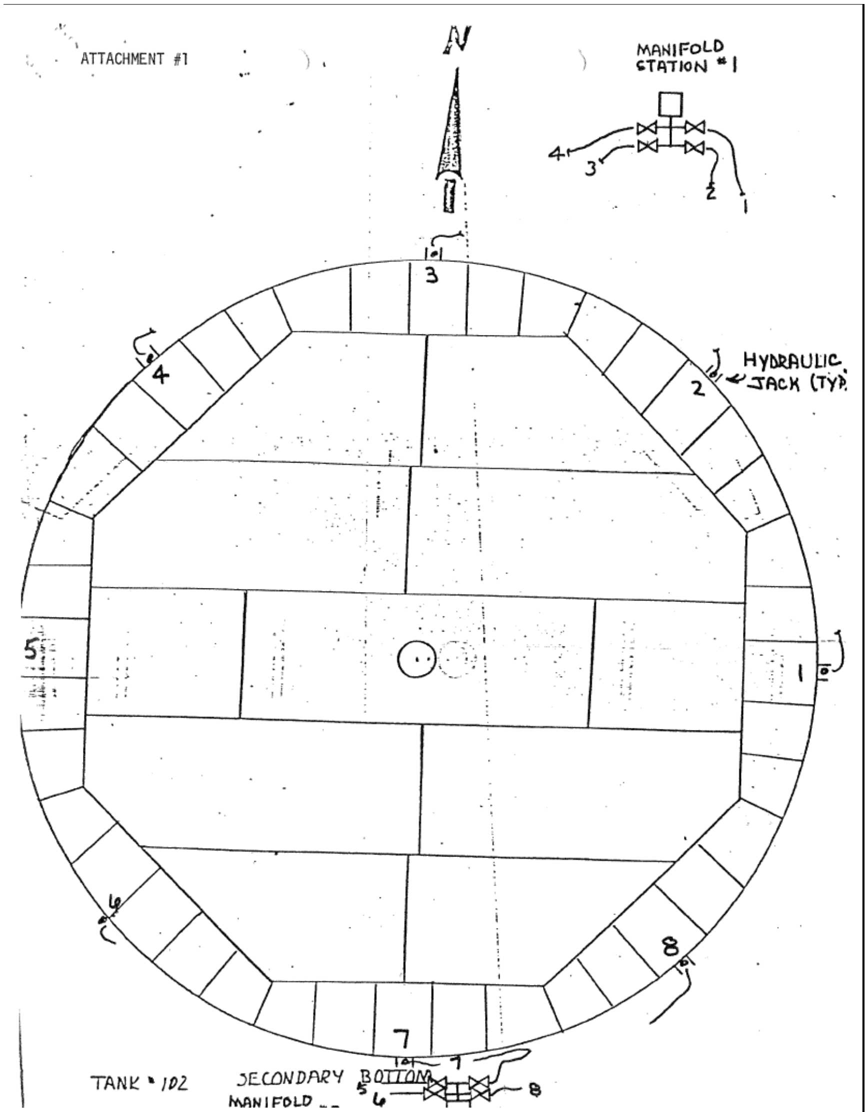

Figure 5-8. Tank Bottom Jack Location

The lowering procedure was noted as the cause for the non-conformance. The procedure was changed to minimize any future issues.

5.4.2 Weld Splice Joint

Steel plates to be used in the 241-SY tank farm were required to go through a receiving inspection to determine if they conformed to the desired specifications. Two primary bottom plates were measured for thickness and found to be out-of-tolerance. One of these plates was used in primary tank SY-101. To correct the issue, the end of the steel plate which did not meet thickness tolerances was cut off and a new plate spliced (welded) on. The welded splice joints created an issue during fit-up and welding of the primary bottom in tank SY-101. The plate with the splice resulted in four plates meeting at a single weld joint. Specification B-101-C1 called for no more than three plates to meet at a single weld joint. This issue is identified in nonconformance report (NCR) B-101-25-2307-10, included as App Figure C-15. The suggested disposition and justification in NCR B-101-25-2307-10 was as follows:

> *"Accept as is since joint is permitted by ASME Section VIII, and all welds will receive visual, liquid penetrant (before and after stress relief), and radiographic examination. In addition, each weld seam shall be liquid penetrant examined on the tank exterior surface for a minimum distance of twelve inches from point of junction."*

The other plate found to be out-of-tolerance was used in primary tank SY-103. NCR B-101-26-2307-11 (see Appendix C, App Figure C-16). was generated and the plate accepted as is using the same disposition and justification as in NCR B-101-25-2307-10 above

5.4.3 Air Leak During Concrete Dome Pour

On 10/20/1975 in tank SY-101, the QA log states the following:

> *"…I noticed that the tank had a leak in it, 1'-0" West of the 42" riser at center, the air and water was bubbling up through the concrete (very slowly).*

On 10/27/1975 in tank SY-101, the QA log states the following:

> *"I accompanied Dex Lien during his field evaluation of water/air bubbling incident on tank 101 dome concrete."*

No further information was located regarding the leak found in the dome of primary tank SY-101.

5.4.4 Primary Tank Bottom Plate Drop

It was also noted in the QA logs on 11/20/1974 that, *"…Primary tank bottom was put in place on 102 tank jack stands* (sic). *One plate was dropped when one of the four clamps came loose. It fell pointed end first which hit the ground while the other end landed on the 102 secondary tank skirt…"* QA personnel checked for damage on both components and found *"no apparent damage."* There is no further documentation or information regarding this incident.

5.4.5 Tank Bottom Lowering Swivel Condition

During the lowering of tank SY-102 primary bottom on 2/10/1975, the QA log states the following, *"…Lowering of primary bottom was commenced at 2:00 PM. By end of shift bottom had come down about a foot, and had began* (sic) *to swivel counter clockwise and to the west…"* The deviation measured with a plumb bob was no more than 5/8 in. This condition was noted as being *"…not yet intolerable…"* The problem was solved on 2/11/1975 by, *"Installation of four come-alongs between primary and secondary tanks.*

5.4.6 Primary and Secondary Shell Tolerances

Several NCR's, deficiency reports, and QA log entries were found that relate to liner fabrication difficulties. These include out-of-roundness, too small circumference and vertical deviations in the tank walls. They are discussed separately below.

5.4.6.1. Tank SY-101

A deficiency report and two NCR's were generated as a result of an out-of-tolerance circumference in the first shell ring of tank SY-101 secondary liner. NCR B-101-33-2307-18 in Appendix C, App Figure C-17 is the first record of this issue in tank SY-101 on 3/13/1975. The discrepancy and disposition was as follows:

> *"Discrepancy: The circumference of the Tank 101 secondary shell ring (1st course) is 251' 1-13/16". Specified circumference is 251' 6-9/32" (theoretical), plus or minus two inches. Thus, the shell ring is 2-15/32" smaller in circumference. This present condition may result in all subsequent shell rings placed on this course to be similarly out of tolerance, as emphasis will be placed on maintaining vertical plumbness* (sic).
>
> *Suggested Disposition and Justification: 'Accept-as-is' – as this condition exists on the secondary shell, permanent storage capacity is not applicable to this situation. Structural integrity and function of the secondary tank as a protective barrier against the release of radioactive material into the environs* (sic) *is not impaired by this condition."*

Another NCR B-101-35-2307-20 (see Appendix C, App Figure C-18) was generated, relating to this out-of-tolerance circumference issue. The discrepancy and suggested disposition from NCR B-101-35-2307-20 was as follows:

> *"Discrepancy: On the Tank 101 secondary shell, areas exist where the maximum deviation of the line of intersection from a true straight line exceeds 1/2 inch in a five foot length. (Actual maximum measurement in areas shown is 1-1/16 inches, see attachment.) These deviations, a result of distortions in the shell plate, were fabricated to achieve a plate-to-skirt fit-up, then were locally aggravated by weld repairs. This condition contributed to the smaller circumference of the first shell course. (See NCR B-101-33-2307-18.)*
>
> *Suggested Disposition and Justification: 'Accept-as-is' – as the length distortion around the periphery is relatively short, the loading of additional shell is insignificant. Subsequently, the concrete tank cylinder placed against the secondary tank will provide additional support of the shell, due to the embedment of the studs and stiffener rings. These are welded to the tank shell prior to concrete placement. Therefore, the function and integrity of the secondary shell remains unaffected."*

Figure 5-9 is the attachment to NCR B-101-35-2307-20 showing the deviations and locations around the tank. Deficiency Report # 23 in Appendix C, App Figure C-19 describes the circumference as being *"…3 1/2" Less than the theoretical circumference. This exceeds the* *tolerance allowance in the dimensional control procedure by 1 1/2" (allowable deviation = +/- 2").*

Cause: Bottom knuckle is slightly tipped in and first ring had to be trimmed 3 + inches."

Tank SY-101 secondary shell deviations were accepted as is based on the dispositions of NCR B-101-33-2307-18 and B-101-35-2307-20.

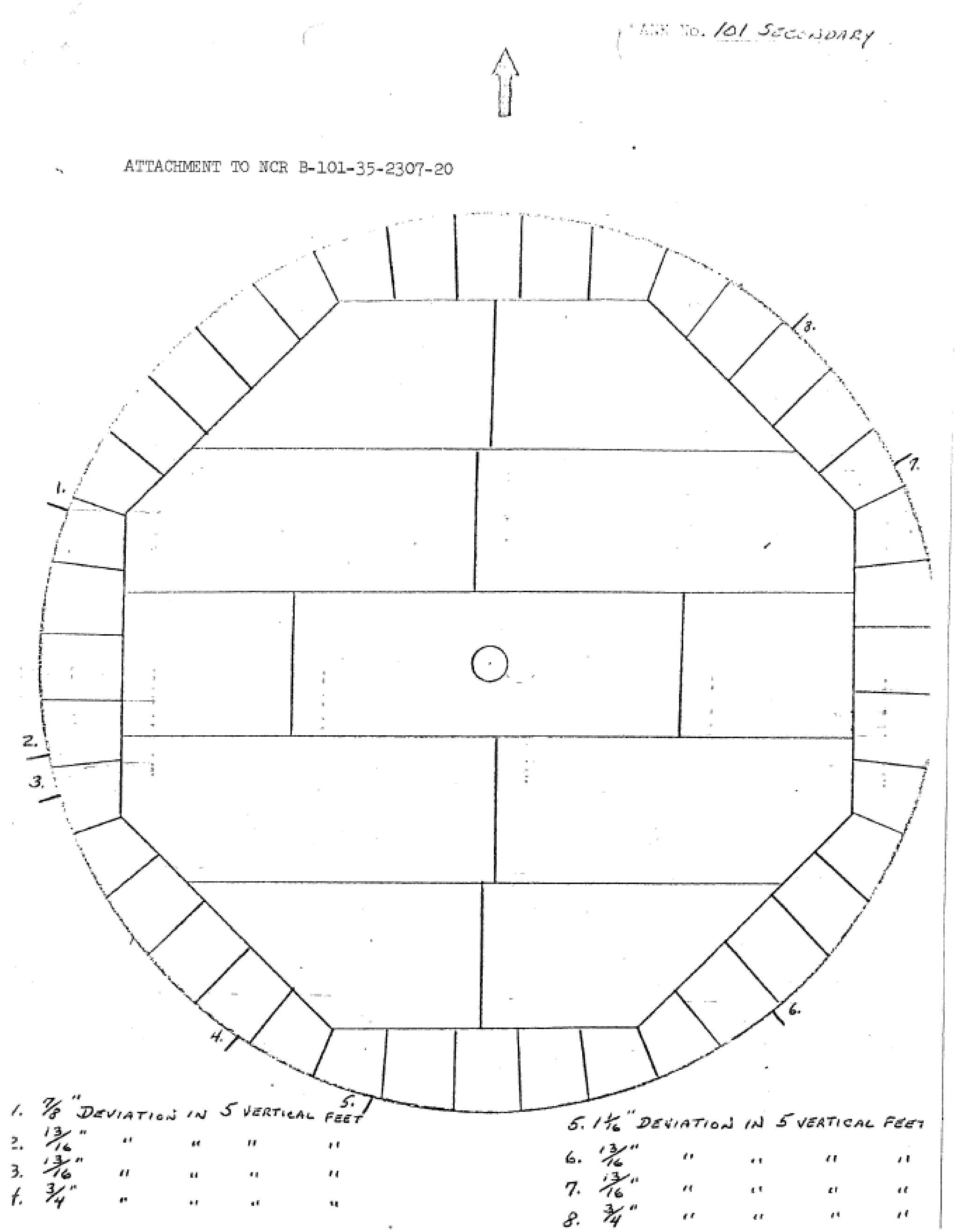

Figure 5-9. Attachment to NCR B-101-35-2307-20 Showing Deviations and Locations

On 4/2/1975 in tank SY-101 primary shell, the QA log states the following:

> *"…Diameter measurements on the second course shell ring show it to be out-of-round. Deviation is 6 1/2", while specified maximum deviation is 4 1/2". Contractor will attempt to correct this condition with guy wires before beginning 2-3 girth seam."*

No NCR was located for this issue. There was no further mention of tank diameter issues in tank SY-101 primary shell QA log after the 2-3 girth seam was welded. It is assumed that the issue was solved after the 2-3 girth seam was welded and the guy wires were removed.

5.4.6.2. Tank SY-102

Measurements taken of the tank SY-102 secondary liner circumference, found the circumference to fall outside of the +/- 2 in. tolerance.

On 2/24/1975 in tank SY-102 secondary liner, the QA log states the following:

> *"…the 102 secondary tank measured 251' 3-3/8" (6" above bottom of 1st course shell plate) and 251' 2-7/8" (6" above 2nd course shell plate). Design calls for 251' 6-9/32" +/- 2"…"*

NCR B-101-29-2307-14 (see Appendix C, App Figure C-20) was generated as a result of the out-of-tolerance circumference. The suggested disposition from NCR B-101-29-2307-14 was as follows:

> *"Suggested Disposition and Justification: 'Accept-as-is' – as this condition exists on the secondary shell, permanent storage capacity is not applicable to this situation. Structural integrity and function of the secondary tank as a protective barrier against the release radioactive* (sic) *material into the environs* (sic) *is not impaired by this condition."*

Deficiency Report # 20 (see Appendix C, App Figure C-21) states the following:

> *"Cause: Bottom knuckle is slightly tipped in & first ring had to be trimmed 3+ inches."*

Based on the disposition in NCR B-101-29-2307-14, the non-conformance was accepted as is.

Further tank wall deviations occurred in tank SY-102 secondary liner as a result of initial shell plate distortions. The discrepancy and disposition documented in NCR B-101-31-2307-16 was as follows:

> *"Discrepancy: On the Tank 102 Secondary shell,* (sic) *areas exist where the maximum deviation of the line of intersection from a true straight line exceed 1/2 inch in 5 feet length. (Actual measurements in areas shown are 1-1/16 inch maximum in 5 vertical feet.) These deviations (see attachment), a result of distortions in the shell plate, were*

fabricated to achieve a plate-to-skirt fit-up. This condition primarily contributed to the smaller circumference of the first shell course (see NCR B-101-29-2307-14).

Suggested Disposition and Justification: 'Accept-as-is' …as the length distortion around the periphery is relatively short, the loading of additional shell courses is insignificant. Subsequently, the concrete tank cylinder placed against the secondary tank will provide additional support of the shell itself, due to the embedment of the studs and stiffener ring. Therefore, the function and integrity of the secondary shell remains unaffected."

The cause of the deviation was shop fabricated knuckles having a bend angle of more than 90°. The condition existed on 3 secondary tank knuckles. For the primary tank knuckles the rings were installed in the field which corrected the problem. Figure 5-10 is the attachment to NCR B-101-29-2307-16 which shows a diagram of the out-of-tolerance condition as well as the locations of the out-of-tolerance issue around the tank.

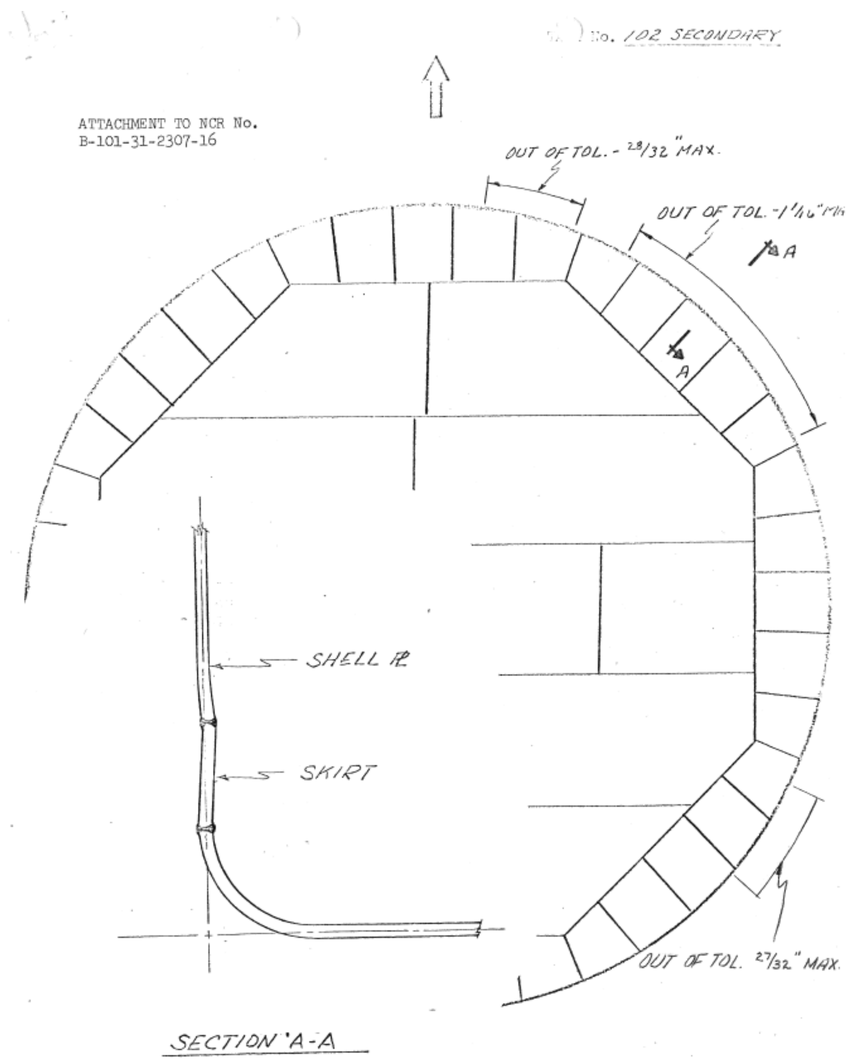

Figure 5-10. Attachment to NCR B-101-29-2307-16 Showing Out-of-Tolerance Locations

On 3/21/1975 in primary tank SY-102, the QA log states the following:

> *"Diameter measurements on the 2nd shell ring show it to be out-of-round. The Vitro field survey crew took measurements this A.M,* (sic) *and found the difference between minimum and maximum diameters to be 6 3/8". Specified maximum deviation is 4 1/2". These measurements were taken after the contractor had installed a guy line to minimize the distortion…"*

A follow up QA log on 3/25/1975 for primary tank SY-102 states the following:

> *"…Conctractor now has 3 guy lines attached to 2nd shell ring, and says he was able to bring distortion back within tolerance. He has since slacked off on guy lines to avoid stresses while making repairs to 0-1 and 1-2 girth seams."*

The next day on 3/26/1975, the QA log states the following:

> *"…CB&I has diameter deviation on 2nd shell ring down to 3 1/2" by use of temporary attachments. (Specified tolerance is 4 1/2"). The plan is to maintain this condition until 2-3 girth seam is welded, then release temporary attachments."*

No NCR related to this specific issue was located. No further mention of primary tank SY-102 out of roundness is documented in the QA log after the 2-3 girth seam. It is assumed that the issue was resolved with the welding of the 2-3 girth seam.

5.4.6.3. Tank SY-103

Measurements taken of the tank SY-103 secondary liner circumference, found the circumference to fall outside of the +/- 2 in. tolerance. This issue was documented in Deficiency Report # 23 (see Appendix C, App Figure C-19) with tank SY-101. The report describes the deficiency as follows:

> "*Description: The circumference of the secondary tanks #101 & 103 is 3 1/2" less than the theoretical circumference. This exceeds the tolerance allowance in the dimensional control procedure by 1 1/2" (allowable deviation = +/- 2".)*
>
> *Cause: Bottom knuckle is slightly tipped in & first ring had to be trimmed 3+ inches."*

The deficiency was resolved on 5/14/1975 using the following corrective action:

1. *"Leave secondary circumferences on tk. 101 & 103 as is for all shell rings.*
2. *Customer to evaluate the consequences of (1) above based on their requirements.*
3. *Customer to allow or reject the 'leave as is' resolution based on (2) above"*

No NCR specific to this this issue was found.

In tank SY-103, a section in the fourth shell ring plate of the primary shell was noted to have exceeded vertical distortion tolerance. Deficiency Report # 31 (see Appendix C, App Figure C-23) describes the deficiency and cause as follows:

> *"Description: Local area noted on attached sketch exceeds local distortion tolerances of 1/2" noted in Vitro specifications B-101-C1 Par. #14-2-E.*
>
> *Cause: Due to the pressure created while fitting & welding make up roof plate. This area was checked for tolerances before roof plates were erected & they checked out ok"*

Figure 5-11 is the attachment to Deficiency Report # 31 showing the local vertical distortion location and magnitude.

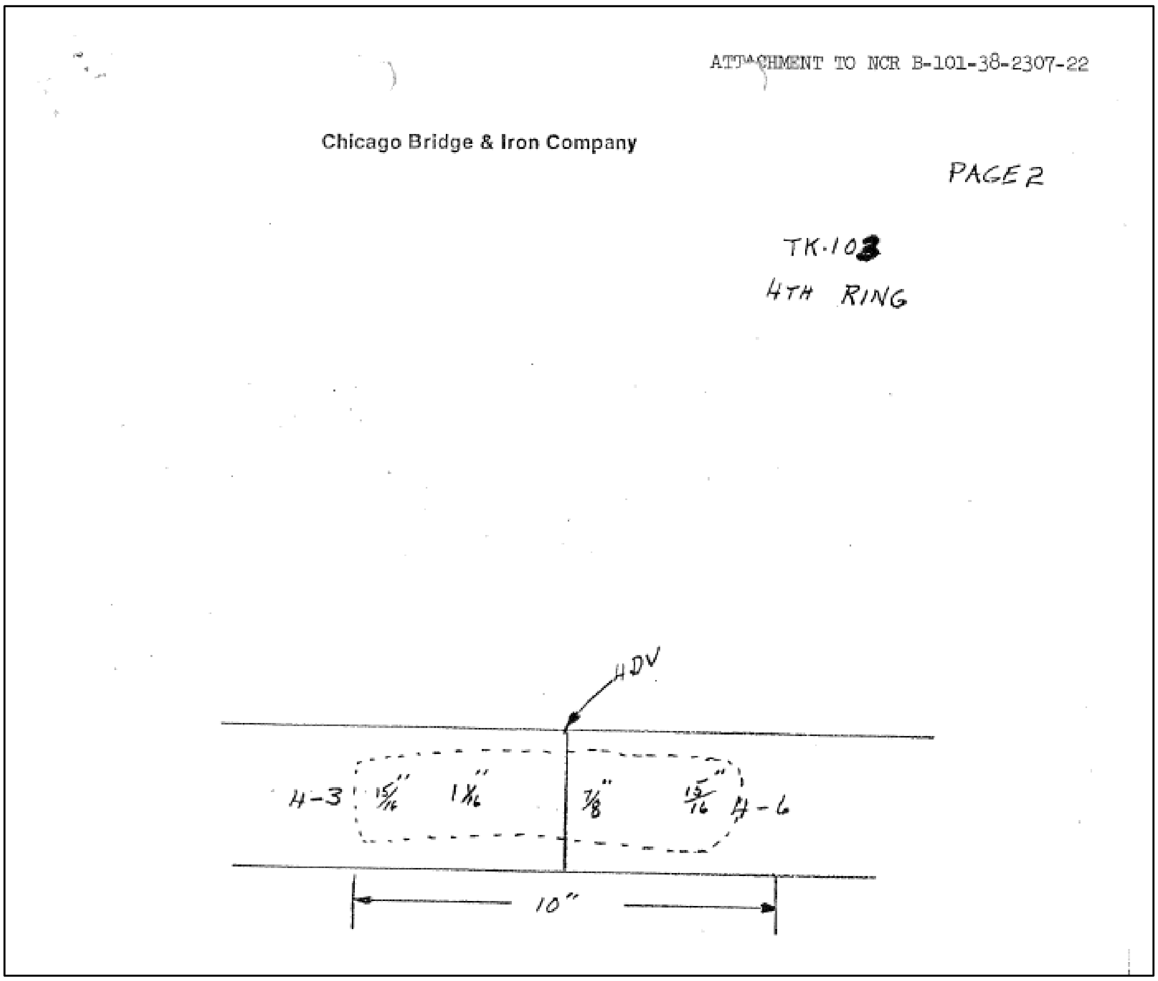

Figure 5-11. Attachment to Deficiency Report # 31 Showing Out-of-Tolerance Condition

The corrective action from Deficiency Report # 31 is as follows:

1. *Place area on hold.*
2. *CB&I recommends* (sic) *to customer to leave area as is for the following reasons.*
    A. *ASME does not address itself to localized deformations.*
    B. *ASME, Section VIII, Division I, Section UG-80 does address itself to pressure vessel out of roundness of cylindrical shells. Tolerances given are 1% of diameter which is met. Allowable for this tank would be approximately 8".*
    C. *Specification diameter tolerances are met.*
    D. *Shell sweep board tolerances are met*
    E. *With the existing localized deformation the tank remains structurally sound and will not have any detrimental effects during or after further fabrication operations (stress relief & dome concreting).*
    F. *Any cosmetic value will be lost after the tank is enclosed.*
    G. *Repair of the area would entail cutting vertical and horizontal seams with extra buildup of plate edges and rewelding which based on previous similar repairs would create greater distortions than exist.*
3. *Customer to allow or reject the leave as is resolution based on 2 above."*

The deficiency was accepted as is on 8/6/1975 based on the criteria 1 through 6 listed in NCR B-101-38-2307-22 attachment 1 (see Appendix C, App Figure C-24).

5.4.7 Tank Dome Drooping

On 5/8/1975 the QA log states the following:

> *"Several efforts have been made to erect the first section of dome plate. To date, these efforts have been unsuccessful. When lifted by crane hoist, dome plate droops enough so that contractor has not been able to position it correctly."*

There was no mention of a corrective action related to this issue. However On 5/13/1975 the QA log states the following:

> *"…One section of the dome plates was erected and tacked in place."*

Based on the 5/13/1975 QA log, it is assumed that lifting issues were resolved.

Two areas of tank SY-102 primary tank dome exhibited deformations after installation. The issue was documented in NCR B-101-37-2307-21 (see Appendix C, App Figure C-25), which states the following:

> *"Discrepancy: Two areas of 102 Primary tank dome exhibit flat spots and reverse curvature (see attached sketch for location). Maximum deformation from theoretical curvature does not exceed 1".*
>
> *Suggested Disposition and Justification: 'accept-as-is' since dome plate will be restrained by installation of 6" x 4" x 3/8" angle to be welded to roof for temporary*

support during stress relieving. Installation of these angles are shown on contractor drawing HT 9, Rev. 2."

The suggested disposition from NCR B-101-37-2307-21 did not accomplish the desired purpose and another NCR was generated. NCR B-101-39-2307-23 (see Appendix C, App Figure C-26) states the following:

> *"Discrepancy: Suggested disposition, as called out on NCR B-101-37-2307-21, did not accomplish desired purpose. Although temporary angles provided support during stress relief, the dome sagged upon their removal. Deviation from theoretical curvature is now approximately 2-1/2". Without correction, further deflection could be expected when concrete and reinforcing steel is installed.*
>
> *Suggested Disposition and Justification: Disposition as per attached contractor's suggestion. The present deflection results in no unworkable problems. Operation of completed facility will not be impaired. The proposed additional support will prevent any additional deflection."*

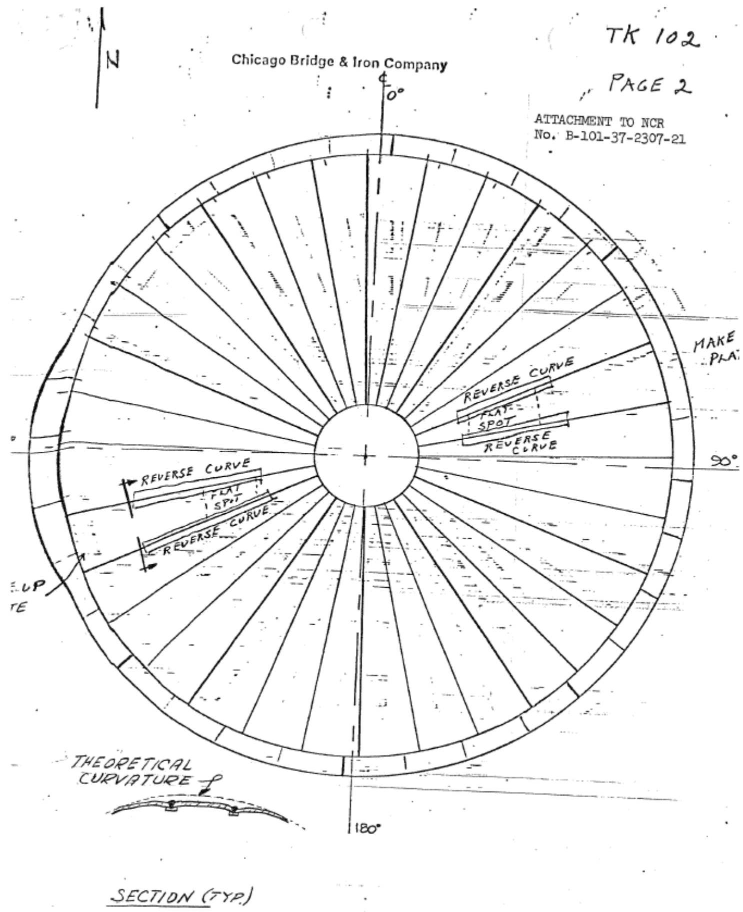

Figure 5-12. Attachment to NCR B-101-37-2307-21 Showing Dome Deviations

Figure 5-12 is the attachment to NCR B-101-37-2307-21 which shows the locations of dome deviation in tank SY-102. The following sequence was used to stiffen the roof:

1. *"Install and weld complete the dollar plate.*
2. *Leave all stiffening presently in place until flat spot has been pulled up and secured.*
3. *Refer to attached Sheet #1 for stiffening details. Install circumferential stiffeners and weld complete. If depressed area extends inside 17'-6" radius or outside 22'6" radius, additional circumferential stiffeners will be required.*
4. *Install all radial stiffeners required and weld them to circumferential angles.*
5. *Pull roof plate up to radial stiffeners and weld. If additional circumferential angles are required, span between them with additional radial stiffeners.*
6. *If above system stabilizes the roof in this area, remove all other stiffening from roof.*

7. *Stiffening at depressed spot must remain in place through concreting. If customer will not accept this, then we will have to stiffen the underside of the roof and remove this stiffening after concrete is set up."*

There is no further information on this non-conformance. It is assumed that the stiffening sequence resolved the dome non-conformance.

5.4.8 Concrete Issues

On 10/28/1975 in tank SY-103, the QA log states the following:

> *"…There were some spots of honey comb…they were very shallow, and they were cut out and repaired imediately* (sic) *which I witnessed. I also witnessed clean up on the dome for the remaining concrete pour."*

There was no further information regarding honey comb in the concrete.

5.4.9 Tank Elevations

On 9/30/1974, The following is written in the QA log:

"…Vitro survey checked the high-low elevation on the insulating concrete, tank 102. The design elevation is 617.20' with a maximum tolerance of (+/-) 1/4". The maximum deviation from the design elevation was (+/-) 1/2"…"

There was no further documentation of this incident in the QA logs, and the NCR was not located.

6.0 CONCLUSION

The leak assessment report for tank AY-102, RPP-ASMT-53793, identified first-of-a-kind construction difficulties and trial-and-error repairs that compromised the intended robustness of the tank. A review of the construction records for the 241-SY tank farm was completed to determine if similar or other difficulties were experienced during construction of the 241-SY double-shell tanks.

It is apparent that the 241-SY tank farm had similar difficulties in primary and secondary steel tank construction. Table 6-1 compares the issues seen in 241-AY-102 and the 241-SY tank farm.

The 241-SY tank farm experienced high primary tank bottom weld rejection rates of 22% - 30.1%. Rejected welds were repaired and eventually accepted. Post-weld stress relief was successfully completed without incident.

Weld rejection is thought to be a contributor to the out-of-tolerance distortions, or bulges, found in tanks SY-101, SY-102 and SY-103 secondary liner bottoms, and tank SY-101 and SY-103 primary tank bottoms. The bulges in the secondary liner bottoms of tanks SY-101, SY-102 and SY-103 will compress under a filled primary tank, which could lead to cracking of the refractory.

All three tanks experienced secondary liner bulges that were eventually accepted “as is.” Significant primary tank bulges were also present in tanks SY-101 and SY-103. The bulges in primary tank SY-101 bottom were supported by chipping out the refractory beneath the bulge and using grout to fill in the areas up to the out-of-tolerance distortions. For SY-103, strain gauge testing, acoustic testing, and structural analysis were conducted to show that the stresses were not a threat.

Damage and repairs to the refractory were minor. The castable refractory was protected from freezing during construction, reducing the extent of rework. Minor cracking was found around some of the cribbing supports, and one bad area was repaired prior to lowering the primary tank bottom.

New issues, not experienced during construction of either the 241-AY or 241-AZ double-shell tanks occurred in 241-SY tank farm construction. During the lowering process of tank SY-102 secondary liner bottom, distortions of up to 18 in. were noted. No permanent distortions were left in the secondary liner bottom, and the non-conformance was conditionally accepted after the secondary liner passed liquid penetrant examination.

Numerous difficulties were experienced during erection of the secondary and primary liners, including weld splice joints exceeding the design specification, secondary shell tolerance issues with circumferences and vertical plate deviations, temporary out-of-round conditions on primary liners, and “*drooping*” sections of the primary dome plates. Ultimately, all these conditions were either corrected or accepted on the basis that structural integrity was not affected.

The 241-SY tank farm had improved construction practices in some areas as compared to tank AY-102, yet many of the construction issues experienced by tank AY-102 re-emerged. Overall, the condition of the tank liners in the 241-SY tank farm are considered to be similar to tank AY-102. Factors thought to have caused unsupported areas in the primary tank bottom and the potential for areas of high residual stress in tank AY-102 are also present in all of the 241-SY tank farm tanks.

Table 6-1. Summary Comparison 241-SY Tank Farm Construction to Tank AY-102

Tank	AY-102	SY-102	SY-101	SY-103
Evaluation Document	RPP-ASMT-53793, *Tank 241-AY-102 Leak Assessment Report*	RPP-RPT-54819, *241-SY Tank Farm Construction Extent of Condition Review for Tank Integrity*		
Construction Order	1st DST constructed	1st DST in 3rd Farm	2nd DST in 3rd Farm	3rd DST in 3rd Farm
Construction Contractor	Pittsburgh-Des Moines (PDM)Steel Company	Chicago Bridge and Iron (CBI) Company		
Secondary Bottom Material	0.25-in. plate, ASTM A515, Gr 60	0.375-in. plate, ASTM A516, Gr 65		
Secondary Liner Bottom Bulges	Excessive distortion and bulges noted throughout. Maximum slope noted as much as 1-in./ft. 22 places exceed 2-in. peak-to-valley tolerance.	Out of tolerance in several areas, up to 0.8125-in./ft. NCR generated. Flattening unsuccessful.	Out of tolerance in several areas, up to 0.625-in./ft. NCR B-generated.	Weld pattern changed, still out of tolerance, up to 1-in./ft. NCR generated. Flattening attempts unsuccessful, including a 6000 lb. weight.
		All SY farm secondary bulges accepted based on liquid penetrant tests after lowering and inspection and repair of refractory cracks and depressions after partial loading. Out of tolerance areas are localized.		
Primary Bottom Material	0.375-in. plate, ASTM 515, Gr 60	0.5-in. plate, ASTM A516, Gr 65		
Primary Bottom Weld Rework	33.8%	21.9%	30.1%	25.7%
	Ultimately all welds were accepted and stress relieved, although problems with that process were noted.	Ultimately all welds were accepted and stress relieved.		

Tank	AY-102	SY-102	SY-101	SY-103
Primary Liner Bottom Bulges	Primary bottom flatness described as "generally good."	Out of tolerance areas noted until primary was lowered and found acceptable.	Out of tolerance areas noted and plate repairs performed, causing new out of tolerances, maximum bump height of 0.26 ft. and bottom grouted in two locations to support primary.	Out of tolerance in several areas, up to 0.8125-in./ft. NCR generated. Later accepted based on strain gauge monitoring and acoustic testing during hydro test, which showed stresses to be acceptable
Stress Relieving Process	Required 2 days to remove all the water in the refractory and temperature recorder just prior to initiating 3 hour hold time was 915°F (accepted as being 1000°F).	One hour hold at 1100°F. Minor steaming from refractory noted during heat up.	Three hour hold at 1000°F.	One hour hold at 1100°F.
Refractory	Kaolite 2200-LI	Lite-Wate 50		
Refractory Protection	Allowed to saturate with rain water, not protected from freezing.	Temporary heating grid installed and covered.		Weather allowed to warm before pour
Refractory Condition	After hydro test refractory found to be degraded, extensively cracked and spalled. Samples showed excessive carbonation.	Inspected after hydro test and 3 areas of minor damage noted, no repairs after hydro test	No reports on post hydro test inspection were found	No reports on post hydro test inspection were found, NCR B-101-32-2307-17 on out-of-level condition ± 1 in vs. spec of ± 1/4 in, accepted "as-is"
Refractory Repair	21 inches of perimeter removed and replaced with concrete and rebar	Minor damage from primary liner support cribbing, 5-ft. by 8-ft. by 2.5-in. area replaced.	Minor repairs made during initial pour, none after post weld stress relieving.	None reported

Tank	AY-102	SY-102	SY-101	SY-103
Other Issues	Unsupported areas of primary bottom filled with foam.	Lack of control during lowering of secondary bottom led to distortions of up to 18-in, Accepted based on actions identified for secondary bulges (penetrant examination, refractory examination and repair after partial loading).	Primary bottom had four plates meet at a weld junction. Specification calls for no more than three. Accepted based on ASME Boiler and Pressure Vessel Code (allowed four) and weld NDE.	Primary bottom had four plates meet at a weld junction. Specification calls for no more than three. Accepted based on ASME Boiler and Pressure Vessel Code (allowed four) and weld NDE.
Overall Conclusion on Construction Difficulties	Difficultly with liner fabrication and the castable refractory left the tank with unsupported areas in the tank bottom and unexpected residual stresses in the tank bottom that probably contributed to failure.	A new contractor (CBI) was employed for the third DST farm constructed. Some improvement was seen in issues related to refractory construction, weather protection, and post-weld stress relieving processes. Other difficulties identified as contributing factors in tank AY-102, returned. These included a high weld rework rate, nearly as high as tank AY-102 and higher than the other DSTs examined so far. The most significant construction issue was the lack of bottom flatness with secondary liner bottoms as well as primary bottoms. “Trial and Error” repairs of this issue were attempted and eventually bulges were accepted, either by extensive testing and analysis (SY-103) or by grouting the worst areas (SY-101). Those factors that caused unsupported areas and the potential for areas of high residual stress in tank AY-102 are present in all of the SY farm tanks.		

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APPENDIX A 241-SY FARM KEY EVENT TABLE

No.	Date	Initials of Inspector	Tank	Comments	Event Type
1.	12/31/73	AWA		Steel purchase specification issued.	Construction
2.	1/2/74	AWA		Don Nelson directed Al Akerson (AWA) to take over project management from Edgar F. Smith due to illness.	Construction
3.	2/22/74	JHP		Excavation observed.	Construction
4.	3/5/74	JHP		Excavation complete to 645 feet. Request for pile driving to begin.	Construction
5.	3/13/74	JHP		Pile driving began.	Construction
6.	4/30/74	JHP		Placed rebar for leak detection pits.	Construction
7.	5/2/74	JHP		Soil failed compaction test 97% with 16% moisture. Un-compacted soil was 92% compaction ±5% moisture was unknown. Two more tests were taken.	Issue
8.	5/2/74	AWA		Issue with refractory testing taking more than a month based on 241-AY experience. If required, the project was going to go back to Kaolite specified.	Issue
9.	5/3/74	JHP		Concrete bases for all three sumps (tertiary leak detection pits) were poured.	Construction
10.	5/3/74	JGCD	101, 102, and 103	Check forms, reinforcing steel, anchor bolts, and placed five cubic yards of concrete for leak detector risers on tanks 101, 102, and 103. Concrete slump was 3 ¼” the pour went very good.	Construction
11.	5/6/74	JD	101 and 102	Placing rebar for Tank 102 and grading for 103.	Construction
12.	5/7/74	JD	101	Compacting 101 base slab.	Construction
13.	5/15/74	JHP	102	Tank 102 drain line didn’t pass spark test.	Issue
14.	5/16/75	JHP	102	Tank 102 drain line passed spark test..	Issue
15.	5/16/74	JHP	102	Drain line for 102 failed its spark test. Covered with more Bitumaster.	Construction
16.	5/17/74	JHP	102	Hydro test and spark test of 102.	Construction

No.	Date	Initials of Inspector	Tank	Comments	Event Type
17.	6/5/74	JGCD	102	Starting pouring base slab for 102. Drop bucket on four sections of wood drain slots. Slots had to be brought back to proper elevation. Came close to getting cold joints. Crew was directed so as to prevent cold joints.	Construction
18.	6/7/74	JHP	102	Concrete curing continued with use of burlap blankets and visqueen.	Construction
19.	6/7/74	AWA		Tests regarding Lightweight Number 50 castable refractory. • Not enough sample • Mixture wrong needs more water to be pourable (.11 pints per pound to 0.7 pints per pound) • Funding	Issue
20.	6/14/74	JHP	101	Soil compaction test obtained and shipped to batch plant. Started placement of concrete at 9:00 a.m. and finished at 3:30 p.m.	Construction
21.	6/15/74	JHP	101	Concrete deemed to have acceptably cured cover with wet blankets and visqueen.	Construction
22.	6/17/74	JPH		Backfill changes from 1” to 3” rock. Backfill being placed in greater than 8” lifts and contractor not removing rock greater than 3”.	Issue
23.	6/18/74	JPH		Compaction test form 6/14 failed area re-compacted. Another test done and accepted as is at 92% to 93% as compared the required 95%.	Issue
24.	6/24/74	RAN	103	Thermocouples placed.	Construction
25.	6/26/74	JHP	103	Concrete for Tank 103 was poured starting 7:00 a.m. and finishing at 3:30 p.m. Temperatures ranged from between 60 °F and 80 °F.	Construction
26.	6/26/74	JGCD	103	First two loads were dry (2 ½” of slump). Batch plant added 1 gallon per cubic foot and the problem was fixed. 369 cubic yards were place by 3:15 p.m.	Issue
27.	7/4/74	JGCD	103	Inspected slabs found curing cracks from the surface drying too fast.	Issue
28.	7/29/74	JH		Plates and knuckle sections arrive at site. Knuckle section stress relieved prior to radiograph inspections of the weld. Grinding and repair was performed after stress relieved.	Issue

No.	Date	Initials of Inspector	Tank	Comments	Event Type
29.	7/30/74	JH		CBI confirmed the observation cited the specification B-101-C1, Section 13.0a, page 17; which states the knuckle plates shall be stressed relieved after forming and prior to shipment.	Issue
30.	7/31/74	JH	102	Welding began on Tank 102 secondary liner without an approved procedure. Deemed visually acceptable.	Construction/Issue
31.	8/2/74	JH	102	Worked continued without approved procedures. One weld was removed because it didn't comply with the unapproved procedure. A wash pass weld was used to restore the edge as opposed to stringer bead.	Issue
32.	8/12/74	JH	102	Weld number 4-A-L #1 was cut out for distortion.	Issue
33.	8/13/74	JH		Weld procedures approved with exceptions.	Construction
34.	8/16/74	JH	101	Two repairs and several re-shots were required on Tank 101.	Issue
35.	8/20/74	JH		All welds requiring repair complied with ASME V, 1974 Edition, Including the summer of 74 Addenda.	Construction
36.	8/23/74	JH	102	Shop fabricated knuckle, Section 4-A-V, was off by 1 ¼ ". The subcontractor cut out a 12" section and inserted a piece of plate to comply with the weld geometry requirements.	Issue
37.	8/29/74	AWA		Project 8.4% complete due by 1/1/76.	Construction
38.	9/5/74	JH	103	Two sections rejected that had been accepted by the sub-contractor.	Issue
39.	9/6/74	JH	102	Three seams were split on Tank 102 to correct distortion.	Issue
40.	9/10/74	JH	103	Changed welding sequence on Tank 103 to prevent distortion. NCR filed because of procedural change.	Issue
41.	9/13/74	JH	102	One area was rejected Tank 102.	Issue
42.	9/13/74	JH	103	Two areas were rejected Tank 103 and one required a re-shot.	Issue
43.	9/16/74	JH	102	Five welds on Tank 102 were rejected and five re-shots on other areas.	Issue

No.	Date	Initials of Inspector	Tank	Comments	Event Type
44.	9/17/74	JH	102	Rejected four areas on Tank 102 and required on re-shot.	Issue
45.	9/18/74	JH	102	Three welds were rejected on Tank 102.	Issue
46.	9/19/74	RRT	102	Tank 102 lowered radiograph inspections in order,	Construction
47.	9/19/74	JH		Completed inspection of Tank 102.	Construction
48.	9/19/74	JH	101 and 103	Reviewed Tank 101 and 103 and rejected three welds and required on re-shot.	Issue
49.	9/19/74	JH	102	Observed lowering of Tank 102 bottom. Lack of control led up to 18" of distortion. A special report was supposed to be written.	Issue
50.	9/20/74	JH	101, 102, and 103	Tank 101 and 103 two areas rejected and two areas require re-shots. Tank 102 had 5/8'' per foot slope and a 2 ¼" high low delta. Vitro inspected deflection in knuckle 4-A-A damaged the integrity of Tank 102.	Issue
51.	9/21/74	JH	102	Wrote special report on the sequence of events while lowering 102. Don Mager wrote 3 non-conformance reports.	Issue
52.	9/23/74	JH	101 and 103	Reviewed Tank 101 and 103. Three areas were rejected and 17 areas required re-shots.	Issue
53.	9/24/74	JGCD	102	Failed to cool tank bottom (102) with water below 90 °F (went from 114 °F to 106 °F). Delayed placement of Lite Wate 50 refractory till tomorrow.	Issue
54.	9/25/74	JH	101 and 103	Reviewed Tank 101 and 103. Eight areas were rejected and three areas required re-shots.	Issue
55.	9/25/74	JGCD	102	Started placement of refractory in Tank 102 at 5:30 a.m. delayed from 4:00 a.m. because of mixer problems. Eight sections were poured by 2:15 p.m.	Construction

No.	Date	Initials of Inspector	Tank	Comments	Event Type
56.	9/26/74	JGCD	102	Started placement of the last four sections at 7:30 a.m. One of the machines broke down at 8:30 a.m. Machine repaired by noon. Cast completed by 1:50 p.m.	Construction
57.	9/27/74	JGCD	102	Cleaned up of the refractory and started cutting the V-shaped trenches on top of the slab.	Construction
58.	9/30/74	JGCD	102	Thompson Mechanical cut out trenches on top light weight concrete.	Construction
59.	9/30/74	JH	101	Radiographs reviewed, Tank 101 lowered, and P.T. examination of welds after lowering to point where refractory could be poured.	Construction
60.	9/30/74	JH	102	Tank 102 design elevation is suppose to 617.2' ± ¼". The maximum deviation was ½" a NCR has been written.	Issue
61.	10/1/74	JH	101 and 103	Rejected one area of Tank 103 secondary bottom. Tank 101 bottom high low was 3 1/8". Maximum slope per foot was 13/16". A NCR was written.	Issue
62.	10/2/74	JGCD	101	Delayed pouring Tank 101 because tank bottom out of tolerance.	Issue
63.	10/3/74	JGCD	101	Tank 101 refractory placement delayed from 4:00 a.m. to 7:30 a.m. Placed eight of twelve sections	Construction
64.	10/4/74	JGCD	101	Placed the remaining fours section in Tank 101. Started at 7:00 a.m., one of the two machines broke down at 8:00 a.m., repaired by noon, and pour was completed by 1:00 p.m. Lowest temperature was 46 °F at 6:30 a.m.	Construction
65.	10/7/74	JGCD	101	Tank 101 air slots cut.	Construction
66.	10/9/74	JGCD	101 and 102	Thompson mechanical installed drain lines (sic) in Tank 101 and 102.	Construction
67.	10/14/75	JMJ	101, 102 and 103	Witnessed welding 101 and 102 primary bottom and 103 secondary.	Construction
68.	10/15/74	JGCD	101 and 102	Thompson Mechanical poured lite weight concrete over drain lines (sic) in Tank 101 and 102.	Construction

No.	Date	Initials of Inspector	Tank	Comments	Event Type
69.	10/22/74	SLW	102	Witnessed Lord Electric install heating grid 102 tank bottom. Issue on how to attach to refractory because tape didn't hold. Small hand driven staples were used to prevent damage to heating cable. Small samples removed from concrete poured over vent pipes. No cylinders were obtained because of boilermaker's strike.	Construction
70.	10/24/74	SLW	101 and 102	Heat grid completed Tank 102 one inch of sand cover placed. Started placement of grid on 101. Temperature 32 °F.	Construction
71.	10/28/74	SLW	101	Heat grid completed for Tank 101.	Construction
72.	10/29/74	SLW	101 and 102	All power for Tank 101 and 102 heating grids on at 4:00 p.m.	Construction
73.	11/19/74	SLW	101 and 102	Placed jack stands and leveled supports for Tank 101 and 102.	Construction
74.	11/20/74	SLW	102	Primary tank placed 102. One plate fell when clamp came loose. Fell pointed end first, which hit the ground. The other end hit the skirt to secondary. No damage to skirt or plate.	Construction/Issue
75.	11/25/74	SLW	102	Started walls on 102 secondary.	Construction
76.	11/27/74	SLW	101	Skirts being set in place on primary for 101. These welds were field welds unlike 102 where they were shop welds.	Construction
77.	12/5/74	SLW	101	One area of excessive reinforcement about 12 inches long on circumferential weld 4AV knuckle section.	Issue
78.	12/9/74	SLW	103	Started lowering Tank 103. Left it on jacks at 2:00 p.m.	Construction
79.	12/10/74	SLW	103	Finished Tank 103 lowering and conducted liquid penetrant tests.	Construction
80.	12/11/74	SLW	103	Finished liquid penetrant test.	Construction
81.	12/12/74	SLW	103	Tank 103 secondary liner inspected because high areas exceeded 3/8" per foot specification.	Issue

No.	Date	Initials of Inspector	Tank	Comments	Event Type
82.	12/18/74	SLW	103	Tank 103 air hammers were used against planishing hammers to reduce the 2 high areas in the secondary bottom (no change). Next 6000 pound was placed on the humps and again air hammers were used (no change).	Issue
83.	12/19/74	SLW	103	The high areas on the bottom of Tank 103 were inspected using magnetic particle. There were no questionable areas in the welds or plate material itself.	Issue
84.	1/15/75	JMJ	101	Tank 101 primary bottom witnessed dye check and weld repair cycles on several seams. In many cases, more than one repair necessary. Two caps missing from conduit.	Issue
85.	1/14/75	JMJ	103	Request to cut access hole in secondary liner issued to AEC for approval.	Construction
86.	1/23/75	JMJ	101 and 102	Tank 101 primary bottom cut out North/South short weld due to humping. Additional strong backs were installed prior to re-welding. Tank 102 primary bottom slightly out of specification 9/16" per foot. Decided to lower tank and see whether it was alleviated.	Issue
87.	1/24/75	JMJ	101 and 102	Tank 101 primary bottom North/South short weld replaced. Tank 102 all pick-ups have been fixed. All welds on Tank 102 up to knuckle skirt visually inspected and found acceptable.	Issue
88.	1/27/75	JMJ		Considerable time lost because hoses frozen to tank bottoms. Contractor attempting to reduce standing water in the tanks to minimize the problem in the future.	Issue
89.	1/30/75	JMS	101 and 103	Tank 101 and 103 had shop splice seam a designed three plate weld junction. This created a four plate weld junction, which violated B-101-C1 pp. C-13.	Issue
90.	*2/4/75*	*JMJ*		*Blizzard in progress.*	N/A
91.	2/5/75	JMJ		Contractor spent most of the morning removing snow from all three tanks.	Issue
92.	2/7/75	JMJ	102	Tank 102 cracking in refractory around twelve cribbing supports. Thompson to repair only really bad spots over the weekend.	Issue

No.	Date	Initials of Inspector	Tank	Comments	Event Type
93.	2/8/75	JD	102	Repaired Kaolite in Tank 102 area about 8'x5'x2". It was chipped out to 2 ½ ". Concrete mixed by hand placed at 65 °F.	Issue
94.	2/10/75	JCGD	102	Inspected the Kaolite repair. It looked very good.	Issue
95.	2/10/75	JMJ	102	Frost on refractory of Tank 102 (30 °F). It passed hammer test. Began lowering primary bottom at 2:00 p.m. Lowered one foot by end of shift. It was swiveling and had 5/8" deflection.	Issue
96.	2/11/75	JMJ	101 and 102	Strong backs removed for Tank 101. Bottom was out of level in several places. Contractor evaluated which welds to cut out to make corrections. Tank 102 was lowered. Thermocouple (TE-102-1) was caught between the tank and refractory. Tank was raised and it was slid into to its slot.	Issue
97.	2/14/75	JMJ	101	Removing 3 to 4 foot of weld near peak of distortion.	Issue
98.	2/19/75	JMJ	101	Tank 101 removing plywood, insulation, and sand from insulating concrete. Space heater installed. Too wet to continue mag particle inspection.	Construction
99.	2/21/75	JMJ	101	Completed mag particle and visual inspection of primary bottom.	Construction
100.	2/24/75	JMJ	102	Tank 102 secondary circumference out of specification. Required to 251' 6 9/32" ± 2". It was 251' 3 3/8" 6 inches above the bottom of the 1st course shell plate and 251' 2 78" 6 inches about the bottom of 2nd course shell plate. Condition "accepted as is" in NCR B-101-29-2307-14.	Issue
101.	2/25/75	JMJ		Dome plating sub-assemblies being welded.	Construction
102.	2/26/75	JMJ	101	Tank 101 thermocouples being installed.	Construction
103.	2/27/75	JMJ	101	Completed lowering check list and start lowering tank at 1:40 p.m.	Construction
104.	2/28/75	JMJ	101	Lowered Tank 101 primary bottom. Four inches in the air and center, but tank had swiveled about 1 ¼" in counter clockwise direction. Come along installed and correction attempted and corrected.	Construction

No.	Date	Initials of Inspector	Tank	Comments	Event Type
105.	3/3/75	JMJ	101	Tank 101 completed lowering operation and began post-placement penetrant testing.	Construction
106.	3/4/75	JMJ	101	Tank 101 primary completed penetrant testing.	Construction
107.	3/5/75	JMJ	101	Tank 101 installed insulating boards and plywood for protection.	Construction
108.	3/8/75	JGCD	103	Started pumping refractory at 9:05 a.m. and finished at 3:00 p.m. It went well with no break downs. Completed four sections of twelve.	Construction
109.	3/9/75	JGCD	103	Started placing concrete at 7:55 a.m., blew a piston gasket at 1:10 p.m., wheeled in stand-by pump, started pumping with it, shutdown stand-by after two baskets, and completed pour with one pump at 2:00 p.m.	Construction
110.	3/10/75	JMJ	101	Visually inspected Tank 101 secondary shell and found numerous instances of poor workmanship. Protest filed because the sub-contractor is suppose to perform the visual inspection.	Issue
111.	3/10/75	JMJ	102	Tank 102 secondary stud welding and fillet welding on stiffener ring in progress.	Construction
112.	3/10/75	JMJ	103	Tank 103 refractory was poured over the weekend. Air slots being cut.	Construction
113.	3/11/75	JMJ	101	Tank 101 secondary installing 1st stiffener ring.	Construction
114.	3/14/75	JMJ	103	Tank 103 secondary installing 1st stiffener ring.	Construction
115.	3/18/75	JMJ	101 and 103	Tank 101 insulating concrete was pumped into tank refractory in the two damaged areas, which had been chipped out. Tank 103 was poured in the twelve cribbing stacks that had interfered with the original pour.	Construction/Issue
116.	3/21/75	JMJ	102	Tank 102 primary second shell ring show it to be out-of-round. The difference between the maximum and minimum diameters was 6 3/8" exceeding the allowable 4 ½". Guy wire installed. Next ring can't be placed until correction is made.	Issue
117.	3/25/75	JMJ	102	Contractor used 3 guy wires to bring 2nd shell ring back into tolerance	Issue
118.	3/26/75	JMJ	102	Diameter deviation on 2nd shell ring down to 3 ½	Issue

No.	Date	Initials of Inspector	Tank	Comments	Event Type
				inches by use of temporary attachments, they will be released when the 2-3 girth seam is welded	
119.	4/2/75	JMJ	101	Tank 101 primary second shell ring is measured and shown to be out of round. Deviation is 6 ½ inch while specified maximum is 4½ inch. Will correct with guy wires before welding 2-3 girth seam.	Issue
120.	4/15/75	JMJ		All dome sub-assemblies welded.	Construction
121.	5/8/75	JMJ	102	Problems continued with attempting to lift dome plate because it droops too much so that the contractor can't correctly place it.	Issue
122.	5/12/75	JGCD	102	Tank 102 placing vertical steel some with spacing of 15". Corrected.	Issue
123.	5/16/75	JGCD	102	Starting pouring concrete of first lift on Tank 102. First truck sent away after placement of 2 cubic yards because it was too dry. Truck had about four yards left in it. The truck had been loaded with a 7-bag mix about an hour and 15 minutes prior to delivery. Pouring started at 8:30 a.m. and stopped at 5:15 p.m. with a total of 150 cubic yards being poured.	Issue
124.	5/21/75	JGCD	101	Tank 101 concrete was poured for the first lift between 8:15 a.m. and 1:10 p.m. The pour was good with no cold joints.	Construction
125.	5/28/75	JGCD	102	Concrete was placed in the upper walls of Tank 102 between 7:45 a.m. and 3:10 p.m. Went good no cold joints.	Construction
126.	6/2/75	JGCD	102	First lift on Tank 103 poured between 8:00 a.m. and 12:15 p.m. Placement was very good.	Construction
127.	6/4/75	JGCD	102	Pour walls on Tank 101 started at 6:00 a.m. and completed at 2:10 p.m.	Construction
128.	6/6/75	DDB	101 and 103	Tank 101 and 103 mag particle where attachments were removed.	Construction
129.	6/12/75	DDB	101	Studs bend and torque tested on Tank 101 to 130 foot pounds on a test plate. Plate dropped on steam line. Plate was examined and showed no appreciable damage and it was used.	Issue

No.	Date	Initials of Inspector	Tank	Comments	Event Type
130.	6/21/75	?	102	Start up at 3:00 p.m. At 5:00 p.m. all burners operating at 1/6th potential capacity. Flame viewed at 5:00 p.m. about 5 feet in length.	Construction
131.	6/21/75	JMJ	102	Turned on four burners on Tank 102 at 5:00 p.m.	Construction
132.	6/22/75	DB	102	As many as 13 thermocouples taken out service. 12 may have returned after steam dry out.	Issue
133.	6/23/75	JMJ	102	At 3:30 p.m. the contractor still in process of baking out steam from the insulating concrete.	Issue
134.	6/23/75	DK	102	All four burners out at 2:00 a.m. Relit by 2:12 a.m.	Issue
135.	6/23/75	DK	102	At 10:42 a.m. contractor began official hold time and was terminated at 11:42 a.m. At 12:30 p.m. temperatures were dropping at 60 °F per hour. Maximum foundation concrete temperature recorded was 170 °F, which was below 500 °F allowed.	Construction
136.	6/24/75	JMJ	102	Recorders turned off on Tank 102 at 7:30 p.m. Noted problems with thermocouples under primary tank due shorting.	Construction
137.	6/26/75	JMJ	101 and 102	Erected leak detection riser for Tank 101. Tank 102 dollar plate welded and ready for installation.	Construction
138.	6/30/75	DDB	103	Tank 103 radiation detection pit riser erected.	Construction
139.	7/2/75	DDB	102	Penetrant testing completed on Tank 102. Started cleanup of excavation to support backfill.	Construction
140.	7/3/75	DDB	All	Completed cleanup of excavation for backfill at 11:30 a.m. and CBI went home.	Construction
141.	7/4/75	JGCD	102	Began rolling the back fill with a D-4 Caterpillar. Scrapper got stuck on three conduits on the South side Tank 102. Bent two and flatten one. Two straighten out and third replaced.	Issue
142.	7/7/75	DDB	102	Dollar plate being welded into Tank 102.	Construction
143.	7/9/75	DDB	101, 102 and 103	Tank 101 ready to hook all of the thermocouple wires. Tank 102 is being filled with water for hydrostatic test. Welding of the roof dollar plate completed.	Construction

No.	Date	Initials of Inspector	Tank	Comments	Event Type
				Tank 103 ready for insulation.	
144.	7/10/75	SLW	101	Turned on four burners in Tank 101 at 2:00 p.m.	Construction
145.	7/10/75	DDB	102	Tank 102 filling for Hydro test.	Construction
146.	7/11/75	DK	101	Completed two hour hold time at 600 °F hold time at 5:30 a.m.	Construction
147.	7/12/75	DBK	101	At 12:10 a.m. three hour hold time for 1000 °F was met. CBI started down at 100 °F at a time from 1000 °F requirement. At 8:10 a.m. all recorder below 600 °F and recorders turned off.	Construction
148.	7/12/75	JMJ	101	At 8:10 a.m. all recorders below 600 °F and turn off.	Construction
149.	7/15/75	DDB	101	Started penetrant test Tank 101.	Construction
150.	7/21/75	DDB	102	Tank 102 fittings on roof dollar plate are being erected. Secondary knuckles are being fitted too.	Construction
151.	7/22/75	DDB	101	Tank 101 dollar plate being welded.	Construction
152.	7/24/75	DDB	101	Tank 101 all seams below 39 feet of water have been coated with blue chalk for hydro test.	Construction
153.	7/25/75	EAG	102	Investigated Tank 102 insulating concrete around tank perimeter after stress relief. Found three notable areas deterioration. About half of the perimeter had friable area about 1/8" thick at the perimeter.	Issue
154.	7/25/75	DDB	101	Completed hydrostatic test of Tank 101.	Construction
155.	7/29/75	DDB	101	Tank 101 fit up and welding of upper secondary knuckle.	Construction
156.	8/1/75	DB	103	Tank 103 stress relieving start at 10:00 a.m. Insulating concrete cure completed at 10:00 p.m. and rise toward stress relieve temperature initiated.	Construction
157.	8/2/75	SLW		End of 1100 °F hold at 3:00 p.m. Vertical growth of tank was 3 ½" from ambient to 1100 °F. At 11:20 p.m., last thermocouple passed below 600 °F.	Construction
158.	8/4/75	DB	102	Tank 102 final inspection of annulus space to	Construction

No.	Date	Initials of Inspector	Tank	Comments	Event Type
				facilitate erection of the make-up sheet on the upper secondary knuckle.	
159.	8/5/75	JMJ	103	Tank 103 bottom re-surveyed to compare with pre-stress relieved measurements. Inspector observed little change in the area greatest humping.	Issue
160.	8/5/75	JGCD	102	Tank 102 rebar was being placed.	Construction
161.	8/5/75	DB	102	Tank 102 make-up sheet welded.	Construction
162.	8/6/75	JGCD	102	Tank 102 cleaned key way and placed reinforcing steel.	Construction
163.	8/6/75	DB	103	Tank 103 passed penetrant test for bottom plates.	Construction
164.	8/7/75	DB	103	Tank 103 strained gauges were installed to get readings prior to water be introduced.	Construction
165.	8/7/75	RAN	103	Inspected 12 strain gauges on Tank 103. Installed per manufacture (Microdot) manual. Gauge #3 broke from extension and couldn't be used. No tank load data was taken between 11:30 a.m. and 12:30 p.m.	Construction
166.	8/8/75	DB	101, 102 and 103	Tank 101 final annulus inspection, which allowed closing of the annulus space. Tank 102 inspection construction joint for proper depth and continuous length. Tank 103 assisted in taking strain gauge measurements at 15 feet 3 inches.	Construction
167.	8/8/75	AWA	102	Tank 102 Phase IV contractor (Moen) worried that the Phase III contractor (CB&I) didn't follow procedure for dome support.	Issue
168.	8/11/75	DB	101 and 103	Tank 101 make-up plate was welded in place. Tank 103 hydrostatic test completed.	Construction
169.	8/11/75	JMJ		Received confirmation from design (E.A. Gonkey) that minor deviations from design in secondary top knuckle section pose no structural problem.	Issue
170.	8/11/75	FMS	103	Unstable strain gauge readings at 39 foot water level made it unpractical to obtain useful	Issue

No.	Date	Initials of Inspector	Tank	Comments	Event Type
				information.	
171.	8/11/75	AWA	102	Tank 102 CB&I installed two riser caps and brought water to the desired level.	Issue
172.	8/12/75	DB	103	Tank 103 welded three secondary knuckle plates satisfactory.	Construction
173.	8/12/75	FMS	103	Used another instrument to obtain stress reading, which didn't work either.	Issue
174.	8/13/75	DB	101	Tank 101 cleared for rebar placement after inspection of upper knuckle plates.	Construction
175.	8/14/75	FMS	103	Unsuccessful obtaining data with three-wire connections to gauges.	Issue
176.	8/15/75	FMS		Tried low resistance setting and continued to have trouble reading a balanced condition. No further effort was expended.	Issue
177.	8/14/75	DB	103	Tank 103 upper knuckle secondary plates being welded.	Construction
178.	8/14/75	JGCD	102	Tank 102 rebar is being placed and cadwelded. Placed 1 ½" plate on the West 24" Riser.	Construction
179.	8/15/75	JGCD	101 and 102	Tank 101 chipping out key way. Tank 102 continued placing and cadwelding rebar. Placed plate around East 24" Riser. Placing J bolts.	Construction
180.	8/20/75	AWA	102	ARCHO and CB&I expressed concern about material placed on dome. Tank 102 was reviewed and deemed satisfactory. Stressed to contractors to keep stacks to a minimum.	Issue
181.	8/20/75	DB	103	Tank 103 checked the cleanliness of annulus. Make-up plate welded into place.	Construction
182.	8/21/75	DB	103	Tank 103 inspected secondary upper haunch and noted areas needing repair.	Issue
183.	8/22/75	DB	103	Tank 103 accepted repairs and visually accepted the tank. Check that all plugs were installed in air intakes.	Issue
184.	8/26/75	JGCD	103	Tank 103 chipping out key way.	Construction

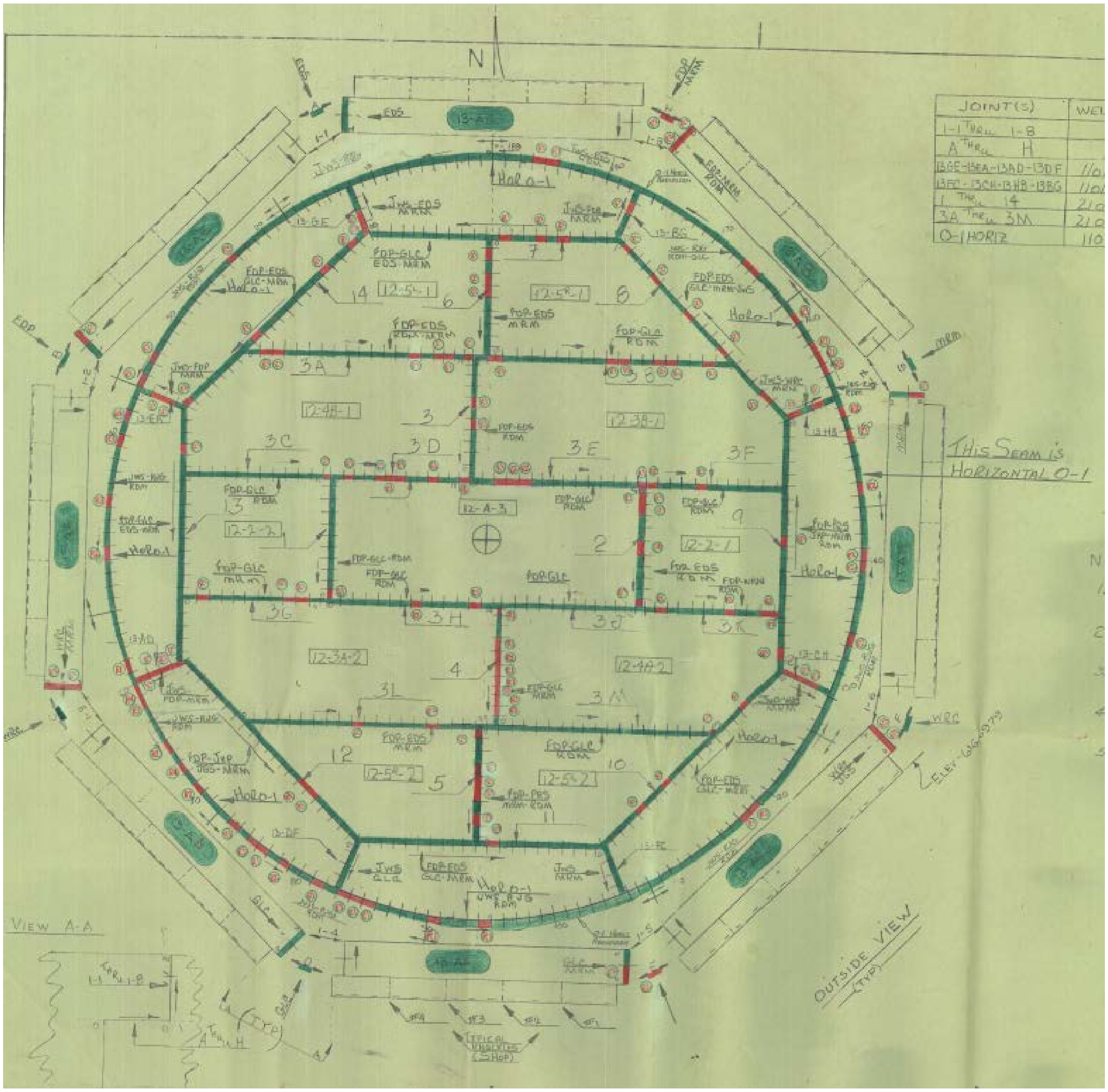
No.	Date	Initials of Inspector	Tank	Comments	Event Type
185.	8/28/75	JGCD	101 and 102	Rebar being placed on Tanks 101 and 102. Carpenter installing bulkhead 9'-0" in from vertical wall.	Construction
186.	8/28/75	JGCD	102	Tank 102 center horizontal rebar were placed too close to the outside wall. In the majority of locations, the configuration won't allow 5 ½" OD pumpcrete lines to enter for pumping concrete.	Issue
187.	8/29/75	AWA	102	Investigated misplacement of rebar in Tank 102. An NCR will occur.	Issue
188.	9/18/75	AWA	103	Tank 103 at 5:30 a.m. pumps shut off liquid level 20 feet. Battelle started taking strain gauge measurements at 9:30 a.m. Readings were finished at noon and pumps were re-started.	Issue
189.	9/24/75	RAN	103	Tank 103 thirteen new strain gauges installed.	Issue
190.	9/26/75	RL	103	Instrument checked out and calibration completed. Fill started at 1715 and turned off at 1814 water level 1' 3". Water turned on at 1910.	Issue
191.	9/27/75	RL	103	Water off at 8:00 a.m. for data inside completed. Enter annulus a 9:00 a.m. to inspect it. Completed inspection at 10:30 a.m. water on at 10:40 a.m.	Issue
192.	9/28/75	RL	103	Water off at 4:00 a.m. at request of Exxon too much noise for data. Data collected at 10:00 a.m. Water turned on at 10:15 a.m.	Issue
193.	10/1/75	JGCD	102	Tank 102 workers cleaned and blew forms. Carpenters placed key way at top of the pour.	Construction
194.	10/2/75	JGCD	102	Tank 102 checked out forms.	Construction
195.	10/3/75	JGCD	102	Tank 102 poured 400 cubic yards of concrete for the haunch. Fifteen cylinders taken 3 for 4-day, 6 for 7-day, and 6 for 28-day breaks.	Construction
196.	10/6/75	JGCD	101 and 102	Tank 101 placed bulk head. Tank 102 stripped forms from concrete and applied curing compound.	Construction
197.	10/10/75	JGCD/JMJ	102	Tank 102 concrete was placed on the dome.	Construction
198.	10/13/75	JGCD	101	Tank 101 concrete placement started 7:15 a.m. and finished at 9:15 p.m. Three inch pump broke down used four inch pump until it was repaired.	Construction

No.	Date	Initials of Inspector	Tank	Comments	Event Type
199.	10/14/75	JGCD	101 and 103	Tank 101 removed the bulk head. Tank 103 installed rebar.	Construction
200.	10/15/75	JGCD	101	Tank 101 removed forms from section where pump broke down. No signs of cold joints.	Issue
201.	10/16/75	JMJ	103	Tank 103 recalled radiographs to compare with acoustic emission data.	Issue
202.	10/20/75		103	Compare radiographs to Exxon's acoustic emission testing. A report is forthcoming.	Issue
203.	10/20/75	JGCD	101	Tank 101 concrete was placed on the dome from 8:40 a.m. to 2:15 p.m.	Construction
204.	10/20/75	JGCD	101	Tank 101 ran out concrete had to order back 7.5 cubic yards.	Issue
205.	10/20/75	JGCD	101	Tank 101 had a leak 1 foot West of 42" riser at the center. Air and water was bubbling through the concrete (very slowly).	Issue
206.	10/24/75	JGCD/JMJ	103	Tank 103 placed concrete in haunch from 7:15 a.m. to 6:30 p.m.	Construction
207.	10/27/75	JGC	103	Tank 103 concrete was damaged. P 167	Issue
208.	10/27/75	JMJ	101	Investigated water/air bubbling incident on Tank 101 dome concrete.	Issue
209.	10/28/75	JGCD	103	Honeycomb Tank 103.	Issue
210.	10/30/75	JGCD/JMJ	103	Tank 103 dome concrete was placed between 8:30 a.m. and 2:30 p.m.	Construction
211.	10/31/75	JMJ	103	Two concrete cylinders from Tank 103 haunch broke at 3130 and 3180. Backfill authorized, but not to extend up to dome area poured 10/30/75.	Construction
212.	11/1/75	JGCD	103	Tank farm back filled with 3 D-9 Cats during an 11.5 hour shift, which place 2,500 cubic yards of backfill. The backfill was placed in 6 inch lifts.	Construction
213.	11/11/75	JGCD	101 and 103	Back filling Tank 101 and 103.	Construction
214.	11/11/75	JGCD		Dowels reversed for the pump pit.	Issue

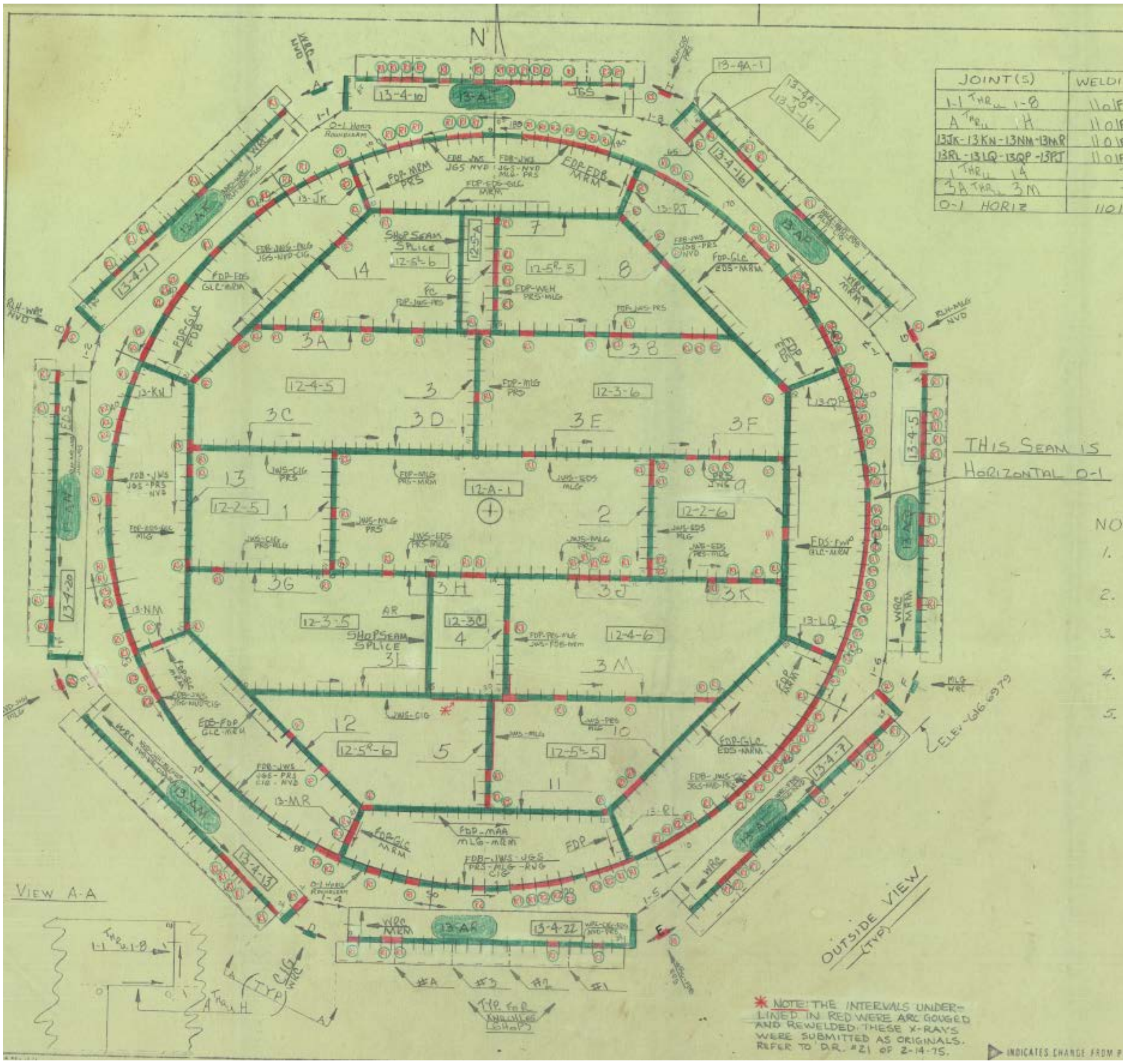
No.	Date	Initials of Inspector	Tank	Comments	Event Type
215.	11/13/75	JGCD		Formed A&B valve pits and drain pit. Back filling on Tank 101. Place steel for A&B pits.	Construction
216.	11/3/75	JMJ		Backfill completed at 3:00 p.m. NCR to be raised to document presence of rocks larger than 3".	Construction
217.	12/29/75	JGCD	101	Formed walls for Tank 101 pump pit.	Construction
218.	4/22/76	HWD		Backfilling on south side A&B pits. Applied primer and sealer in pits 03C, 03B, and 03A.	Construction

APPENDIX B 241-SY WELD MAPS

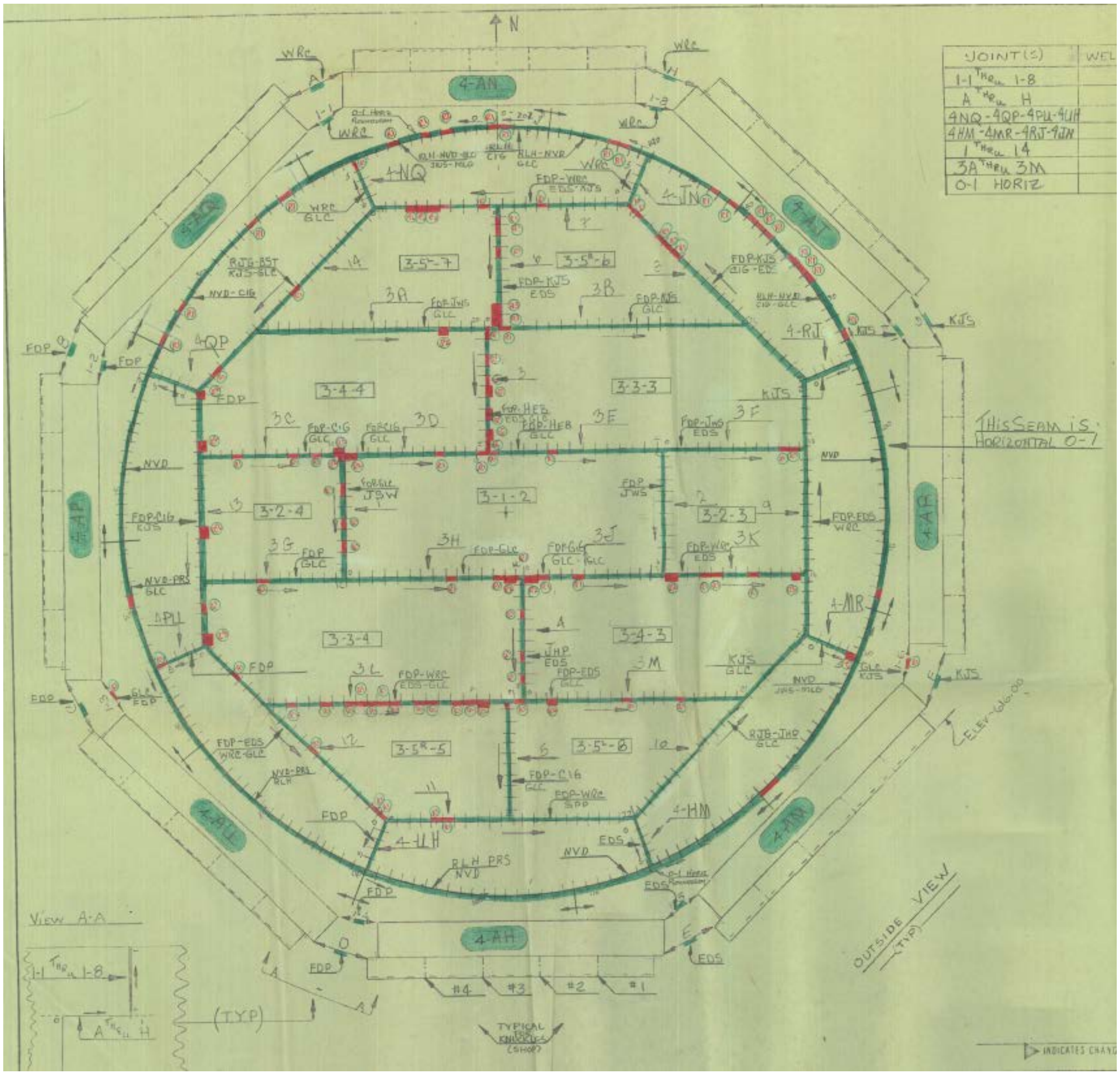
App Figure B-1. Tank SY-101 Primary Tank Bottom Weld Map



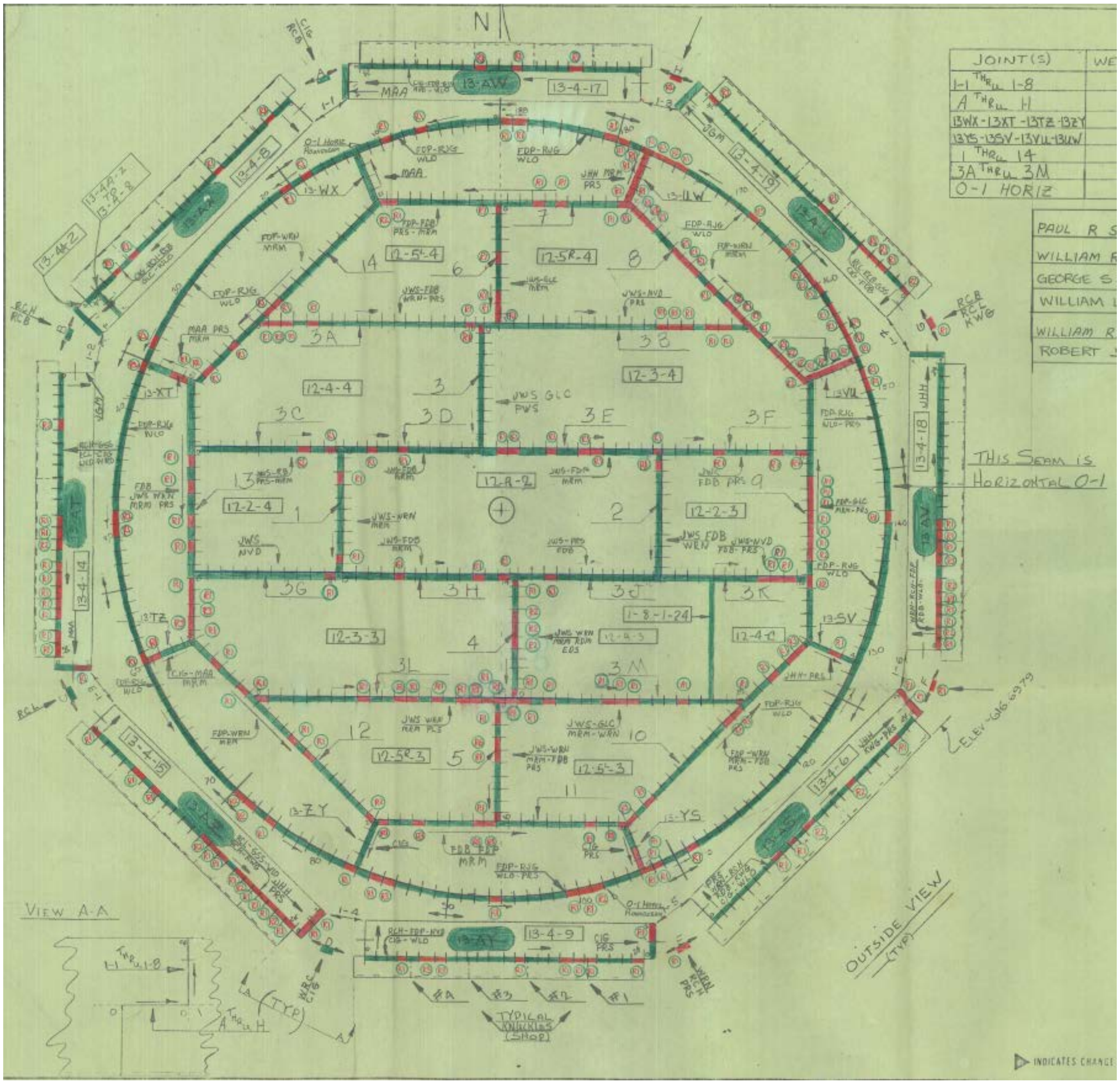
App Figure B-2. Tank SY-102 Primary Bottom Weld Map



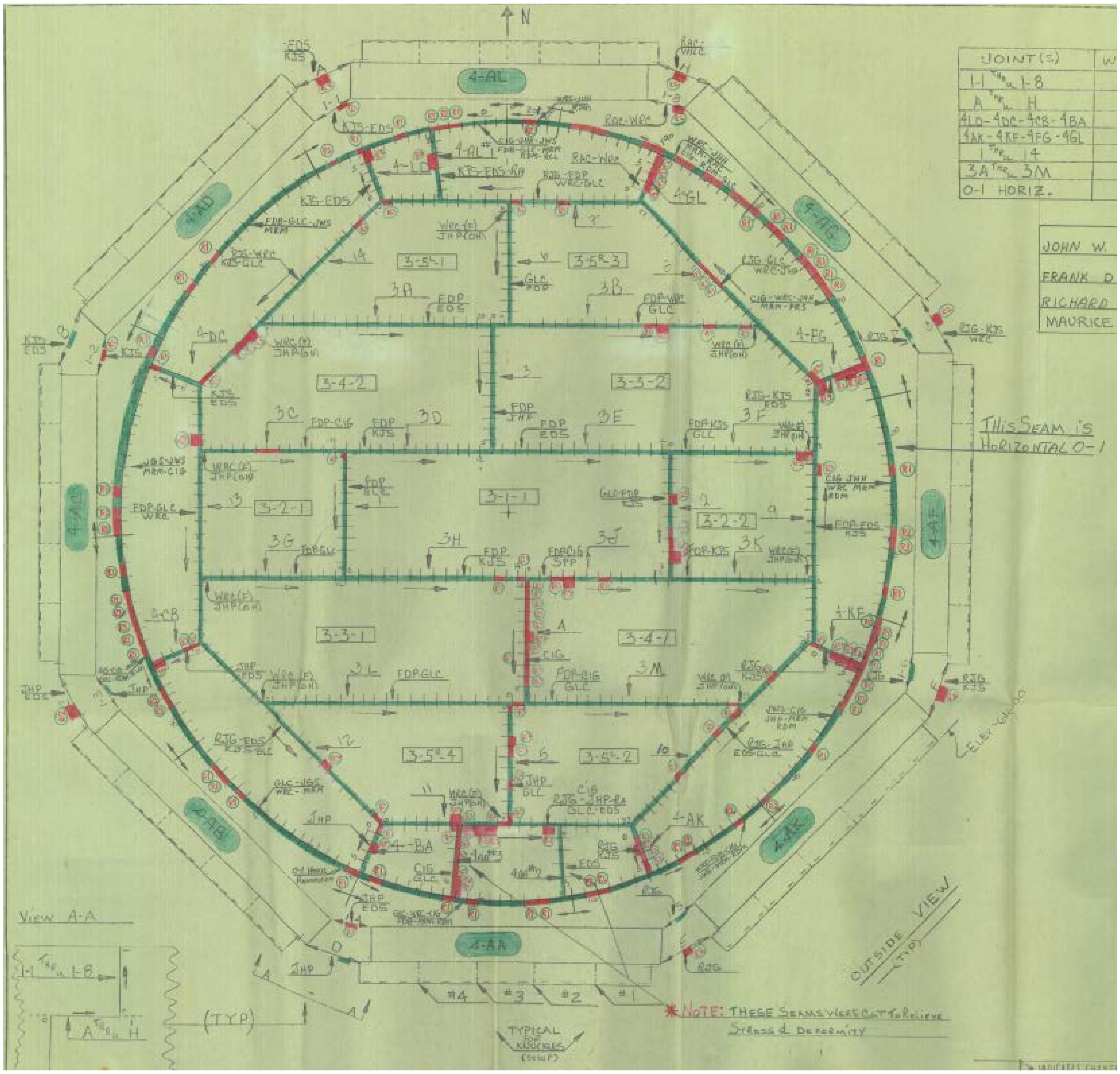
App Figure B-3. Tank SY-103 Primary Bottom Weld Map



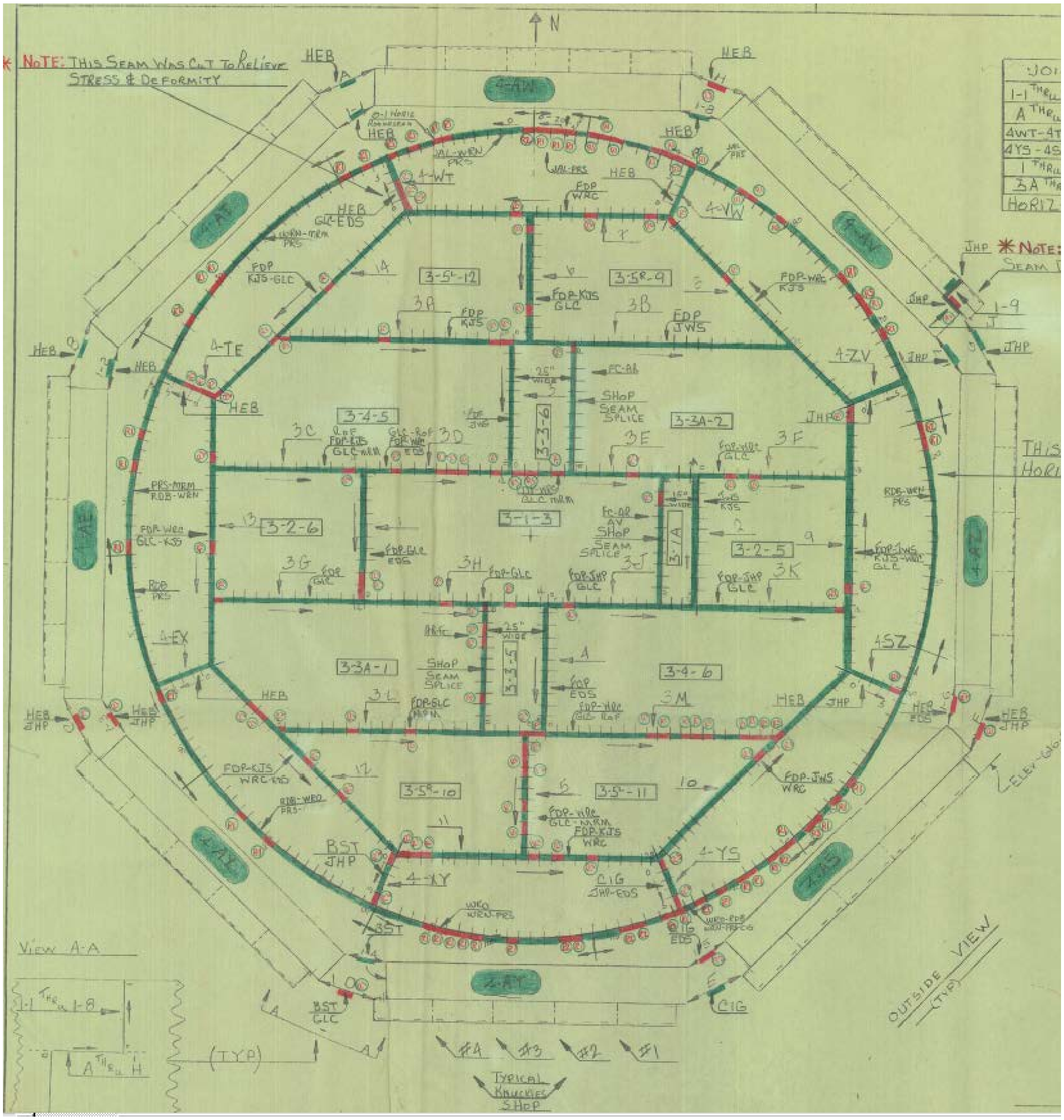
App Figure B-4. Tank SY-101 Secondary Bottom Weld Map



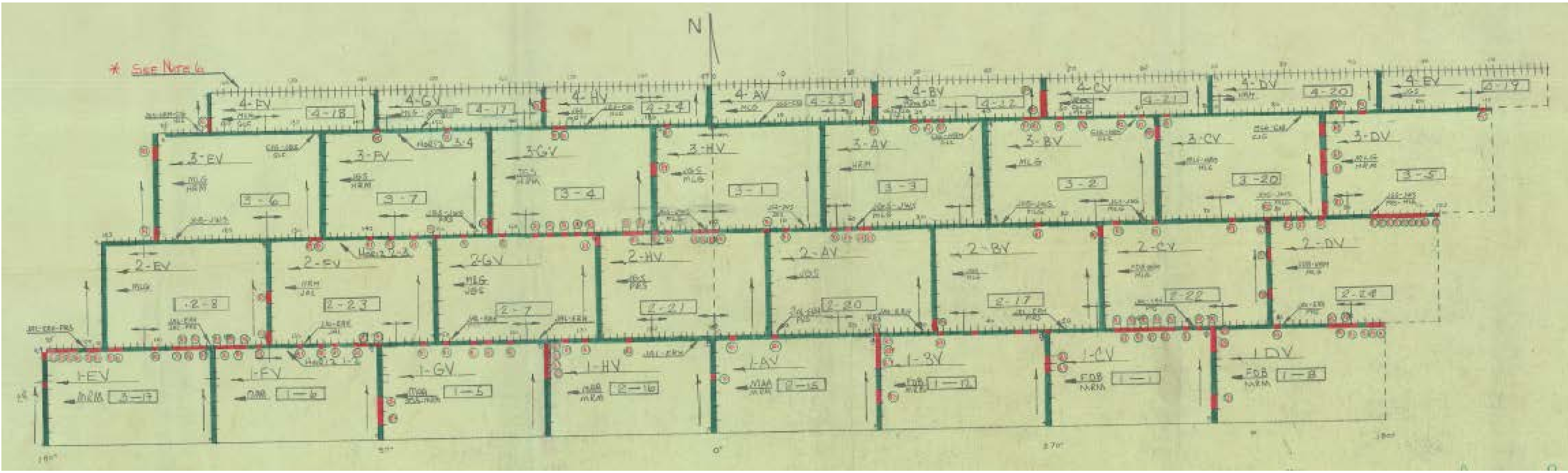
App Figure B-5. Tank SY-102 Secondary Bottom Weld Map



App Figure B-6. Tank SY-103 Secondary Bottom Weld Map



App Figure B-7. SY-101 Primary Shell Weld Map

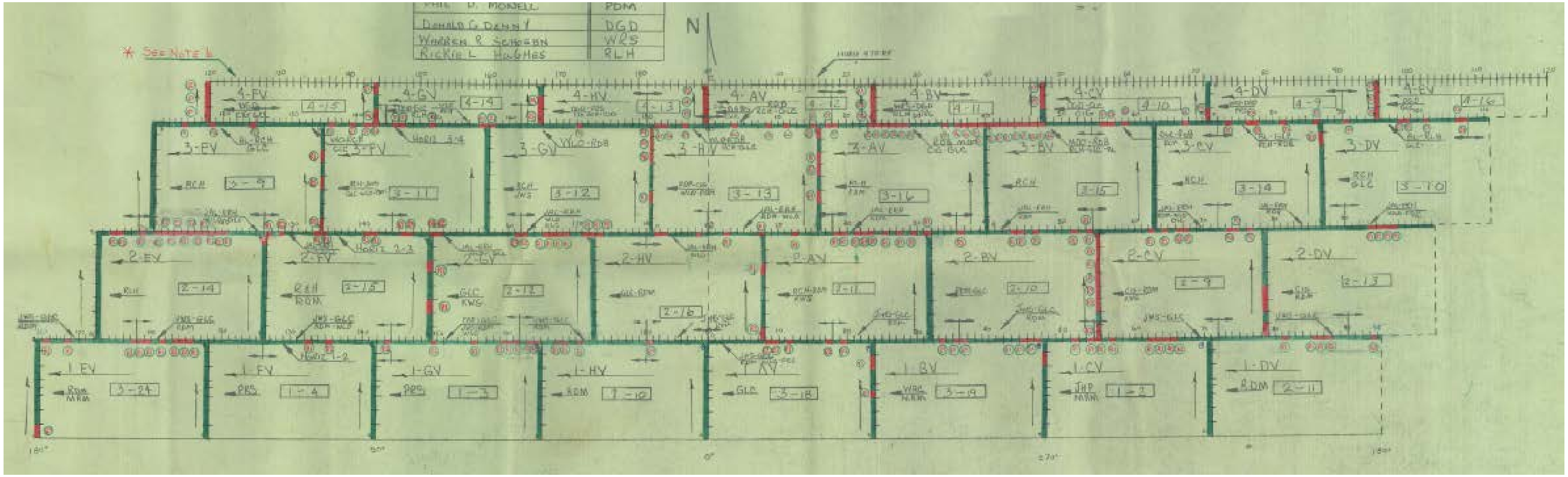


NOTES:

1. NUMBER EACH WELD JOINT ON THE SKETCH
2. RECORD TH HEAT & SLAB OR SERIAL NUMBER OF EACH PIECE ON THE SKETCH.
3. RECORD THE WELDING PROCEDURE IN THE TABLE
4. RECORD THE WELDER'S I. D. FOR EACH JOINT
5. INDICATE EACH R T INTERVAL ON EVERY JOINT, & AS A MINIMUM, SHOW THE NUMBER OF THE FIRST & LAST INTERVAL.

* 6. NEED FOR X-RAY of 4TH RING TO KNUCKLE SECTIONS WAIVERED BY CUSTOMER, REFER TO VITRO DFC-B-101-49

App Figure B-8. SY-102 Primary Shell Weld Map

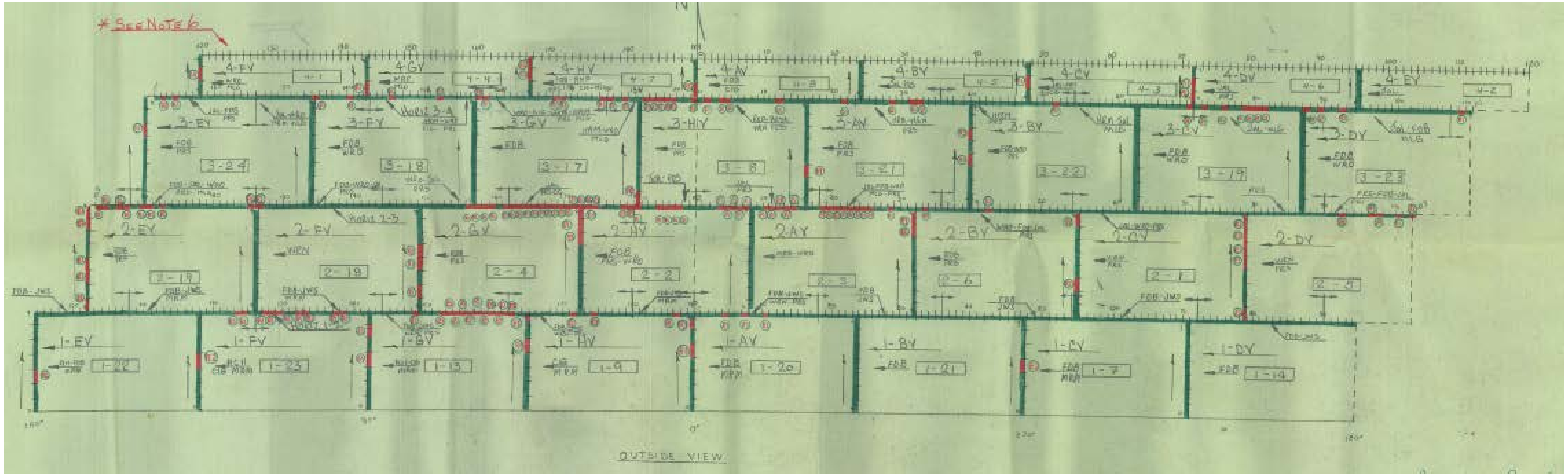


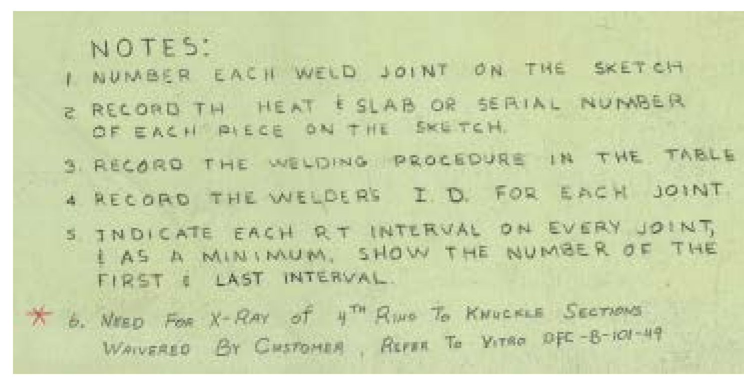
NOTES:

1. NUMBER EACH WELD JOINT ON THE SKETCH
2. RECORD TH HEAT & SLAB OR SERIAL NUMBER OF EACH PIECE ON THE SKETCH.
3. RECORD THE WELDING PROCEDURE IN THE TABLE
4. RECORD THE WELDER'S I. D. FOR EACH JOINT.
5. INDICATE EACH RT INTERVAL ON EVERY JOINT, & AS A MINIMUM, SHOW THE NUMBER OF THE FIRST & LAST INTERVAL.

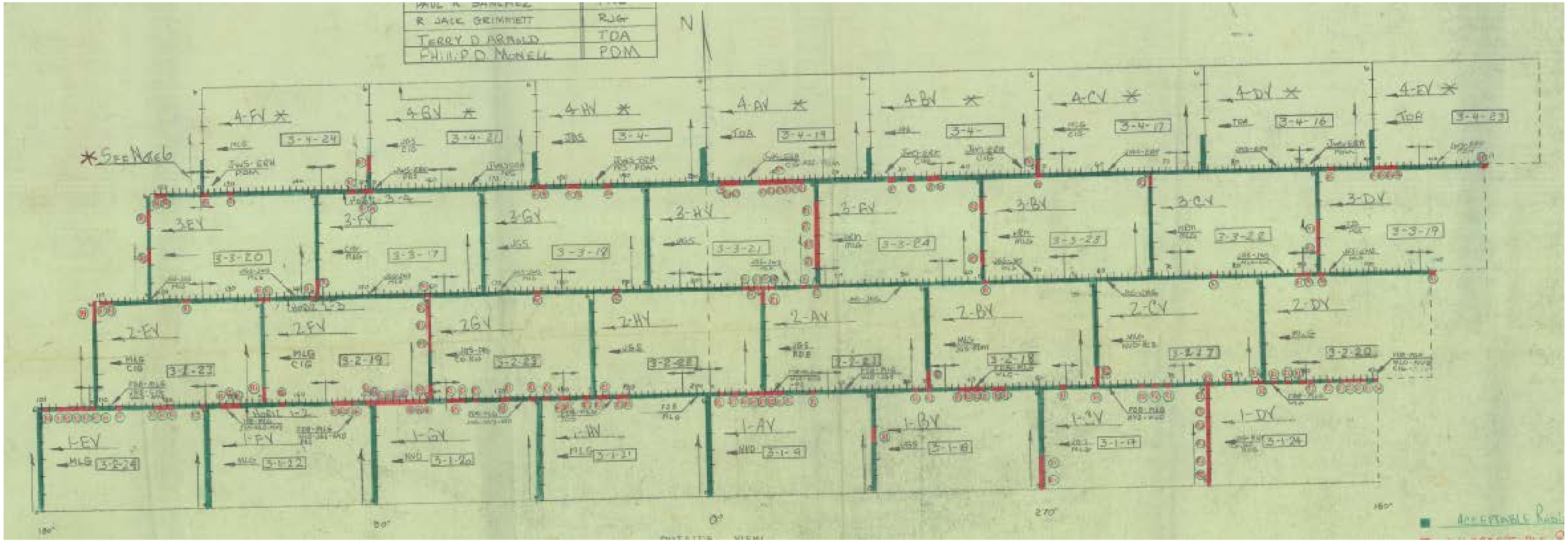
* 6. NEED FOR X-RAY of 4TH RING TO KNUCKLE SECTIONS WAIVERED BY CUSTOMER, REFER TO VITRO DFC-8-101-49

App Figure B-9. SY-103 Primary Shell Weld Map

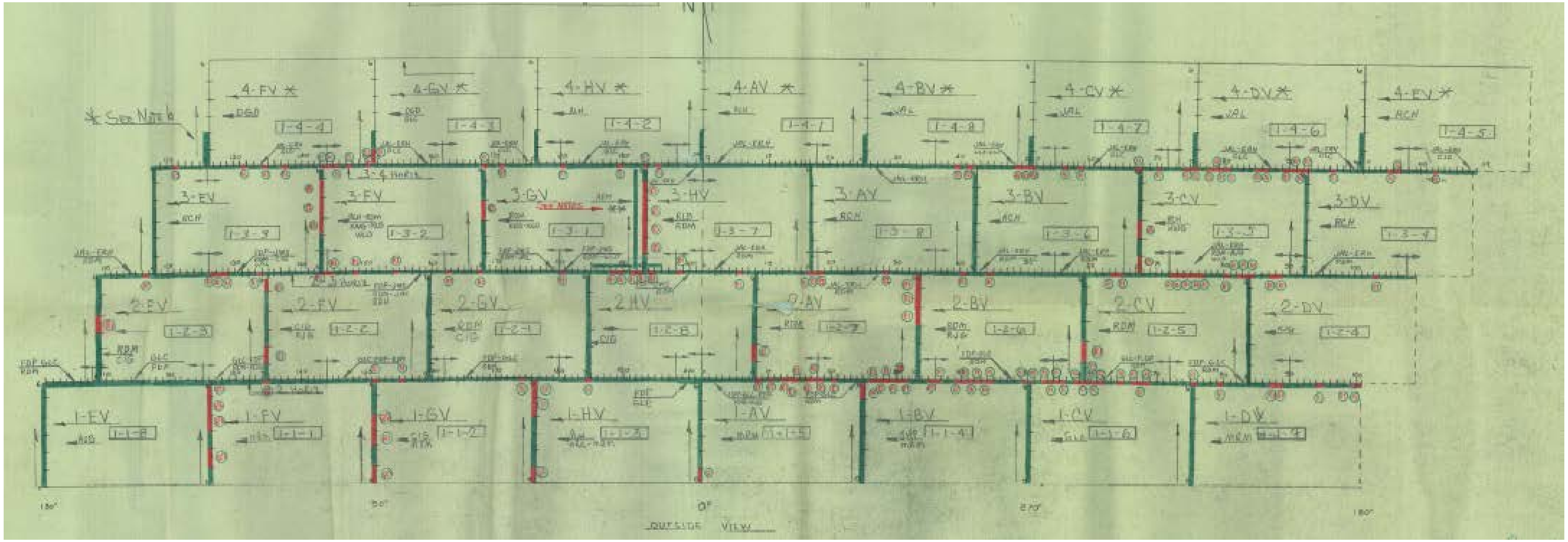




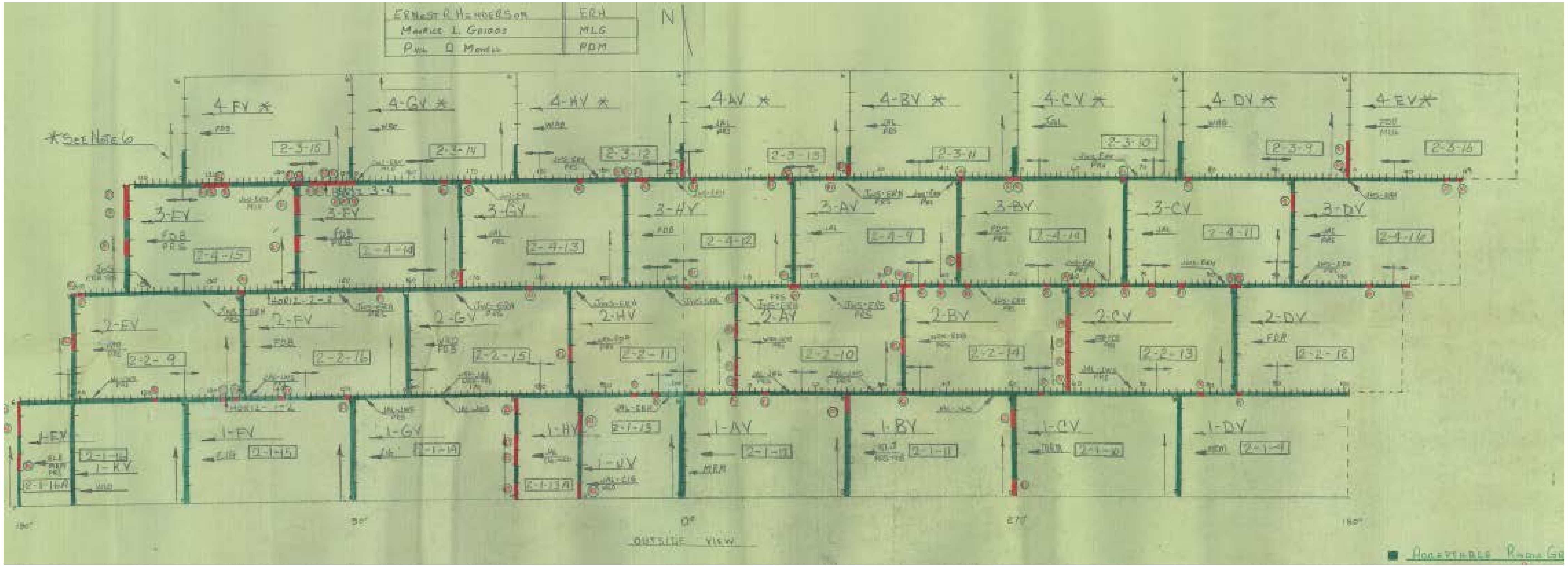
App Figure B-10. SY-101 Secondary Shell Weld Map



App Figure B-11. SY-102 Secondary Shell Weld Map



App Figure B-12. SY-103 Secondary Shell Weld Map



APPENDIX C TANK DEFICIENCY DOCUMENTATION

App Figure C-1. Weld Rejection Correspondence

CC: L. F. Shafranek
*R. J. Landrum, ESD
*D. M. Klein
*N. J. Sullivan
M. G. Stroud
*W. F. Showers
IC #33 (2)

September 2, 1975

[redacted]

TO: B. H. KIRK

FROM: W. F. SHOWERS

WORK REQUEST 860379 - SAVANNAH RIVER PLANT
WASTE STORAGE TANKS
HEAT TREATMENT

NOTE: Parts of the information contained in this report are covered by a "Non Disclosure Agreement" between Chicago Bridge & Iron Co. and those persons on the copy list indicated with an asterisk. It must not be divulged to any person through whom it might do harm to the Chicago Bridge & Iron Co.

SUMMARY: The Chicago Bridge & Iron Co. has the ability and expertise to heat treat large field erected steel tanks successfully. Their safety or lack thereof would be of great concern if they were to obtain an order at SRP. The potential for a catastrophic explosion by regulating oil flow by a plug cock is considered significant by the writer. A slight overtravel of the valve to a completely closed position, very easy to do with a plug cock, and an immediate reopening of the valve without assurance that there is a source of ignition in the burner throat could admit large quantities of oil vapor into the tank which would ignite from a source of ignition such as another burner. The sudden combustion of this oil vapor could instantly raise the pressure within the tank to more than 40 psig. A momentary loss of power to the fuel oil pumps and a restart of the pumps without assuring that the pilot burners were operating could also cause an explosion.

The writer accompanied by those identified in the copy list visited the Hanford Works of the Energy Research & Development Administration on July 10 through 13, 1975 to observe the stress relieving procedure on a radioactive waste storage tank similar in general to those at Savannah River. CB&I has submitted a proposal for constructing six tanks at SRP for FY '76.

The design of the Hanford tanks and the construction sequence is different from SRP. Their tanks are 80' in diameter by 32' high, without a center riser section such as ours. They are designed with a steel lined concrete outer tank similar to ours but include a concrete basin beneath that tank with a system of collector pipes leading to standpipes so that any leakage through the two steel tanks and the concrete tank is collected in the "sub-basin" and directed to the standpipes from which it can be detected and removed.

The construction sequence required partial encasement and backfilling to proceed with the construction of the waste tank. This permitted much work to proceed from "grade" at the level of backfill and greatly reduced the height of the top of the tank above grade during stress relieving as improvements. The cessation of work while other phases proceeded would be negative aspects, plus the necessity to clean off the concrete joints before pouring leaves. The wisdom of this sequence is in doubt.

This design will be used at SRP for the FY '75 and later tanks but we will continue to erect and stress relieve the tank before erecting the outer tank.

The insulating refractory tank support was an 8" thick layer of CE #50. This material gave a 150°F maximum concrete temperature beneath the refractory.

The stress relieving procedure as developed by Chicago Bridge & Iron Co., was well executed, based on long experience with many large field erected tanks. The largest was a containment vessel for a nuclear power house, 110 ft in diameter by 220 ft high, which was constructed of 3" steel plate on the bottom and 2" plate on the top with intermediate thicknesses in between.

For "proprietary" information reasons and safety, we were not permitted on top of the tank. From discussion and observation, we determined that the heating system consisted of a 4 ft diameter steel tube resting on supporting legs on the bottom center of the tank. Four, approximately 10 million btu/hr high pressure (90 - 100 psi) air atomizing oil burners, located possibly 3 to 4 ft from the tank bottom, discharged flame into the tank. I have reason to believe that these burners were located at some tangent angle to the tube to cause a swirling motion of the hot gasses in the tank. The venturi action of the air-oil stream induces combustion air through the refractory burner throats. The combustion air is drawn down through the 4 ft diameter tube, which is insulated, and can be entered, if necessary, while the burners are in service.

A number of dampered ports discharge gas at a safe elevation above the tank. These dampers are operated by rods, from the operating platform in the center, to equalize the temperatures at various locations throughout the tank.

No attempt is made to maintain any specified pressure within the tank. The top of the tank is supported by temporary stiffeners welded across the top of the tank. These are burned off and the welds ground smooth after the stress relieving operation. The burner support tube is removed and a 6' plate cover is welded over the center of the tank after stress relieving. Since this weld is above any possible operating liquid level, it does not require stress relieving.

The tank is insulated during stress relieving by two layers of wire-cloth faced mineral wool batts banded around the tank with steel strapping. This is satisfactory for the desert, but could be a problem if a heavy rain would occur unless a weatherproof covering were applied on a tent like structure over the tank.

The burners are fired with diesel fuel using two air compressors with a spare. Control is strictly manual from visual observation of the flame through inspection ports in the top of the tank.

Plug cocks on a manifold are operated by wrenches using pressure gages on the oil and air lines to the individual burners as a guide. Verbal instructions are shouted from the operator on top of the tank to the man at the valve manifold. The burners are visible from the platform on top of the tank through ports.

Propane fired pilot burners located in the oil burner throats are operated continuously. No monitoring of the pilot burners or the main oil burners is attempted. Solenoid oil valves were noted among the parts in various boxes shipped in for the stress relieving operation. The CB&I supervisor commented that the flame safety equipment was "too much trouble to keep operating" from false shutdowns, etc., so was not used.

Thermocouples were located in the insulating refractory supporting the tank as well as selected spots on the tank bottom, sides and top for a total of about 150. These results were recorded on 12" strip chart recorders and manually logged on data sheets. We received a copy of this log and diagrams of the thermocouple location, which is available for inspection.

The heat up operation had started on July 10 just before noon, and on our visit late in the evening was progressing according to schedule, within the specifications as issued by ARCHO, the operating contractor for the Hanford site. The heat up continued for the next day, July 11, and late in the evening reached the 1000°F minimum specified by ARCHO. Du Pont specifies 1100°F for SRP. Mr. Landrum had discussions with various Hanford personnel who referred to test work allegedly done by Battelle Northwest to support the lower temperature for a longer period of time. We requested copies of this test data or a reference where we might examine the data.

There was a supposition on the part of some that the limit of the burners had been reached. The writer observed the pressure gages on the burner manifold at about 10:00 pm when the temperature "hold" was in progress. Based on previous experience with similar burners, I would estimate that 20 to 25% more heat input was available. A more likely reason to limit the maximum temperature might be the tank top support. A review of this temperature limit with members of ERDA and Jones Construction Co. staff on the following day indicated total agreement that test data indicated that 1000°F stress relieving temperature would prevent stress corrosion and cracking of the tanks.

Mr. O. G. Sikora of CB&I was in charge of the stress relieving operation. We gained the impression that the technique, and the results, were his responsibility. In view of the proprietary nature of this operation, he was somewhat vague on exactly how CB&I would stress relieve tanks that they might erect at SRP. He frequently stated "After a contract has been signed, we'll get together to discuss details on how we'll do it."

Mr. William Gross, Quality Assurance Engineer for CB&I, stated that all X-ray pictures are jointly examined at the site by himself and Vitro Co. engineering personnel on a "good" or "bad" basis with no borderline work accepted. The final X-ray pictures are reviewed by the regional CB&I Quality Assurance Engineer and are filed. Surface defects on the plates were a big problem on the current tank accounting for 8 to 10% of the rejections.

WFS/ren

App Figure C-2. NCR B-101-34-2307-19, 241-SY Tank Farm Salt Cake Storage Facility

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a division of AUTOMATION INDUSTRIES, INC.

NONCONFORMANCE REPORT

(1) PROJ/WO NO.	(2) TITLE	(3) NCR NO.
B-101	241-SY TANK FARM SALT CAKE STORAGE FACILITIES	B-101-34-2307-19

(4) DESCRIPTION OF NONCONFORMANCE - REFERENCE - SUGGESTED DISPOSITION AND JUSTIFICATION

Reference: Construction Specification B-101-C1, Rev. 0 Attachment

Discrepancy: In several areas of the Tank 103 Primary bottom, the slope of ridge and peak distortions exceeds the 3/8 inches per foot allowable. Thus, the tank bottom presently exhibits slopes in localized areas (see attached sketch) up to 13/16 inch per foot.

Suggested Disposition: "Conditional accept" provided that the subsequent liquid penetrant examination required after lowering is acceptable.

Justification: The areas out of tolerance are localized. Thus, the distribution of loadings will not affect the tank function and integrity.

HOLD TAG APPLIED: ☐ YES ☒ NO

(A) DS Mager — INSPECTOR OR ORIGINATOR — DATE 3-20-75

(B) Donald L Mager — TITLE III SUPERVISOR — DATE 3/20/75

(5) VITRO REVIEWING AUTHORITY ACTION

☐ REPAIR ☐ MODIFY ☐ REWORK ☐ REJECT ☐ ACCEPT-AS-IS ☒ CONDITIONAL ACCEPT ☐ OTHER (DESCRIBE)

(C-1) [signature] — DESIGN ENGINEER — DATE 3/21/75

(C-2) I. M. B. Garcia — QA MANAGEMENT — DATE 3/21/75

(C) A.W. Akerson — PROJECT MANAGER OR ENGR — DATE 3-21-75

(6) CLIENT APPROVAL

☒ APPROVED ☐ DISAPPROVED

(D) Michael J. Eaton — OPERATING CONTRACTOR P/E — DATE 4-16-75

(D-1) [signature] — AEC — DATE 4-16-75

SEE ATTACH. LTR JEP/MJF 4-10-75

(7) CAUSE OF NONCONFORMANCE AND CORRECTIVE ACTION TO PREVENT RECURRENCE

See attached letter.

(E) [signature] Parsons — SIGNATURE AND TITLE — DATE 4-23-75

(8) VERIFICATION OF ACTION TAKEN: ☒ DISPOSITION EFFECTED AS DIRECTED ☐ RECORD OF FIELD CHANGE NO. ______ INITIATED ☐ OTHER (DESCRIBE)

(F) [signature] Johnston — INSPECTOR — DATE 4/23/75

(9) DISTRIBUTION: DATE: 4-22-75

DSM TITLE III SUPRV
AWA PROJ MGR/ENGR
CNZ QA MGR
WSG DESIGN ENGR
VITRO CENTRAL FILE

(G) NCR CONTROL DESK
MJF OPER CONTR. P/E
RAZ OPER CONTR QA
JEP CONST CONTR JOB SUPRT
CONST CONTR P/E
CONST CONTR QA

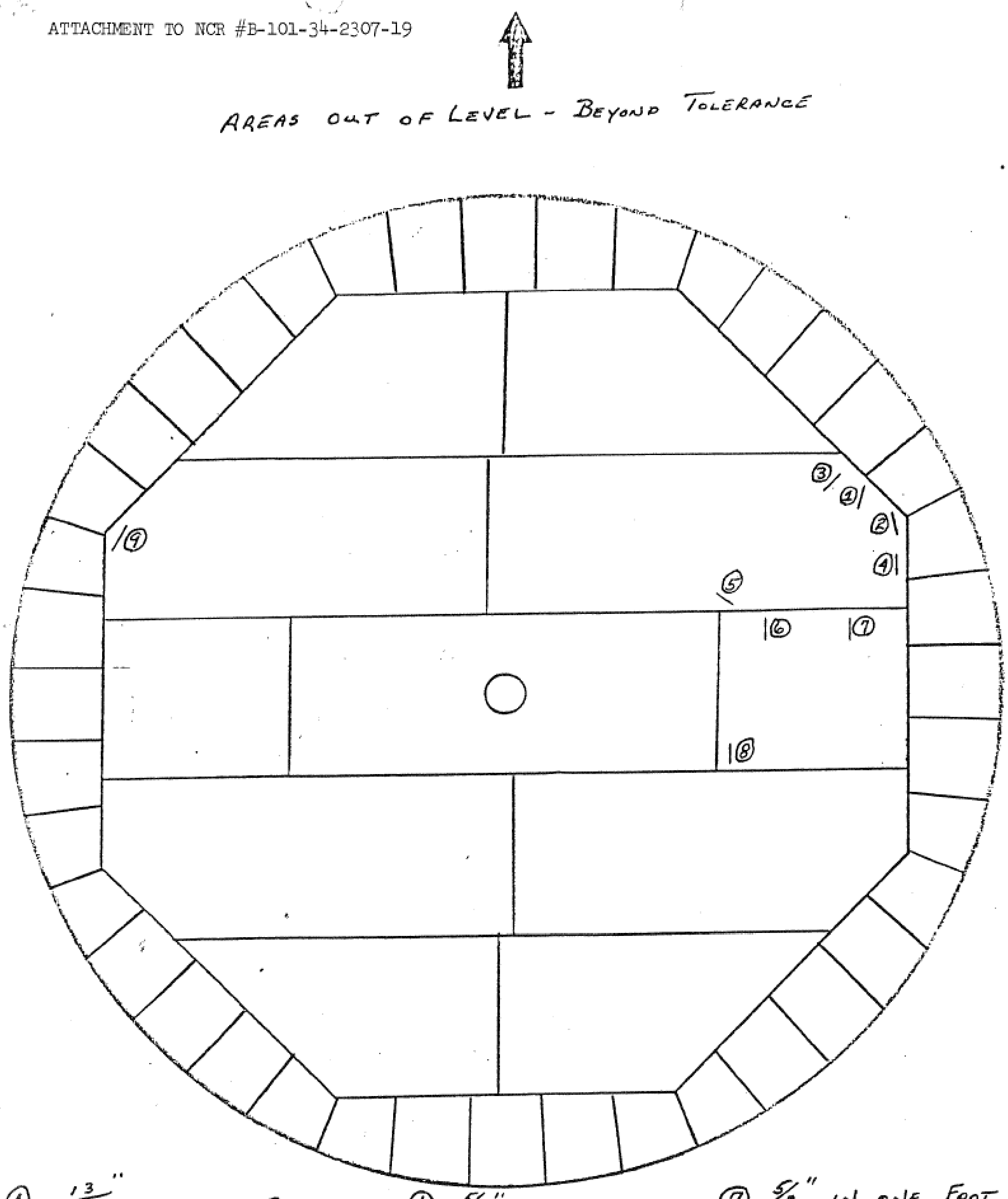
AGL/JMN

ERDA Rep.
ERDA QA
DR Nelson/Vitro
VR Weil/ARHCO

TANK No. 103 PRIMARY

ATTACHMENT TO NCR #B-101-34-2307-19

AREAS OUT OF LEVEL - BEYOND TOLERANCE



① 13/16" IN ONE FOOT
② 3/4" IN ONE FOOT
④ 5/8" IN ONE FOOT
⑤ 5/8" IN ONE FOOT
⑦ 5/8" IN ONE FOOT
⑧ 5/8" IN ONE FOOT

J. A. JONES CONSTRUCTION COMPANY
801 FIRST STREET • RICHLAND, WASHINGTON • 99352 • (509) 942-6707

To: MJ Fatur

April 10, 1975

From: JE Parsons

Subject: PROJECT B-101 SALT CAKE STORAGE FACILITY
NCR B101-34-2307-19

Subject non-conformance report documents discrepancies in tank 103 primary bottom. The discrepancy is a conflict in the fabrication as it exists and construction specifications B101-C1 section 14.3. Specifically, "The slopes of peak or ridge distortions shall be gradual and in no case shall be more than 3/8" per foot." As indicated in the above mentioned NCR, the slopes measure up to 13/16" per foot in localized areas.

Project B-101 has six tank bottoms to be fabricated, three secondary and three primary. As a review the following is a historical sequence of events related to this particular slope problem.

1. Deviations in specified slope tolerances were first experienced on the first secondary tank bottom to be fabricated (tank bottom 102). This discrepancy was noted prior to lowering. In an attempt to correct the discrepancy, the contractor made extensive repairs which consisted of cutting open seams, trimming plates and rewelding with the associated NDT. The result of this repair was that other areas then fell out of tolerance and the repaired area itself was marginal. The tank bottom was lowered and after lowering the areas that were out of tolerance moved to new locations. An NCR was written (NCR B101-20-2307-6) and accepted on the basis that the areas out of tolerance were localized and the distribution of loadings would not affect the tank integrity or function.

2. The second secondary tank bottom (tank 101) was then approximately 90% complete and the same conditions existed (see NCR B101-22-2307-8). Here again locations of discrepancies moved after lowering. The NCR on these discrepancies was also accepted. It was determined that the primary cause of these distortions was the sequencing of the actual welding operations and plate layout.

3. For the third secondary tank bottom the welding sequence was revised in an effort to correct this tolerance problem. This change was only partially successful since the third tank bottom also was out of tolerance. The contractor again attempted to repair the out of tolerance sections by heating and locally deforming the buckled areas. This effort was not successful. This discrepancy was noted and accepted in NCR B101-24-2307-9.

J. A. JONES CONSTRUCTION COMPANY

4. As a result of the third secondary bottom, the contractor again extensively modified his welding sequence and added an elaborate system of jig work in an effort to hold specification tolerances of 3/8" per foot. The first results of this new procedure were evidenced in the primary bottom of tank 102. On completion of fabrication this primary bottom was out of tolerance, however after lowering the areas out of tolerance shifted and reduced so that tolerances were achieved.

5. The same procedure was again used on the tank 101 primary bottom with the following results. The bottom was fabricated and was out of tolerance. One area that was out of tolerance was determined to be a ridge distortion caused by the weld could be fixed by removing and rewelding three seams. This was done and that particular location came within tolerance, however new areas developed which were marginal as to being within tolerance. The bottom was then lowered and the our of tolerance areas redistributed leaving a bottom within tolerance.

6. On the third primary tank bottom (103) the same procedures were followed producing areas out of tolerance. A review of the areas revealed that they were not caused by ridge peaking of the welds and rework of these areas in the manner done on the second tank bottom would not bring them within tolerance. Since the magnitude of these discrepancies were less than had been experienced prior to lowering the last two tank bottoms (primary), it was expected that after lowering they would redistribute and be within the 3/8" per foot slope. Upon lowering areas that were questionable improved but other areas increased resulting in NCR B101-34-2307-19.

The results of any repairs that could be made to correct the deficient areas are questionable as to their success for the follwoing reasons:

1. Deficient areas move as a result of lowering the tank bottoms and if the the bottom is raised to affect a repair the same area may not be out of tolerance when raised.
2. Past experience on tanks 102 and 101 indicated that reworking seams creates added distortion elsewhere in the tank bottom which could result in a worse new condition than presently exists.
3. Since the discrepancies in the 103 primary bottom are not limited to the seam areas themselves, additional seams would be required to be added to the bottom plates.

Since engineering design has examined the areas and determined that existing discrepancies will not affect the tank function or integrity and because of the inability to guarantee a successful repair, we feel that a repair cannot be justified.

For future tanks this tolerance of 3/8" per foot should be carefully reviewed. This arbitrarily arrived at tolerance has caused expensive and elaborate systems to be employed with very marginal results. Future tank fabrication bids will be considerably higher if this tolerance is left unchanged.

JP:st

cc: ML Marlin

App Figure C-3. NCR B-101-22-2307-8, 241-SY Tank Farm Salt Cake Storage Facilities

Box # 63495

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a division of AUTOMATION INDUSTRIES, INC.

NONCONFORMANCE REPORT

(1) PROJ/WO NO.	(2) TITLE	(3) NCR NO.
B-101	241-SY TANK FARM SALT CAKE STORAGE FACILITIES	B-101-22-2307-8

(4) DESCRIPTION OF NONCONFORMANCE - REFERENCE - SUGGESTED DISPOSITION AND JUSTIFICATION

Reference: Project Specification B-101-C1, Paragraph 14.3
Attachment

Discrepancy: In several areas of the Tank 101 secondary bottom (see attachment), the slope of ridge distortion exceeds the 3/8 inches per foot allowable. Thus, the tank bottom presently exhibits slopes in localized areas up to 13/16 inches per foot.

Suggested Disposition: "Conditional accept" provided that:

1. the subsequent liquid penetrant examination required after lowering is acceptable.
2. with load of primary tank bottom on refractory and before primary bottom is lowered, inspect and repair refractory cracks and depressions that are greater than the tolerances specified on the drawings and in the construction specifications.

Justification: The areas out of tolerance are localized. Thus, the distribution of loadings will not affect the tank function and integrity.

HOLD TAG APPLIED: ☒ YES ☐ NO

(A) DS Mager — INSPECTOR OR ORIGINATOR — DATE 10-1-74

(B) Donald D Mager — TITLE III SUPERVISOR — DATE 10-2-74

(5) VITRO REVIEWING AUTHORITY ACTION

☐ REPAIR ☐ MODIFY ☐ REWORK ☐ REJECT ☐ ACCEPT-AS-IS ☒ CONDITIONAL ACCEPT ☐ OTHER (DESCRIBE)

(C-1) E. L. Smith — DESIGN ENGINEER — DATE 10-3-74

(C-2) MPG area — QA MANAGEMENT — DATE 10/3/74

(C) Anderson AWA — PROJECT MANAGER OR ENGR — DATE 10-3-74

(6) CLIENT APPROVAL

☒ APPROVED ☐ DISAPPROVED

(D) Michael J. Fater — OPERATING CONTRACTOR P/E ARHCO — DATE 10-7-74

(D-1) A J Lassila — AEC — DATE 10/7/74

(7) CAUSE OF NONCONFORMANCE AND CORRECTIVE ACTION TO PREVENT RECURRENCE

Primary cause was an unsatisfactory weld sequence. Sequence has been revised for Tank 103 and will be further revised if required.

(E) E Parsons — SIGNATURE AND TITLE — DATE 10/8/74

(8) VERIFICATION OF ACTION TAKEN: ☒ DISPOSITION EFFECTED AS DIRECTED ☐ RECORD OF FIELD CHANGE NO. ______ INITIATED

☐ OTHER (DESCRIBE)

ITEM 1. ACCEPTED 11-20-74

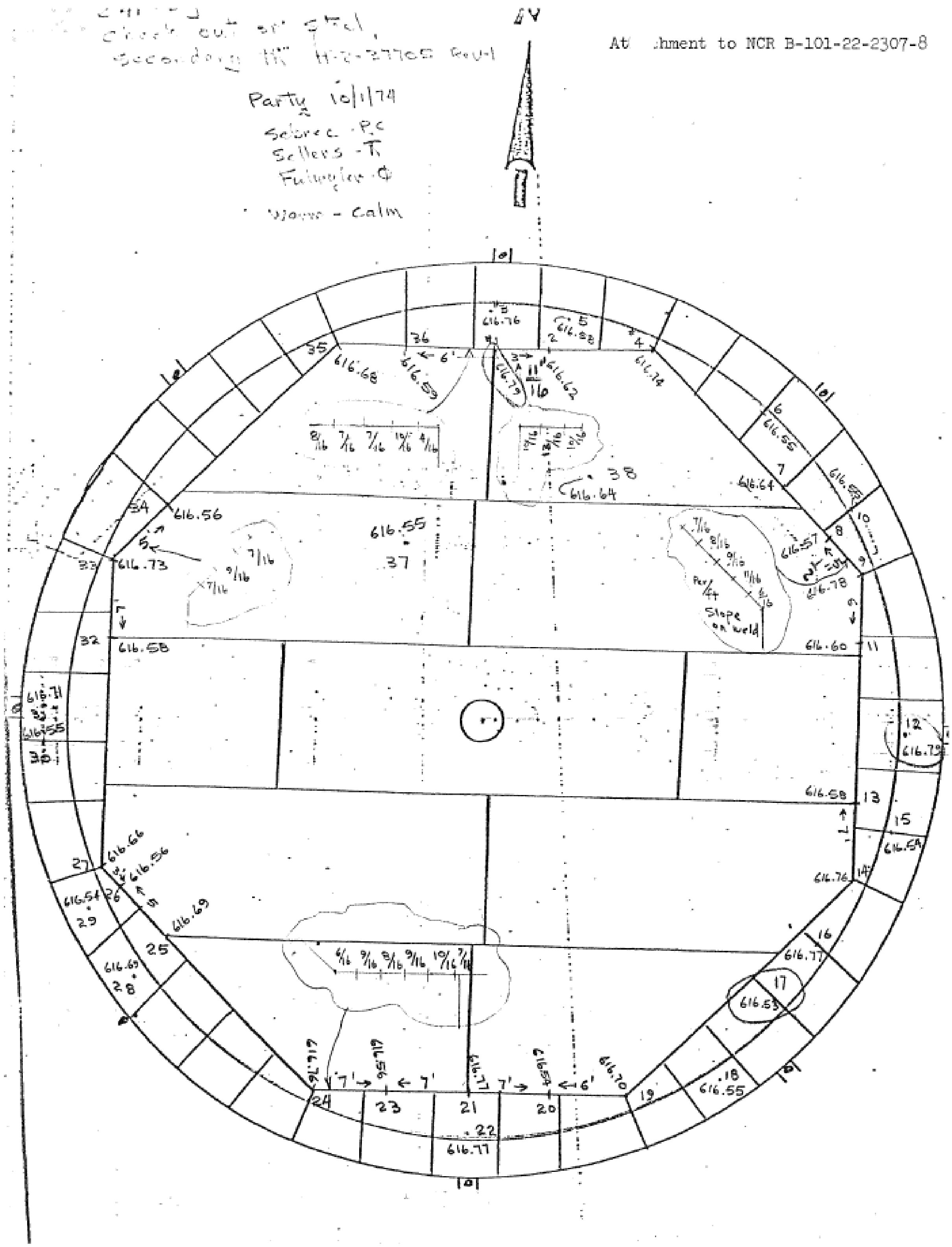
ITEM 2. ACCEPTED 3/18/75

(F) R. E. Johnston — INSPECTOR — DATE 4/9/75

(9) DISTRIBUTION: (G) NCR CONTROL DESK — DATE: 4-10-75

DSM TITLE III SUPRV	MJF OPER CONTR. P/E	AGL/JMN	ERDA Rep.
AWA PROJ MGR/ENGR	RAZ OPER CONTR QA		ERDA QA
CNZ QA MGR	JEP CONST CONTR JOB SUPRT		DR Nelson/Vitro
EES DESIGN ENGR	CONST CONTR P/E		VR Weil/ARHCO
VITRO CENTRAL FILE	CONST CONTR QA		

At[illegible]chment to NCR B-101-22-2307-8



App Figure C-4. NCR B-101-20-2307-6, 241-SY Tank Farm Salt Cake Storage Facilities

VITRO ENGINEERING • architects • engineers
a division of AUTOMATION INDUSTRIES, INC

Box# 63445

NONCONFORMANCE REPORT

(1) PROJ/WO NO.	(2) TITLE	(3) NCR NO.
B-101	241-SY TANK FARM SALT CAKE STORAGE FACILITIES	B-101-20-2307-6

(4) DESCRIPTION OF NONCONFORMANCE - REFERENCE - SUGGESTED DISPOSITION AND JUSTIFICATION

Reference: Project Specification B-101-C1, Paragraph 14.3 Attachment

Discrepancy: In several areas of the Tank 102 secondary bottom, the slope of ridge distortion exceeds the 3/8 inches per foot allowable. Thus, the tank bottom presently exhibits slopes in localized areas (not exceeding three feet per ridge) up to 5/8 inches per foot.

Suggested Disposition: "Conditional accept" provided that:

1. the subsequent liquid penetrant examination required after lowering is acceptable.
2. with load of primary tank bottom on refractory and before primary bottom is lowered, inspect and repair refractory cracks and depressions that are greater than the tolerances specified on the drawings and in the construction specifications.

Justification: The areas out of tolerance are localized. Thus, the distribution of loadings will not affect the tank function and integrity.

HOLD TAG APPLIED: ☐ YES ☒ NO

(A) DS Mager — INSPECTOR OR ORIGINATOR — DATE 9-20-74

(B) Donald J. Mager — TITLE III SUPERVISOR — DATE 10-2-74

(5) VITRO REVIEWING AUTHORITY ACTION

☐ REPAIR ☐ MODIFY ☐ REWORK ☐ REJECT ☐ ACCEPT-AS-IS ☒ CONDITIONAL ACCEPT ☐ OTHER (DESCRIBE)

(C-1) C. E. Smith — DESIGN ENGINEER — DATE 10-3-74

(C-2) M A Garcia — QA MANAGEMENT — DATE 10/3/74

(C) A. Anderson — PROJECT MANAGER OR ENGR — DATE 10-3-74

(6) CLIENT APPROVAL

☒ APPROVED ☐ DISAPPROVED

(D) Michael J. Fatur — OPERATING CONTRACTOR P/E ARHCO — DATE 10-4-74

(D-1) A. J. Lassila — AEC — DATE 10/7/74

(7) CAUSE OF NONCONFORMANCE AND CORRECTIVE ACTION TO PREVENT RECURRENCE

Primary cause was an unsatisfactory weld sequence. Sequence has been revised for Tank 103 and will be further revised if required.

(E) [signature] — SIGNATURE AND TITLE — DATE 10/8/74

(8) VERIFICATION OF ACTION TAKEN: ☐ DISPOSITION EFFECTED AS DIRECTED ☐ RECORD OF FIELD CHANGE NO. ______ INITIATED

☒ OTHER (DESCRIBE) See att. #2

ITEM 1. ACCEPTED 12-3-74

ITEM 2. ACCEPTED 1-10-75

(F) Donald J. Mager — INSPECTOR — DATE 1-10-75

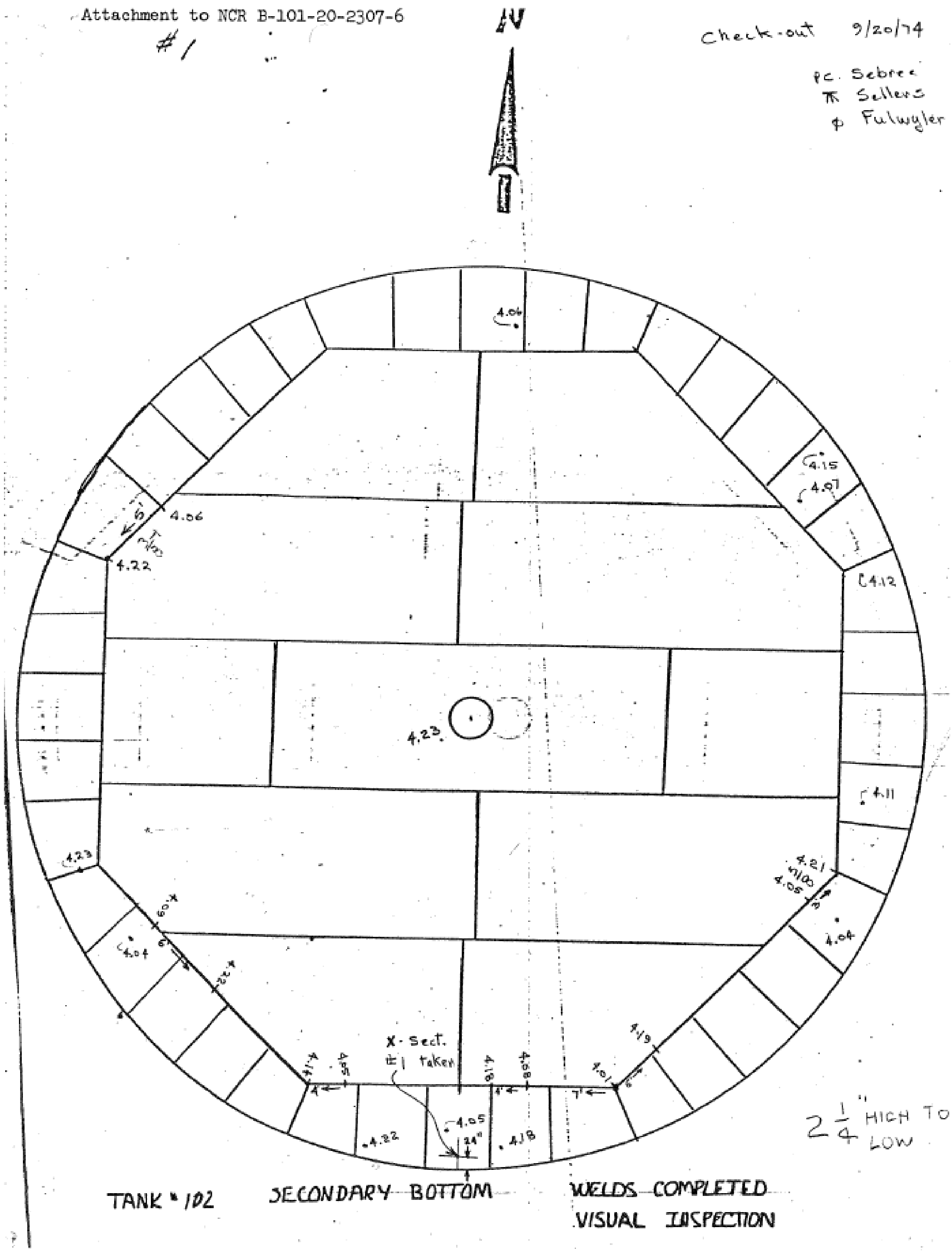
(9) DISTRIBUTION: (G) NCR CONTROL DESK — DATE: 2-12-75

DSM TITLE III SUPRV
AWA PROJ MGR/ENGR
CNZ QA MGR
EES DESIGN ENGR
VITRO CENTRAL FILE

MJF OPER CONTR. P/E
RAZ OPER CONTR QA
JEP CONST CONTR JOB SUPRT
AP CONST CONTR P/E
CONST CONTR QA

AGL/JMN

ERDA Rep.
ERDA QA
DR Nelson/Vitro
JD Galbraith/ARHCO


Attachment to NCR B-101-20-2307-6
#1
N
Check-out 9/20/74
TANK # 102
SECONDARY BOTTOM
WELDS COMPLETED
VISUAL INSPECTION
2 1/4" HIGH TO LOW
X-Sect. #1 taken
4.23
4.06
4.22
4.15
4.12
4.11
4.04
4.05
4.18

ATTACHMENT #6 to NCR B-101-19-2307-5, Item #3
ATTACHMENT #2 t NCR B-101-20-2307-6, Item #2
ATTACHMENT #3 to NCR B-101-21-2307-7, Item #2

DATE: 1-10-75

(8) Verification of Action Taken: Statement of Condition of Refractory

The condition of the refractory was carefully examined prior to lowering of the Tank 102 Primary Bottom. One area (approximately 4' x 6'), was found to be sunken under the loading of a cribbing stack, and was subsequently repaired on February 8, 1975. The repaired area and the remainder of the foundation appeared to be in very satisfactory condition. During the examination of the refractory by E. S. Davis (Vitro) and me, small patches of ice were visible on the surface. Hammer testing of these and other areas provided no indication of frozen or defective material. Minor cracks were noted over the air supply piping and around other cribbing stacks, but were not considered detrimental. Thus, I informed J. E. Parsons (JAJ) and M. J. Fatur (ARHCO) that the condition was considered satisfactory, and that lowering may commence.

For historical purposes, it appears at this time that the product used for the refractory foundation may contain superior qualities with respect to cold weather tolerance than those previously experienced.

App Figure C-5. NCR B-101-21-2307-7, 241-SY Tank Farm Salt Cake Storage Facilities

VITRO ENGINEERING • architects • engineers
a division of AUTOMATION INDUSTRIES, INC

Box # 63493

NONCONFORMANCE REPORT

(1) PROJ/WO NO.	(2) TITLE	(3) NCR NO.
B-101	241-SY TANK FARM SALT CAKE STORAGE FACILITIES	B-101-21-2307-7

(4) DESCRIPTION OF NONCONFORMANCE - REFERENCE - SUGGESTED DISPOSITION AND JUSTIFICATION

Reference: Project Specification B-101-C1, Paragraph 14.3
Attachments

Discrepancy: In two areas of the Tank 102 secondary bottom (see attachment #2 for location), distortions exist within the tangent point of the knuckle curvature. (Note: A profile of the worst condition is shown in attachment #1.)

Suggested Disposition: "Conditional accept" provided that:
1. the subsequent liquid penetrant examination required after lowering is acceptable.
2. with load of primary tank bottom on refractory and before primary bottom is lowered, inspect and repair refractory cracks and depressions that are greater than the tolerances specified on the drawings and in the construction specifications.

Justification: The areas out of tolerance are localized. Thus, the distribution of loadings will not affect the tank function and integrity.

HOLD TAG APPLIED: ☐ YES ☒ NO

(A) DS Mager — INSPECTOR OR ORIGINATOR — DATE 9-20-74
(B) Donald J Mager — TITLE III SUPERVISOR — DATE 10-2-74

(5) VITRO REVIEWING AUTHORITY ACTION

☐ REPAIR ☐ MODIFY ☐ REWORK ☐ REJECT ☐ ACCEPT-AS-IS ☒ CONDITIONAL ACCEPT ☐ OTHER (DESCRIBE)

(C-1) E E Smith — DESIGN ENGINEER — DATE 10-3-74
(C-2) J M Garcia — QA MANAGEMENT — DATE 10/3/74
(C) Henderson AWA — PROJECT MANAGER OR ENGR — DATE 10-3-74

(6) CLIENT APPROVAL

☒ APPROVED
☐ DISAPPROVED

(D) Michael J. Fater — OPERATING CONTRACTOR P/E ARHCO — DATE 10-7-74
(D-1) A J Lassila — AEC — DATE 10/7/74

(7) CAUSE OF NONCONFORMANCE AND CORRECTIVE ACTION TO PREVENT RECURRENCE

Primary cause was an unsatisfactory weld sequence. Sequence has been revised for Tank 103 and will be further revised if required.

(E) E E Parsons — SIGNATURE AND TITLE — DATE 10/8/74

(8) VERIFICATION OF ACTION TAKEN: ☐ DISPOSITION EFFECTED AS DIRECTED ☐ RECORD OF FIELD CHANGE NO. ______ INITIATED

☒ OTHER (DESCRIBE) See att. #3
ITEM 1. ACCEPTED 12-3-74
ITEM 2. ACCEPTED 1-10-75

(F) Donald J Mager — INSPECTOR — DATE 1-10-75

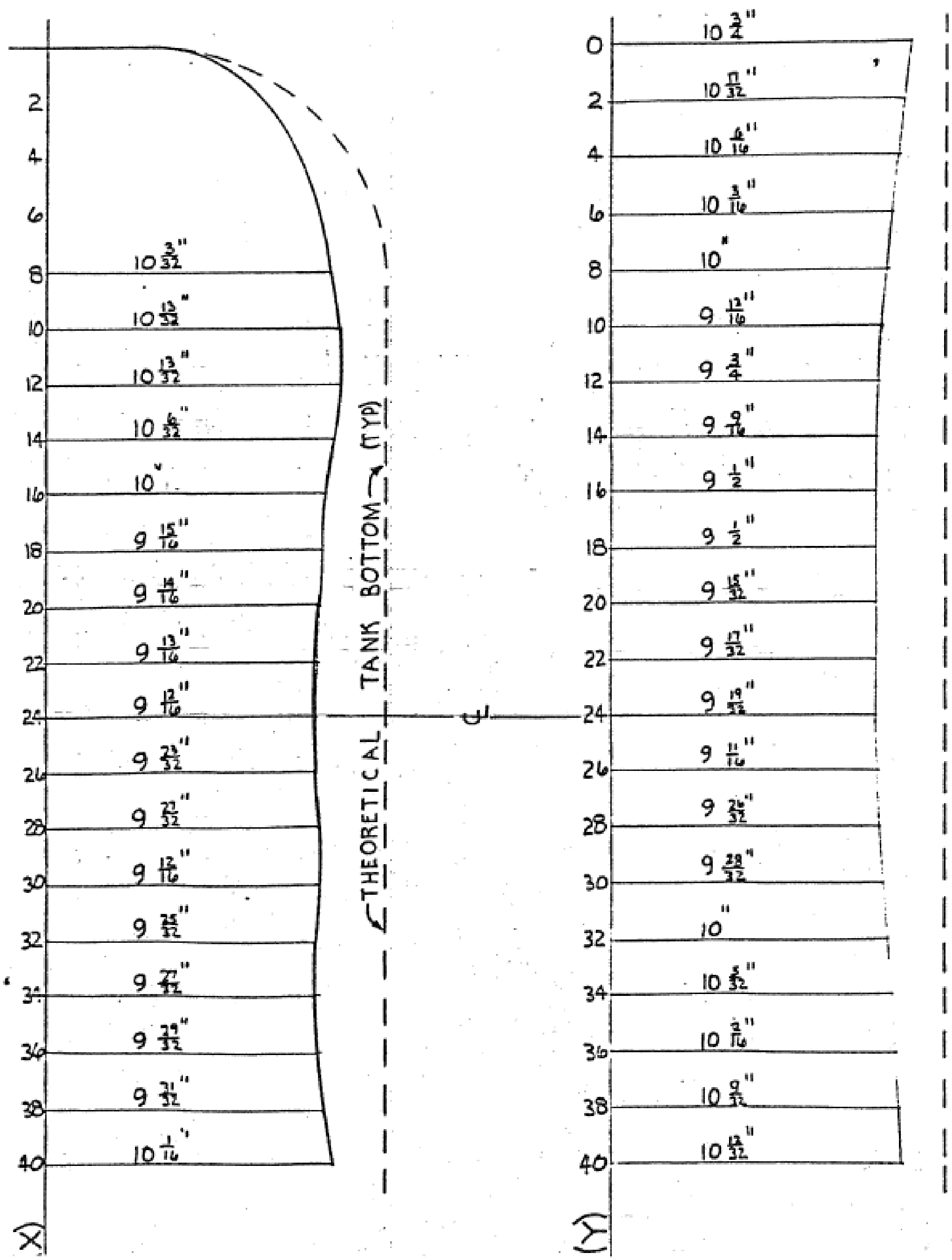
(9) DISTRIBUTION:

DSM TITLE III SUPRV	(G) NCR CONTROL DESK	AGL/JMN	ERDA Rep
AWA PROJ MGR/ENGR	MJF OPER CONTR. P/E		ERDA QA
CNZ QA MGR	RAZ OPER CONTR QA		DR Nelson/Vitro
EES DESIGN ENGR	JEP CONST CONTR JOB SUPRT		JD Galbraith/ARHCO
TRO CENTRAL FILE	AP CONST CONTR P/E		
	CONST CONTR QA		

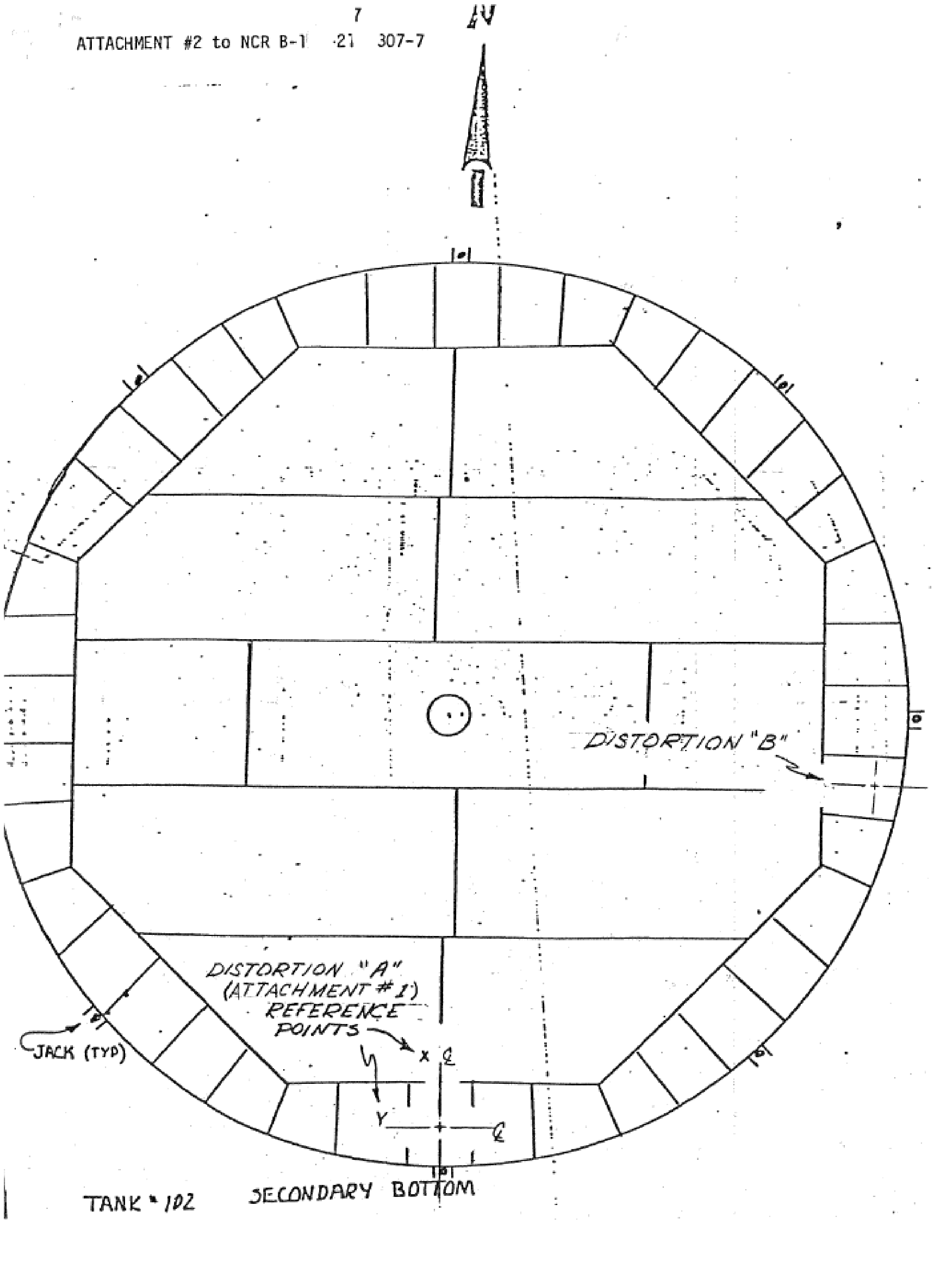
DATE: 2-12-75

ATTACHMENT _ to _CR B-101-21-2307-7

DISTORTION AREA "A"- PROFILE



ATTACHMENT #2 to NCR B-1 ·21 307-7



App Figure C-6. NCR B-101-24-2307-9, 241-SY Tank Farm Salt Cake Storage Facilites

Box # 03441

VITRO ENGINEERING • architects • engineers
a division of AUTOMATION INDUSTRIES, INC

NONCONFORMANCE REPORT

(1) PROJ/WO NO.	(2) TITLE	(3) NCR NO.
B-101	241-SY TANK FARM SALT CAKE STORAGE FACILITIES	B-101-24-2307-9

(4) DESCRIPTION OF NONCONFORMANCE - REFERENCE - SUGGESTED DISPOSITION AND JUSTIFICATION

Reference: Project Specification B-101-C1, and Attachment

Discrepancy: In several areas of the Tank 103 secondary bottom, the slope of ridge distortion exceeds the 3/8 inches per foot allowable. Thus, the tank bottom presently exhibits slopes in localized areas up to 1 inch per foot.

Suggested Disposition: "Conditional accept" provided that:

1. the subsequent liquid penetrant examination required after lowering is acceptable.
2. with load of primary tank bottom on refractory and before primary bottom is lowered, inspect and repair refractory cracks and depressions that are greater than the tolerances specified on the drawings and in the construction specifications.

Justification: The areas out of tolerance are localized. The distortion at location "2" was rechecked and it was noted that the high point lies in the center of that plate material. Since the peak does not occur in the weld area, this distortion and the other distortions will not affect the tank function and integrity.

HOLD TAG APPLIED: ☐ YES ☒ NO

(A) DS Mager — INSPECTOR OR ORIGINATOR — DATE 12-13-74

(B) Donald D Mager — TITLE III SUPERVISOR — DATE 12/13/74

(5) VITRO REVIEWING AUTHORITY ACTION

☐ REPAIR ☐ MODIFY ☐ REWORK ☐ REJECT ☐ ACCEPT-AS-IS ☒ CONDITIONAL ACCEPT ☐ OTHER (DESCRIBE)

(C-1) [signature] — DESIGN ENGINEER — DATE 1-3-75

(C-2) [signature] — QA MANAGEMENT — DATE 1-3-75

(C) A.N. Alerson — PROJECT MANAGER OR ENGR — DATE 1-3-75

(6) CLIENT APPROVAL

☒ APPROVED ☐ DISAPPROVED

(D) Michael J. Fetue — OPERATING CONTRACTOR P/E — DATE 1-13-74 — ARHCO

(D-1) A.J. Lassila — AEC — DATE 1-14-74

(7) CAUSE OF NONCONFORMANCE AND CORRECTIVE ACTION TO PREVENT RECURRENCE

Cause - Deviations in slope tolerances were the result of unsatisfactory weld sequence.

Corrective action - Weld sequence was revised and an elaborate system of strong backs was utilized on the following bottoms.

Note: Results are marginal and on future projects the 3/8"/ft should be relaxed.

(E) L.E. Parsons — SIGNATURE AND TITLE — DATE 3/11/75

(8) VERIFICATION OF ACTION TAKEN: ☒ DISPOSITION EFFECTED AS DIRECTED ☐ RECORD OF FIELD CHANGE NO. ______ INITIATED

☐ OTHER (DESCRIBE)

ITEM #1. ACCEPTED 12/18/75
ITEM #2. ACCEPTED 3/18/75

(F) R.S. Johnston — INSPECTOR — DATE 4/9/75

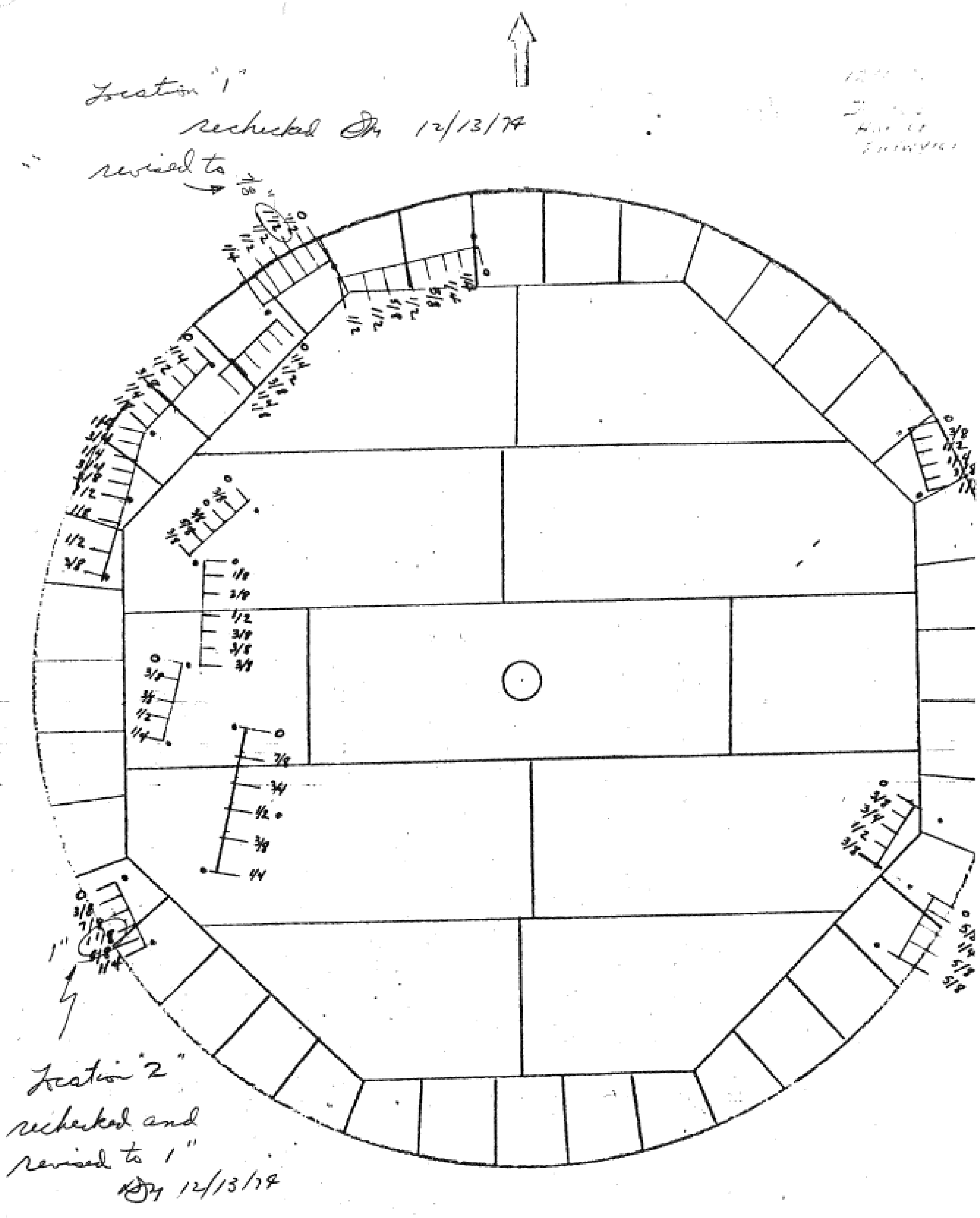
(9) DISTRIBUTION: (G) NCR CONTROL DESK — DATE: 4-10-75

DSM TITLE III SUPRV
AWA PROJ MGR/ENGR
CNZ QA MGR
WSG DESIGN ENGR
VITRO CENTRAL FILE

MJF OPER CONTR. P/E
RAZ OPER CONTR QA
JEP CONST CONTR JOB SUPRT
CONST CONTR P/E
CONST CONTR QA

AGL/JMN ERDA Rep.
ERDA QA
DR Nelson/Vitro
VR Weil/ARHCO

ATTACHMENT TO NCR B-101-24-2307-9



App Figure C-7. Oct 1, 1975 Letter to J.F. Albaugh

Atlantic Richfield Hanford Company

Date: October 1, 1975

To: J. F. Albaugh

From: J. D. Galbraith, 2-2382

Subject: DOCUMENTATION OF VERIFICATION OF SY TANK FARM TANK BOTTOM FLATNESS

As per your request I have reviewed the Vitro documentation that verifies that the 101 and 102 primary tank bottoms do comply with the construction specification. Vitro Title III is in compliance with their approved Title III Inspection plan and with the approved Construction Specification (B-101-C1).

Upon review of the documentation that Vitro Title III did have on file, it was found that there were no outstanding NCR's on the 101 or 102 primary tank bottoms. All of the records that Vitro had committed themselves to generate were in place and did have the acceptance signature of an authorized Title III Inspector.

During the review of the documents pertaining to the fabricated condition of the 101 and 102 tank bottoms, a Survey Report was reviewed that indicated that the 101 tank bottom was not in compliance with the Construction Specification. After further investigation of this indication, a Deficiency Report (#21), which was generated by CB&I confirmed this condition. This condition was found before the primary tank bottom had been lowered into its final position on the insulating concrete. The deficiency report was initiated on February 14, 1975 which is also the date that Vitro Title III surveyed the tank bottom. The area that was identified as not being in tolerance was then re-worked and the deficiency report was signed off by Richard Ford (CB&IQC) on April 28, 1975 as being resolved by re-working. It should be noted that no further documentation was generated to establish the slope of this area after re-work. On March 3, 1975 the 101 primary tank bottom was lowered into position and on March 4, 1975 Vitro Title III Inspection signed off on their Summary Checklist that the 101 primary tank bottom did comply with the flatness requirements as specified in the B-101-C1 Construction Specification.

The main item of interest that was found during this review was that the mode of inspection for flatness was not the same for the 101 tank as the inspection for the 102 and 103 tanks.

Atlantic Richfield Hanford Company

J. F. Albaugh
Page 2
October 1, 1975

Surveys of the 102 and 103 bottoms were made after lowering, but on the 101 tank no survey was made after lowering.

The consistancy of documentation of inspection is therefore somewhat questionable for the 101 tank bottom. It should be noted that there is not any requirement in the Construction Specification or Vitro Title III Inspection plan which establishes that a survey will be made of the primary tank bottoms for flatness. Vitro Title III does state in their inspection plan that they will do what is necessary to verify the dimensional requirements of the tank bottoms, which in this case was a visual examination of the 101 primary tank bottom.

JDG:fd

cc: JD Galbraith
AG Lassila
D Schrag
VR Weil
AT White
RA Zinsli
ERDA-RL, QA

App Figure C-8. May 4, 1976 Letter to V.D. Schrag

VITRO ENGINEERING CORPORATION
Architects • Engineers

ERDA RL OFFICE RECEIVED MAY 5 1976 CONST. MGMT. DIV.

TO VD Schrag, ARHCO
2704-W Bldg, 200-W Area

FROM DE Anderson

DATE May 4, 1976

SUBJECT Bottom Flatness Survey Tank 101-SY

JOB NO. B-101

The survey requested for the 101-SY primary tank bottom was completed on 4-22-76. The rod readings and plot of the maximum bump are as shown on the engineering sketch attached (ES-B101-M6).

The purpose of the survey was to check the tank bottom for flatness since it was the only remaining tank of the three that was not checked after stress relieving following the flatness problem associated with Tank 103. The 101 primary bottom was checked prior to being lowered onto the refractory and one area around the weld T-joint approximately 20 ft south of the tank center on the north-south axis exceeded the 3/8"/ft slope tolerance. The area was cut open and rewelded to bring the slope in tolerance. The primary bottom was lowered onto the refractory and checked for flatness using a carpenter's level and rule. No slopes in excess of the specified limit were found and the bottom was accepted and signed off by the inspector on the inspection check list. No survey data was recorded as there was no nonconforming condition to report. The change in bottom configuration is believed to have been caused by subsequent loading imposed on the knuckle during construction, especially during stress relieving.

The maximum bump height is 0.26 ft as opposed to the 0.25 ft reported previously following our preliminary survey of 4-5-76. The maximum slope is 0.07 ft/ft or approximately 27/32 inches/ft. There was 2-1/2 to 3 inches of water in the tank when the 4-5-76 survey was taken. The water level was reduced approximately 2 inches, prior to the 4-22-76 survey. There were some minor elevation differences noted between the two surveys at the same tank bottom location. For example, the maximum high to low increased from 0.25 ft to 0.26 ft, and the center of the tank was 0.02 ft higher and dry on 4-22-76. The maximum gap between tank bottom and the refractory is believed to be about 2-1/2 inches. The primary knuckle is depressed into the refractory at the tangent point and the maximum difference in bottom elevation at the knuckle tangent is 1/2 inch. The tolerance on the supporting refractory is plus or minus 1/4 inch from level so variations in elevation at the support surface can account for a 1/2 inch elevation difference in the primary tank bottom.

The maximum bump in Tank 101 is similar to the bump in Tank 103 that was subjected to extensive studies previously. Based on the 103 tank

An Automation Industries, Inc. Company VE-8 (12-75)

VITRO ENGINEERING CORPORATION
Architects • Engineers

VD Schrag, ARHCO
May 4, 1976
Page 2

bottom flatness studies, we do not believe that the bumps in Tank 101 will compromise the integrity of the tank beyond that which would be experienced if the 101 tank bottom were free of bumps. It is our understanding that BNW is of the opinion that all bumps should be evaluated on a case-by-case basis. We recommend that BNW be engaged to evaluate the 101 survey attached to resolve any potential issue and hopefully establish some truisms applicable to bumps in general, somewhat similar to the bottom flatness tolerances they have developed for ARHCO. We would prefer to direct BNW in this effort; however, we are primarily concerned with obtaining analyses that will verify our belief regarding the 101 tank bottom, and that is applicable to future tanks. We request your concurrence and/or direction regarding our recommendation.

D. E. Anderson
Project Manager

DEA:mm

Enc. As stated

cc: AG Lassila, ERDA
JM Nelon, ERDA
RP Saget, ERDA
JF Albaugh, ARHCO
RC Roal, ARHCO
HA Zweifel, ARHCO
SS Compton
DRN/DEA-file
JF Nelson/ESD
EE Smith (2)
RR Wyer
Central File
DS Mager
LB

App Figure C-9. Record of Design/Field Change B-101-128, 241-SY Tank Farm Salt Cake Storage Facilities

Box# 00280

RL-144 (5-76)
54-2040-144

RECORD OF DESIGN / FIELD CHANGE

(1) PROJECT NUMBER AND TITLE	(2) RECORDING DATE	(3) APPROVAL DATE	(4) CHANGE NUMBER
Project B-101 241-SY Tank Farm Salt Cake Storage Facilities	1-10-77	1-31-77	B-101-128

(5) DOCUMENTS AFFECTED

(6) DETAILED DESCRIPTION AND JUSTIFICATION

DESCRIPTION

- Grout out-of-tolerance bumps in the primary tank bottom of the 241-SY-101 tank. Location approximately at 0° and 180° of the tank as shown on ES-B101-MG.
- Grouting procedure per JA Jones submittal dated 7/1/76.
- Structural stress supporting rationale per Vitro inputs attached.

JUSTIFICATION

To provide full support to out-of-tolerance tank bottom to eliminate high stress potential.

ATTACHMENTS

A, B, C, & D, E & F

QUALITY ASSURANCE DEPT. FEB 2 1977 J. A. JONES CONSTRUCTION CO.

(17) DISTRIBUTION:

ERDA
AG Lassila

ARHCO
JF Albaugh
AJ Larson

JAJ
LJ Maenpaa
JE Parsons

Vitro
JM Johnston
TA Przybylski
Central File
Project File

(18) ALL DOCUMENTS REVISED

BY:

DATE

(7) EFFECT ON COST: $ 32,000 ~~Not available~~ [X] ADDITIONAL [ ] SAVINGS

BASIS OR REMARKS: Per Vitro Est. 1-22-77

(8) EFFECT ON SCHEDULE: [X] DELAY [ ] IMPROVEMENT

(9) CONTRACTS, PROJECTS OR WORK ORDER AFFECTED:

None

(10) INITIATOR	(11) PHONE	(12) ORGANIZATION	(13) DATE
TA Przybylski	2-6728	Vitro Engineering	1/10/77

APPROVALS

(14) ARCHITECT ENGINEER		(15) OPERATING CONTRACTOR	(16) ERDA
1) Design [signature] 1/14/77	Safety [signature] 1/14/77	1) 1/25/77 [signature]	1) [signature] 1/31/77
2) QA [signature] 1/14/77	PE [signature] 1-14-77	2) [signature] 1/25/77	2) [signature] 1-27-77

STRUCTURAL INTEGRITY PLAN AND ANALYSIS RESULTS

FOR

DESIGN FIELD CHANGE B-101-128

Preliminary stress analysis (phase I) for the proposed Design Field Change (B-101-128) for the support of the 241-SY-101 primary tank bottom anomalies.

I. Analysis

A. Loads

a. Dead Load (D) - primary steel weight
b. Live Load (L) - Liquid weight (specific gravity = 1.7)
c. Pressures (H.S.) - Liquid static pressure and vapor pressure.
d. Thermal - Creep load (T) from concrete dome - used same as B-120
e. Thermal - growth load (T) ________ assumed primary tank-under 30'-3" liquid level = 250°F; above 30'-3" = 210°F

B. Mathematical Model

The out-of-tolerance bumps in the bottom of the tank is a three-dimensional and non-axisymmetric problem with axisymmetric load. A two-phase analysis for the project is being accomplished for cost effectiveness and to meet time requirements. The first phase (completed) was to analyze an axisymmetric model (see Fig. 1) with combining axisymmetric load from Item I. The 147 gap elements (stiff 12 from ANSYS) for the boundary condition in the bottom of the tank were used to make an analogy with actual behavior of the bottom tank. The 207 axisymmetric conical shell elements (stiff 11 from ANSYS) were used to represent the primary tank. The second phase is to make and analyze a three-dimensional mathematical model (see Fig. 2) with gap element at the bottom of tank by using an edge boundary condition. These conditions were derived from the first phase and considered to be of no effect in the stress distribution of critical regions (elements 218-234-235, 91-100-101 Fig. 2 using ANSYS computer program). The analysis considers the resistance of bump due to thermal growth.
The friction coefficient is assumed to be 0.1.

II. Results from Phase I

The maximum wet compressive stress in the bottom of the tank from Phase 1 study is 18.9 ksi (allowable stress for D+L + H.s. + T = 30.53 ksi). The maximum set tension stress in the bottom of the tank from phase 1 study is 4.3 ksi - both well within limits.

The ANSYS computer analysis is printed out on RUN CMD101B dated 1/18/76.

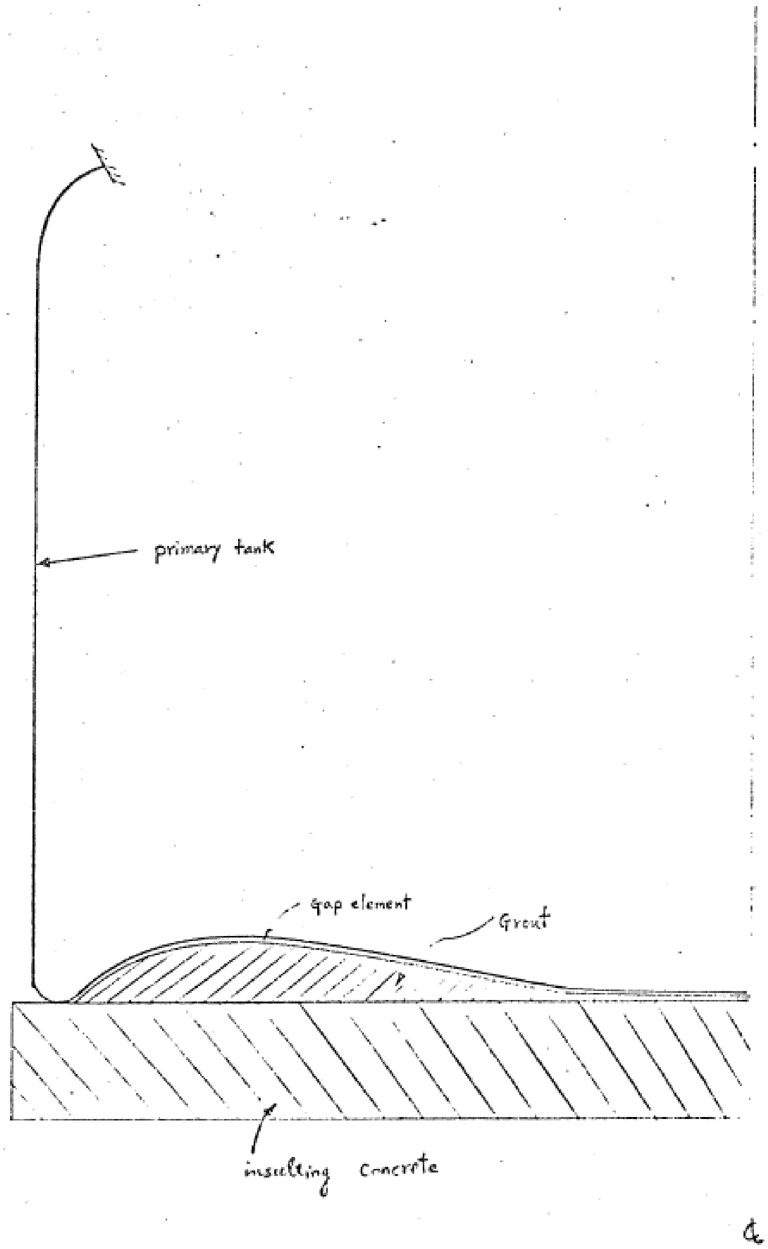


FIG. 1.

Attachment C

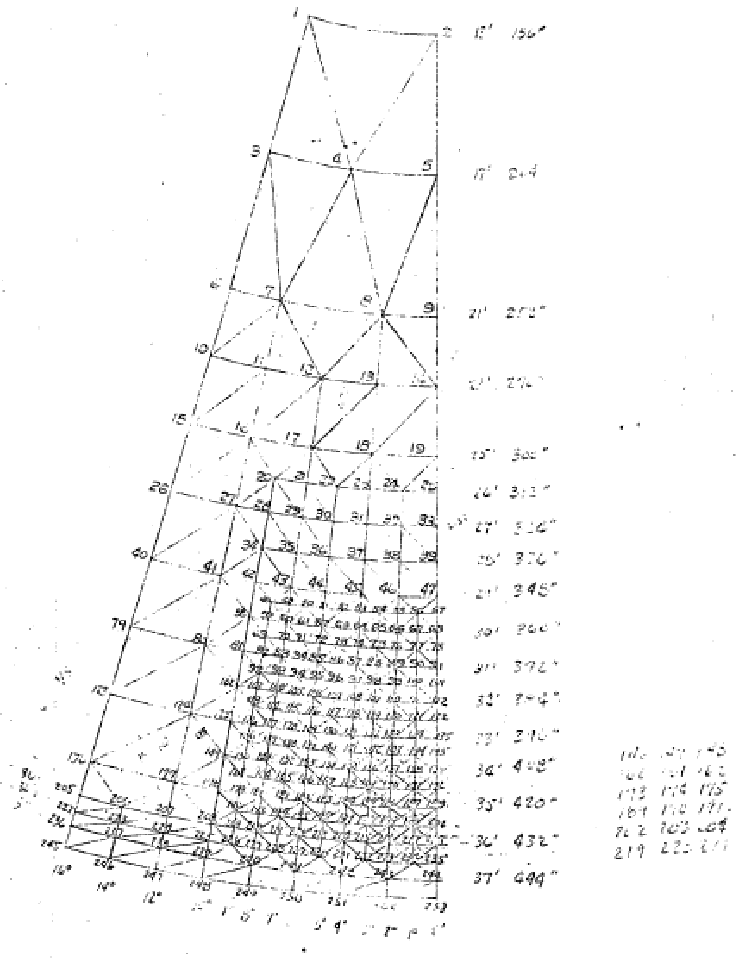


Fig. 2.

Attachment D DFC B-101-128, Att. 4

TANK HEAT TRANSFER ANALYSIS

The addition of insulating concrete to support the primary tank in the area where the tank bottom is distorted should have a negligible temperature effect.

A study of equilibrium tank temperature under normal operating conditions and then a dynamic study of thermal history upon the loss of cooling indicated a very small thermal gradient across the concrete.

With a decay heat load of 100,000 BTU per hour and with cooling air in at 90°F and out at 190°F the gradient across the insulating concrete was calculated to be 13°F with a primary tank temperature of 325°F.

10,000 hours after cooling air circulation fails the primary tank temperature will reach 392°F and the thermal gradient across the insulating concrete reaches 17°F.

After 100,000 hours the primary tank will reach 780°F and the concrete gradient, 25°F.

These calculations are based on an 8 inch thickness of insulating concrete. The addition of one inch more would raise the concrete ΔT about 12%.

Temperatures quoted above are taken from a thermal analysis done for project B-120. The computer run and backup calculations will be filed as backup to the C12002 design report in Vitro Central Files. The ANSYS analysis is printed out on Run TANKØOA dated May Ø7/76.

J. A. JONES CONSTRUCTION COMPANY PROCEDURE FOR GROUTING UNDER TANK 101
PROJECT B-101 - 241-SY TANK FARM
SUBMITTED 7/1/76

PURPOSE

This procedure is to outline the method used to grout under the primary tank bottom of Tank 101 in 241-SY Tank Farm. The reason for grouting is to give full support of the primary bottom in the area defined by Drawing ES-B-101-M6.

(1) Assemble material and equipment.

(2) Check material as being light weight - 50 or 70.

(3) Layout areas to be grouted on the outside of the primary tank.

(4) Cut out retainer band 2 to 3-feet long and remove. Cutout is to be centered on major axis of deformation.

(5) Chip out existing refractory a minimum of 2-feet wide 8-inches deep and 8-feet long. Remove broken refractory and vacuum all dust and particles from work area.

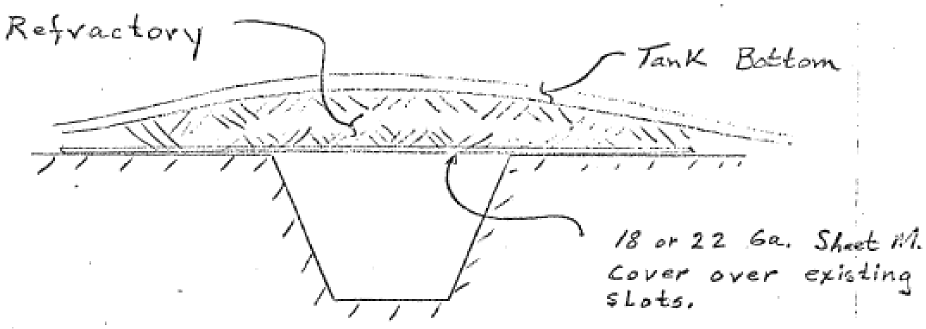
(6) Fabricate slot forms using sheet metal and install.

(7) Mix refractory per manufacture's recommendations and hand pack between existing refractory and tank bottom.

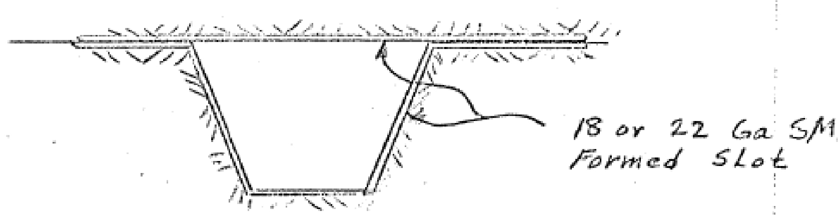
(8) Re-weld retainer band in place after minimum of 48 hours cure on refractory.

(9) Re-clean entire area and inspect.

TYPICAL SLOT CROSS SECTION
FORMING



Existing Slots.



Replaced Slot

VITRO ENGINEERING CORPORATION
Architects • Engineers

1-22-77

Estimate Basis
Primary Tank Bottom Flatness
C10103

The basis of the design field change estimate for the above mentioned project is as follows:

1. Drawings & Documents

   a. Drawing ES-B101-M6 as developed by Vitro.
   b. ARHCO's letter of instructions dated 10-22-76 addressed to AW Akerson by JF Albaugh.

2. Material Prices

   Material prices for the insulating concrete were obtained from a local contractor.

3. Labor Rates

   This project was figured as a JA Jones CPAF effort. The current labor rates as published by JA Jones dated 12-20-76 were used.

4. Contingency & Escalation

   No contingency and escalation has been included in the attached estimate. It was assumed all work would be accomplished within the next 6 (six) weeks.

5. Remarks

   a. No engineering costs were included in the summary of the estimate.

   b. The cost of replacing the refractory under the two bumps depends on the extent of the total area involved, and this will not be known until the refractory removal has taken place. This estimate provided for the maximum area of unsupported tank bottom under the bump as indicated on the drawing times two. The actual unsupported area could be less than indicated. A cost range for this repair of $15-$40 thousand is anticipated. A contingency of approximately 20% is recommended.

JAG:mm

App Figure C-10. SY-101 Grout Out-of-Tolerance Distortion

VITRO ENGINEERING . • architects • engineers
a division of AUTOMATION INDUSTRIES, INC.

CONSTRUCTION AND INSPECTION CHECK LIST

SHEET NO. 1 OF 2

PROJECT B-101 241-SY TANK FARM SALT CAKE STORAGE FACILITIES	PREPARED BY J. M. Johnston
FEATURE DAILY CHECK LIST FOR INSPECTION OF REFRACTORY REPAIR - TANK 101	Approved By Donald [illegible] DATE 1-31-77
REFERENCE CONSTRUCTION SPECIFICATION B-101-C1 RECORD OF DESIGN/FIELD CHANGE B-101-128	DISTRIBUTION
OTHER DATA X REPAIR AREA AT 0° ___ REPAIR AREA AT 180°	

REQUIREMENTS	ACCEPT INITIAL & DATE	REJECT INITIAL & DATE

CONCRETE TEST DATA

[illegible] 2/11/77 130

[illegible] Primary & Secondary [illegible]

[illegible]	8. MIX NO.	9. TIME	10. SLUMP	11. AIR	12. TEMP.	13. TEST DATE	14. AGE	15. P.S.I.	16. REMARKS
7919-1	N/A	9:30	N/A	N/A	N/A	2/17/77	7	W/21.95 3540	CYL NO'S 1 [illegible]
-2					[illegible]			[illegible]	TAKEN FROM [illegible]
-3					[illegible]	"		[illegible]	1st 160 [illegible] CYL. #4 #5 #6
-4					19.21	2/18/77	7	[illegible]	TAKEN 2/11/77 at 0°
-5					20.57	"		4030	17. ACCEPT BY Donald [illegible] DATE 3-26-77
7919-6	N/A		N/A	N/A	N/A 20.84	"		3990	

C31 - PREPARATION
C39 - STRENGTH
C94 - READY MIX

RL-605 (4-76)

II. MATERIALS	ACCEPT	REJECT
A. Refractory material is approved.	[initials] 2-10-77	
B. Weld rod material meets specification and welding procedure requirements.	[initials] 2/16/77	
	—	
	—	

REMARKS

FINAL INSPECTION MUST CONFORM TO APPROVED DRAWINGS ONLY

APPROVED J. M. Johnston DATE 3/28/77

THIS FORM WILL BE USED FOR MATERIAL AND EQUIPMENT RECEIPT AND ACCEPTANCE AS WELL AS CONSTRUCTION.

VE-137.1 (1-75)

JMJ 2/3/76

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a division of AUTOMATION INDUSTRIES, INC.

CONSTRUCTION AND INSPECTION CHECK LIST (CONTINUED)

SHEET NO. 2 OF 2

PROJECT
B-101 241-SY TANK FARM SALT CAKE STORAGE FACILITIES

FEATURE
DAILY CHECK LIST FOR INSPECTION OF REFRACTORY REPAIR - TANK 101

REQUIREMENTS	ACCEPT INITIAL & DATE	REJECT INITIAL & DATE
III. WORKMANSHIP	—	
A. Cutting of concrete retainer band.	—	
1. Retainer band cut in correct location.	RW 2-10-77	
2. No damage done to primary tank during cutting operation.	RW 2-10-77	
B. Formwork for insulating concrete.	—	
1. Air slot forms.	RW 2-10-77	
2. Perimeter formwork or retainer band, as applicable.	[illegible] 2/10-77	
C. Concrete Placement	—	
1. Placement appears adequate to provide maximum support	RW 2-11-77 ~~2-10-77~~	
attainable in presently unsupported areas.	—	
2. Air slots remain free of concrete.	RW 2-10-77	
D. Re-welding of retainer band.	—	
1. Prior to re-welding, inspect weld preparation.	DB 2-15-77	
2. Visual inspection of final weld.	DB 2-16-77	
E. Inspect clean-up of annulus area.	DB 2-17-77	
	—	
IV. TESTING	—	
A. Concrete test cylinders. (See attached concrete test data.)	RW 3-28-77	

VE-137.2 (1-75)

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a division of AUTOMATION INDUSTRIES, INC.

CONSTRUCTION AND INSPECTION CHECK LIST

SHEET NO. 1 OF 2

PROJECT B-101 241-SY TANK FARM SALT CAKE STORAGE FACILITIES	PREPARED BY J. M. Johnston
FEATURE DAILY CHECK LIST FOR INSPECTION OF REFRACTORY REPAIR - TANK 101	Approved By (signature) DATE 1-31-77
REFERENCE CONSTRUCTION SPECIFICATION B-101-C1 RECORD OF DESIGN/FIELD CHANGE B-101-128	DISTRIBUTION
OTHER DATA ___ REPAIR AREA AT 0° X REPAIR AREA AT 180°	

REQUIREMENTS	ACCEPT INITIAL & DATE	REJECT INITIAL & DATE

CONCRETE TEST DATA

1. PROJECT NO.	2. WORK ORDER NO.	3. PREPARED BY/DATE	4. P.S.I. REQUIRED	5. TESTED BY
B-101	C31310	(signature) 2/11/77	130	(signature)

6. POUR DESCRIPTION: Refractory between Primary & Secondary Tank @ 0° & 180° TK101

7. CYL. NO.	8. MIX NO.	9. TIME	10. SLUMP	11. % AIR	12. TEMP.	13. TEST DATE	14. AGE	15. P.S.I.	16. REMARKS
7919-1	N/A	930	N/A	N/A	N/A 23.35	2/17/77	7	3540	CYL No's 1 & 4
-2					19.82	"		3120	Taken ~~From~~
-3					20.00	"		3250	1 at 180° 3 at 0° CYL. #4 #5 #6
-4					19.21	2/18/77	7	3120	Taken 2/11/77 at 0°
-5					20.87	"		4030	17. ACCEPT BY (signature) DATE 3-26-77
7919-6	N/A		N/A	N/A	N/A 20.84	"		3890	

ASTM: C143 - SLUMP; C172 - SAMPLING; C231 - AIR CONTENT; C31 - PREPARATION; C39 - STRENGTH; C94 - READY MIX

RL-605 (4-76)

II. MATERIALS

REQUIREMENTS	ACCEPT INITIAL & DATE	REJECT INITIAL & DATE
A. Refractory material is approved.	(initials) 2-10-77	
B. Weld rod material meets specification and welding procedure requirements.	(initials) 2/16/77	
	—	
	—	
	—	

REMARKS

FINAL INSPECTION MUST CONFORM TO APPROVED DRAWINGS ONLY

APPROVED (signature) DATE 3/28/77

THIS FORM WILL BE USED FOR MATERIAL AND EQUIPMENT RECEIPT AND ACCEPTANCE AS WELL AS CONSTRUCTION.

VE-137.1 (1-75)

(initials) 2/3/76

VITRO ENGINEERING • architects • engineers
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CONSTRUCTION AND INSPECTION CHECK LIST (CONTINUED)

SHEET NO. 2 OF 2

PROJECT
B-101 241-SY TANK FARM SALT CAKE STORAGE FACILITIES

FEATURE
DAILY CHECK LIST FOR INSPECTION OF REFRACTORY REPAIR - TANK 101

REQUIREMENTS	ACCEPT INITIAL & DATE	REJECT INITIAL & DATE
III. WORKMANSHIP	—	
A. Cutting of concrete retainer band.	—	
1. Retainer band cut in correct location.	HW 2-10-77	
2. No damage done to primary tank during cutting operation	HW 2-10-77	
B. Formwork for insulating concrete.	—	
1. Air slot forms.	HW 2-10-77	
2. Perimeter formwork or retainer band, as applicable.	[illegible] 2/15/77	
C. Concrete Placement	—	
1. Placement appears adequate to provide maximum support	HW 2-10-77	
attainable in presently unsupported areas.	—	
2. Air slots remain free of concrete.	HW 2-10-77	
D. Re-welding of retainer band.	—	
1. Prior to re-welding, inspect weld preparation.	DB 2-15-77	
2. Visual inspection of final weld.	DB 2-16-77	
E. Inspect clean-up of annulus area.	DB 2-17-77	
	—	
IV. TESTING	—	
A. Concrete test cylinders. (See attached concrete test data.)	HW 5-26-77	

VE-137.2 (1-75)

App Figure C-11. SY-101 Grout Correspondence

52561

Atlantic Richfield Hanford Company
Federal Building
Richland, Washington 99352
Telephone 509 942-7411

RECEIVED
OCT 27 1976
VITRO
PRO. MGMT.

PROJECT B-101 REDISTRIBU[TION]
DG LIEN
EE SMITH
RR WYER
CENTRAL FILES
AWA/FILES

October 22, 1976

Vitro Engineering
Richland, Washington 99352

Attention: Mr. A. W. Akerson

Subject: PROJECT B-101 - "SALT CAKE STORAGE FACILITIES, 241-SY TANK FARM" - 241-SY-101 PRIMARY TANK BOTTOM FLATNESS

Gentlemen:

Please prepare a Design Field Change to initiate repair to the 241-SY-101 primary tank bottom. The repair procedure that has been discussed would place grout under out-of-tolerance bumps in order to give full support to the primary bottom.

Since this change would affect the structural integrity of the subject tank, the Design Field Change must be accompanied by supporting rationale showing that this repair would reduce the tank plate stresses to an acceptable level without having a detrimental affect on:

1. Tank heat transfer
2. Tank thermal growth
3. Leak detection

Attached is Battelle Northwest, J. A. Jones Construction Company, Vitro Engineering and Atlantic Richfield Hanford Company correspondence on this topic.

Very truly yours,

[signature]

J. F. Albaugh
Project Engineer

JFA:sh

Att.

cc: w/att.
AG Lassila, ERDA-RL
DD Ritter
File
Project File

Battelle
Pacific Northwest Laboratories
Battelle Boulevard
Richland, Washington 99352
Telephone (509) 946-2702
Telex 32-6345

August 19, 1976

Mr. J. F. Albaugh
Atlantic Richfield Hanford Company
P. O. Box 250
Federal Building
Richland, WA 99352

Dear Jim:

The purpose of this letter is to document our discussions with you concerning future possible actions with regards to the SY-101 waste storage tank.

In order to put these discussions in proper perspective, a brief summary of the work that the Structures & Mechanics Section of Battelle-Northwest has carried out for ARHCO in this area is helpful. Our first effort dealt with a detailed analysis of a somewhat idealized form of an out-of-tolerance bump in the bottom of the SY-103 tank, such work being reported in BNWL-B-475. This was followed by work which lead to the development of contour template coordinate tables which provided data for fabricating inspection templates for field use. In a related manner, we performed a generalized analysis of one class of bumps which interacted with the knuckle region in the tank. This last work was documented in our report to you marked SAM 76-1. All the work quoted above has provided us with much insight into the tank fabrication problem and forms the basis for our present attitude on the SY-101 tank bottom question.

In our opinion, it would not be cost-effective for us, or anyone, to spend the necessarily considerable effort analyzing the actual bump configuration in great detail. If such analysis was undertaken, it is very likely to result in a conclusion that using the bumpy bottom without fixing the bumps would be unacceptably risky due to imposed, high flexural stresses during filling. Hence, some stabilizing technique, like bump grouting, would be indicated to support the flexing.

We find no difficulties associated with mechanics problems which might be imagined as a result of grouting, provided, the grout compliance and thermal properties are reasonably like that insulating concrete found under the remainder of the tank bottom (recalling that the insulating concrete has experienced thermal effects from the stress relief treatment). It does seem reasonable, however, to recommend documentation of the analysis which demonstrated such acceptability. We visualize that analysis as showing upper and lower bounds of grout properties which would be expected to perform acceptably in service.

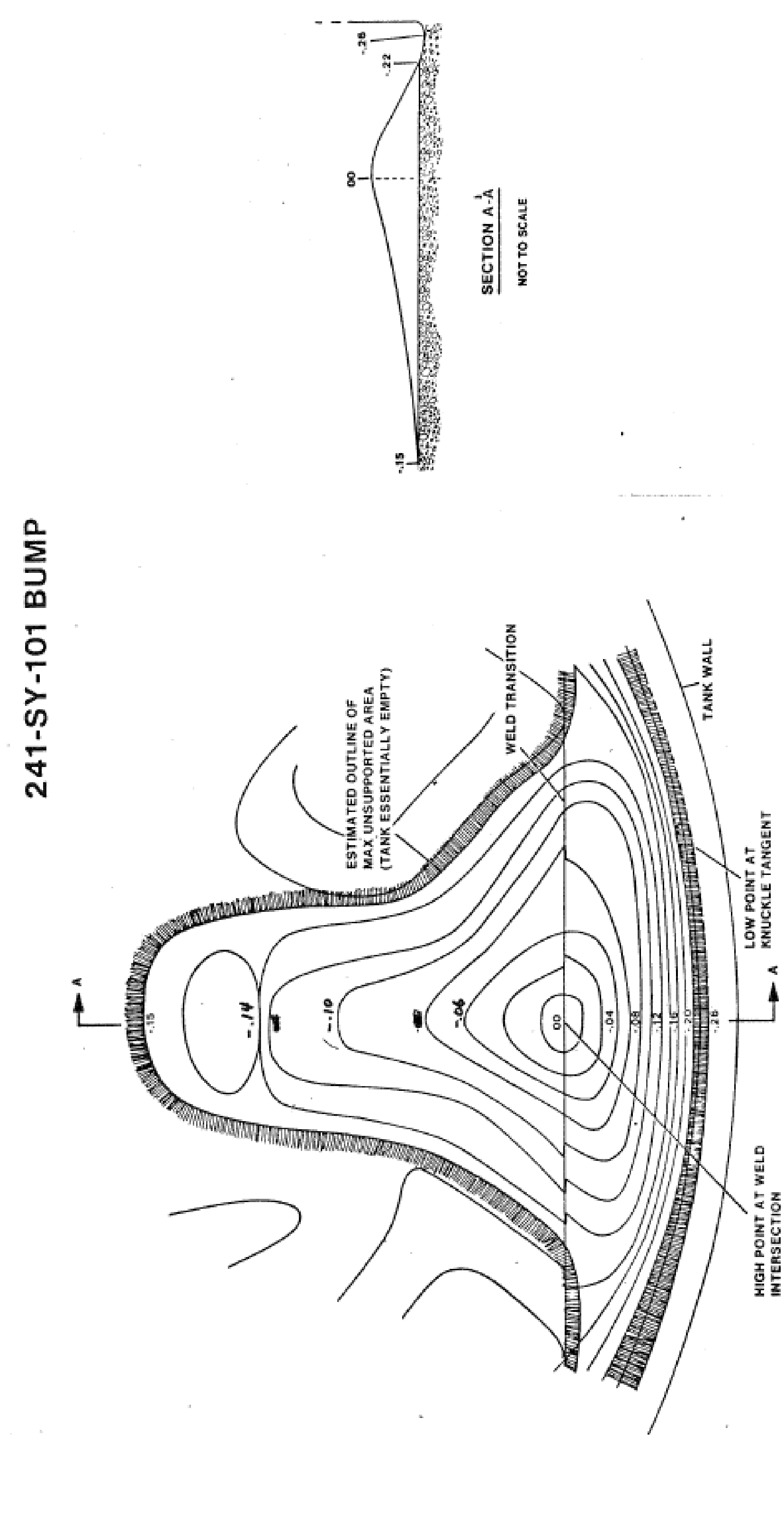
We are prepared to assist you in the analysis of the grouting procedure and resultant structural behavior of the tank in either a direct or indirect manner. In a direct manner we would do the analysis and report the results to you. In the indirect manner we would act as consultants to the party you choose to do the work; or, as we have done in the past, act as an independent "third-party" reviewer.

If you have any questions regarding this letter, please let me know.

Sincerely,

Milton Vagins, Manager
Structures & Mechanics

MV:nlm


241-SY-101 BUMP
SECTION A-A
NOT TO SCALE
PLAN
ESTIMATED OUTLINE OF
MAX UNSUPPORTED AREA
(TANK ESSENTIALLY EMPTY)
WELD TRANSITION
TANK WALL
LOW POINT AT
KNUCKLE TANGENT
HIGH POINT AT WELD
INTERSECTION

COMPARISON OF TANK SPECIFICATIONS WITH THE 241-SY-101 BOTTOM CONDITION

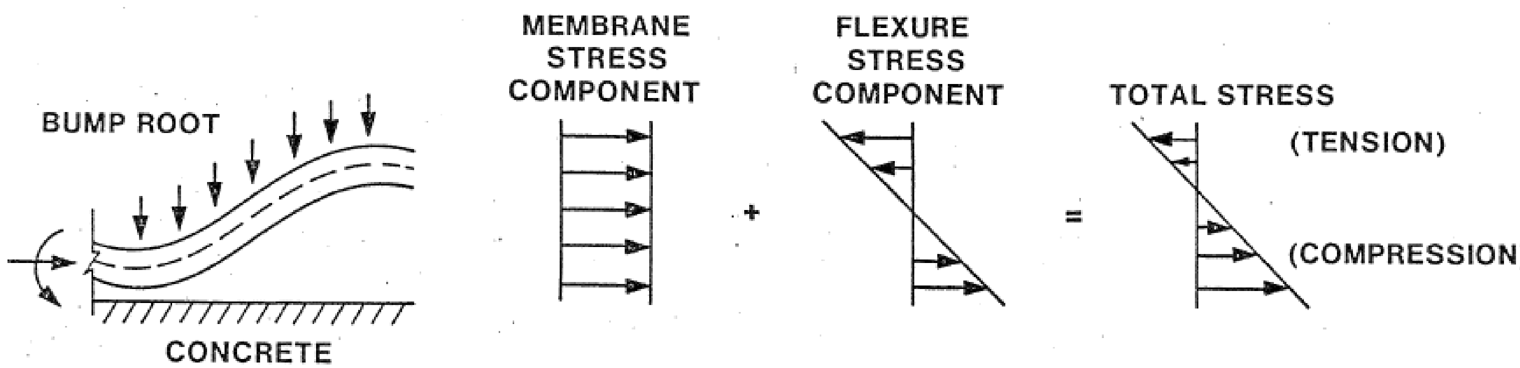
VARIABLES	241-SY* SPECIFICATION	241-AW** SPECIFICATION	241-SY-101 TANK CONDITION
BUMP SLOPE	3/8 IN/FT	3/8 IN/FT	3/4 IN/FT
BUMP HEIGHT	3"	3"	3.12"
7/8" PLATE ROOT RADIUS	–	436"	75"
7/8" PLATE CROWN RADIUS	–	347"	200"
1/2" PLATE ROOT RADIUS	–	249"	≈ 500"
1/2" PLATE CROWN RADIUS	–	198"	200"

*NO ANALYTICAL BASIS EXISTS FOR THIS SPECIFICATION

**SPECIFICATION DEVELOPED BY BNW UNDER ARHCO W.O. 12005, 12006 & 12007

V7608-1.4

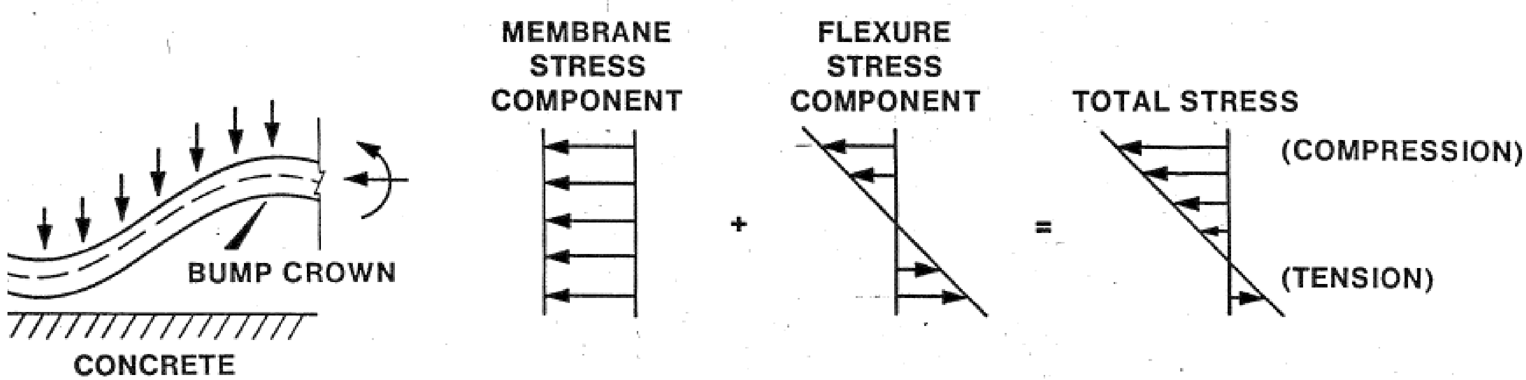
ILLUSTRATION OF EFFECTS OF MEMBRANE AND FLEXURE STRESS COMPONENT SUPERPOSITION IN THE BUMP ROOT



UNDER THE ASSUMPTION THAT THE BUMP WILL FLATTEN BY HYDROSTATIC PRESSURE, THE RESULTANT STRESS DISTRIBUTION IN THE BUMP ROOT WILL BE COMPOSED OF A MEMBRANE STRESS AND FLEXURE STRESS COMPONENT WITH THE RESULTANT STRESS BEING TENSILE ON THE INSIDE FACE

V7608-1.2

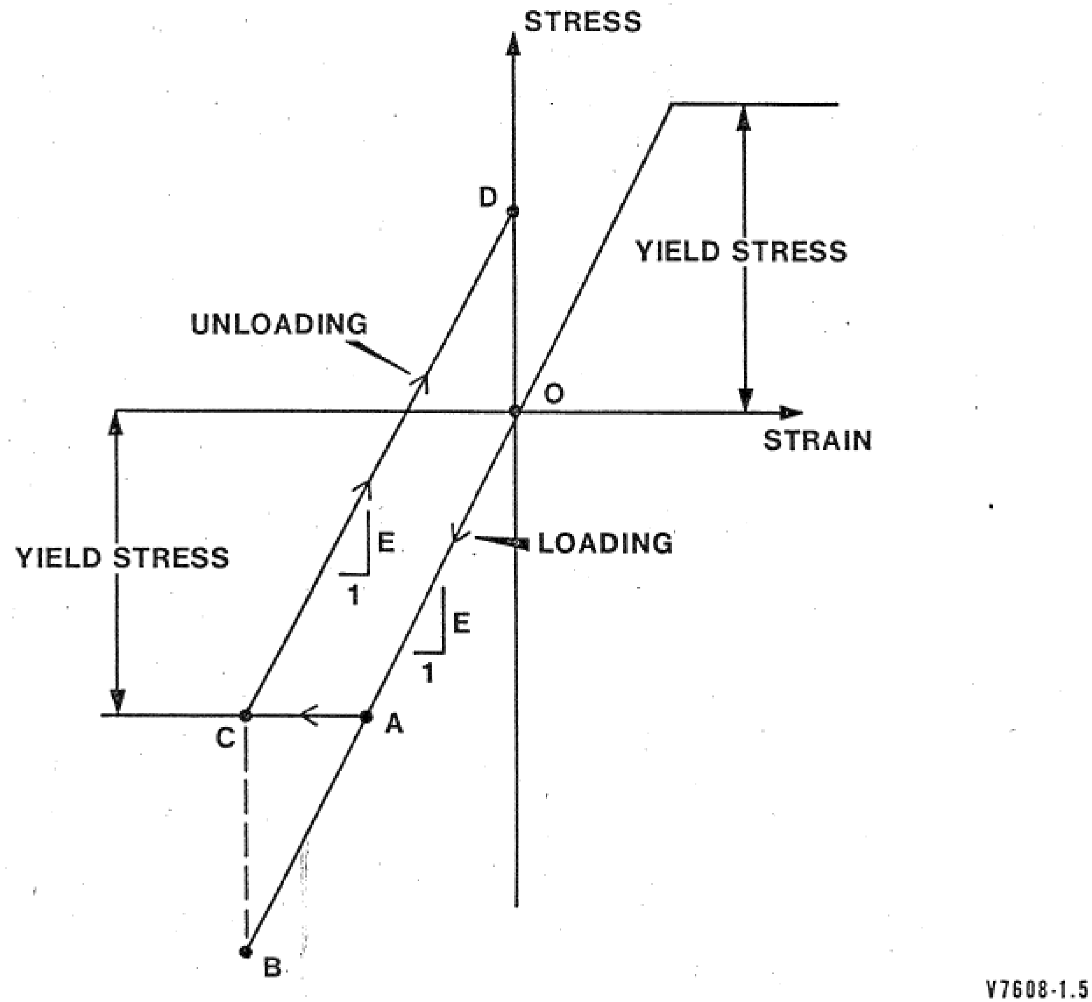
ILLUSTRATION OF EFFECTS OF MEMBRANE AND FLEXURE STRESS COMPONENT SUPERPOSITION IN THE BUMP CROWN



UNDER THE ASSUMPTION THAT THE BUMP WILL FLATTEN BY HYDROSTATIC PRESSURE, THE RESULTANT STRESS DISTRIBUTION IN THE BUMP CROWN WILL BE COMPOSED OF A MEMBRANE STRESS AND FLEXURE STRESS COMPONENT WITH THE RESULTANT STRESS BEING COMPRESSIVE ON THE INSIDE FACE

V7608-1.3

STRESS-STRAIN DIAGRAM ILLUSTRATING CROWN TENSILE SHAKE-DOWN STRESS



APPROACH

PROBLEM

- THE 241-SY-101 BOTTOM CONDITION IS OUT OF SPECIFICATION
- ANALYSIS CONFIDENCE IS LOW
- RESULTS OF ANALYSIS ARE UNLIKELY TO CHANGE ALTERNATIVES

ALTERNATIVES

- NOT USE THE TANK
- USE THE TANK IN THE PRESENT CONDITION
- ELIMINATE THE POSSIBILITY OF HIGH TENSILE STRESSES ON THE TANK INTERIOR

SOLUTION

- MODIFY THE INSULATING CONCRETE SLAB TO SUPPORT THE OUT OF SPECIFICATION BUMPS

CONSIDERATIONS

- AIR SLOTS
- THERMAL TANK GROWTH
- LEAK DETECTION

V7608-1.6

VITRO ENGINEERING CORPORATION
Architects • Engineers

TO J. F. Albaugh/ARHCO
2704-W, 200 West Area

FROM A. W. Akerson

DATE July 12, 1976

SUBJECT Project B-101, 241-SY Tank Farm
241-SY-101 Primary Tank Bottom Flatness

JOB NO. W.O. C10103

Reference: Letter, JF Albaugh to AW Akerson, 7/2/76

Vitro has reviewed the procedure for supporting the 241-SY-101 Tank Primary Bottom, as contained in the referenced letter, and concurs that this method of support should eliminate the high stresses that would otherwise be experienced by the "bumps".

We understand that you are planning to utilize this grouting procedure on the two bumps located approximately at 0° and 180° of the tank as shown on ES-B101-M6. Care should be taken, when chipping out existing refractory and packing in grout, not to contact the tank with metal tools that could scratch or otherwise damage the heat treated surface.

D. G. Lien
D. G. Lien, Civil/Structural

E. E. Smith
E. E. Smith, Piping & Vessels

A. W. Akerson
A. W. Akerson, Project Engineer

AWA:ec

cc: AG Lassila/ERDA-RL
HA Zweifel/ARHCO, 2704W
JE Parsons/JAJ, 241-AW Construction Trailer
DG Lien
EE Smith
RR Wyer
Central Files
AWA/Files
LB

An Automation Industries, Inc. Company

VE-8 (12-75)

ersedes letter
ed, July 2, 1976,
e subject

Atlantic Richfield Hanford Company
Federal Building
Richland, Washington 99352
Telephone 509 942-7411

Action: 7/12/76

July 2, 1976

Vitro Engineering
Richland, Washington 99352

Attention: Mr. A. W. Akerson

Subject: PROJECT B-101 - SALT CAKE STORAGE FACILITIES, 241-SY TANK FARM
241-SY-101 PRIMARY TANK BOTTOM FLATNESS

Reference: (1) Letter, June 17, 1976, J. F. Albaugh to V. D. Schrag, "241-SY-101 Primary Tank Bottom Survey - Project B-101, Salt Cake Storage Facilities, 241-SY Tank Farm"

(2) Letter, May 4, 1976, D. E. Anderson to V. D. Schrag, "Bottom Flatness Survey Tank 101-SY"

Gentlemen:

A Battelle Northwest review of the 241-SY-101 Tank Bottom contour plot concluded that an analytic effort to evaluate the stress levels in the tank bottom would produce results with a low confidence level. Rather than undertake such an analytic effort, it has been proposed that the bumps be supported from beneath thus eliminating the high stresses associated with bump deflection.

Would Vitro Engineering please review this approach. Included in this effort should be a review of the stress levels in the supported areas. In addition, the adequacy of the attached procedure for supporting the 241-SY-101 primary tank bottom in the critical areas defined by Drawing ES-B-101-M6 should be evaluated.

Very truly yours,

J. F. Albaugh
Project Engineer

JFA:sh

Att.

w/att.
Galbraith
Garfield
Huff
Lassila, ERDA-RL
Parsons, JAJ
Roal
Schrag
Vollert
Zweifel
e
ject File

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PROJ. MGMT.

RECEIVED
JUL -9 1976
VITRO
PRO. MGMT.

App Figure C-12. Investigation of Tank SY-102 Insulating Refractory

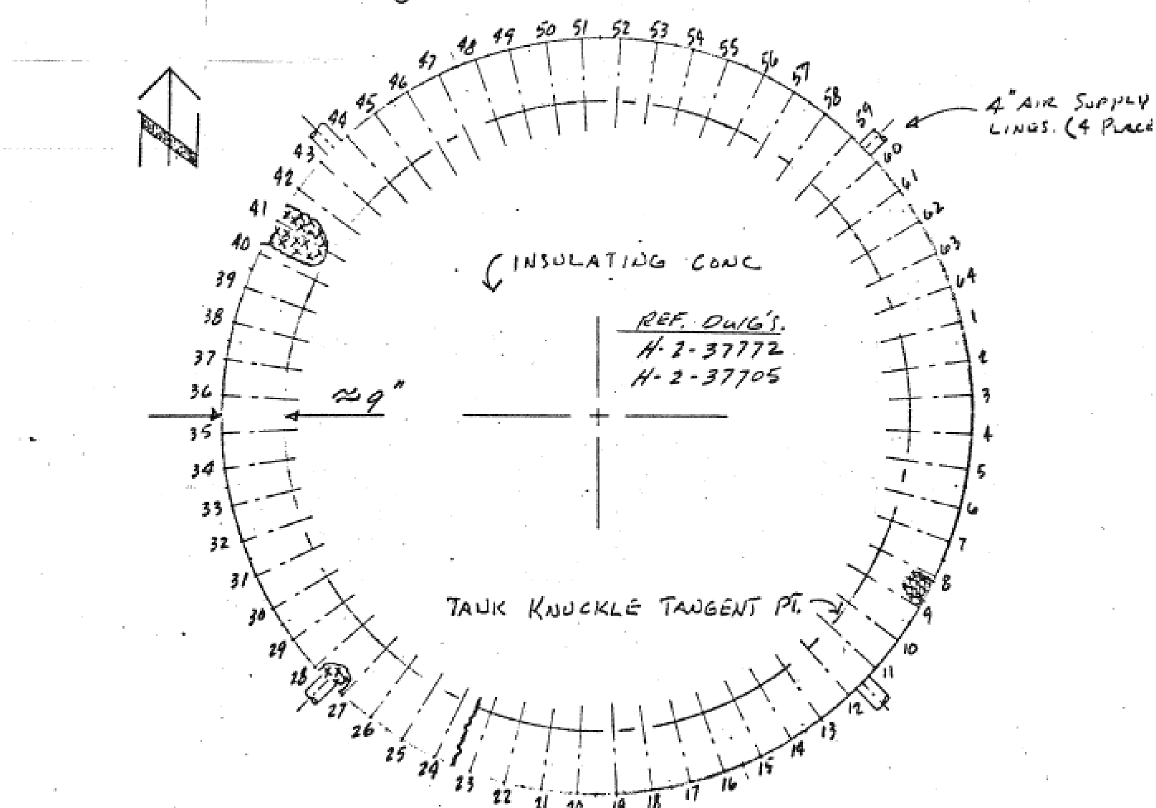
DESIGN ANALYSIS

FOR: ARCHO
LOCATION: 102-SY TANK
SUBJECT: INSULATING CONC - FIELD DATA.

PAGE: SK-H-1
JOB NO.: B-101-03
DATE: 7/25/75
BY: E.A. GOAKEY
CHECKED BY:

REPORT ON FIELD INVESTIGATION OF TANK 102-SY INSULATING CONCRETE around tank perimeter after PRIMARY TANK STRESS RELIEF.

Locations are referenced to slots in the outer perimeter ring and the 4 inch air supply lines.



REMARKS:

Point 8 to 9 — FRIABLE area varies from 1/4" to 1 1/4" thick over an area, 8" x 6" at perimeter area.

POINT 23-24 — 1/8" wide crack (radial)

POINT 41 — 1/2" thick top layer may approach knuckle area, by 2 ft. wide.

NOTE: Approximately 50% of perimeter area had friable area about 1/8" to 3/16" thick at perimeter extending

App Figure C-13. NCR B-101-32-2307-17, 241-SY Tank Farm Salt Cake Storage Facilities

VITRO ENGINEERING • architects • engineers
a division of AUTOMATION INDUSTRIES, INC

Box #63493

NONCONFORMANCE REPORT

(1) PROJ/WO NO.	(2) TITLE	(3) NCR NO.
B-101	241-SY TANK FARM SALT CAKE STORAGE FACILITIES	B-101-32-2307-17

(4) DESCRIPTION OF NONCONFORMANCE - REFERENCE - SUGGESTED DISPOSITION AND JUSTIFICATION

Reference: Dwg. H-2-37705, Rev. 1
Attachment

Discrepancy: The insulating concrete slab of the 103 tank is not level within the "plus or minus 1/4 inch" specified on the referenced drawing. As shown on the attached sketch, the elevation varies from 617.12 to 617.27. This is .95 inches below the specified of 617.20 and .82 inches above.

Suggested Disposition and Justification: "Accept-as-is" since:
1. refractory thickness is adequate for insulating function.
2. primary tank design and function are not affected.
3. subsequent primary tank fabrication should not be affected. (Note: This item confirmed by contractor.)

HOLD TAG APPLIED: ☐ YES ☒ NO

(A) DS Mager — INSPECTOR OR ORIGINATOR — DATE 3-18-75
(B) Donald W Mager — TITLE III SUPERVISOR — DATE 3-18-75

(5) VITRO REVIEWING AUTHORITY ACTION

☐ REPAIR ☐ MODIFY ☐ REWORK ☐ REJECT ☒ ACCEPT-AS-IS ☐ CONDITIONAL ACCEPT ☐ OTHER (DESCRIBE)

(C-1) [signature] — DESIGN ENGINEER — DATE 3/19/75
(C-2) M.A. Garcia — QA MANAGEMENT — DATE 3/19/75
(C) [signature] — PROJECT MANAGER OR ENGR — DATE 3-19-75

(6) CLIENT APPROVAL
☒ APPROVED
☐ DISAPPROVED

(D) Michael J. Fitzer — OPERATING CONTRACTOR P/E — ARHCO — DATE 3-26-75
(D-1) [signature] — AEC — DATE 3-26-75

(7) CAUSE OF NONCONFORMANCE AND CORRECTIVE ACTION TO PREVENT RECURRENCE

Cause - Limited access made resetting of forms difficult after start of pouring to maintain correct elevation.
Corrective action - Future installations should be made prior to primary bottom erection for this close tolerance work.

(E) [signature] Parsons — SIGNATURE AND TITLE — DATE 3/28/75

(8) VERIFICATION OF ACTION TAKEN: ☒ DISPOSITION EFFECTED AS DIRECTED ☐ RECORD OF FIELD CHANGE NO. ______ INITIATED
☐ OTHER (DESCRIBE)

(F) [signature] — INSPECTOR — DATE 3/28/75

(9) DISTRIBUTION:

DSM TITLE III SUPRV
AWA PROJ MGR/ENGR
CNZ QA MGR
WSG DESIGN ENGR
VITRO CENTRAL FILE

(G) NCR CONTROL DESK
MJF OPER CONTR. P/E
RAZ OPER CONTR QA
JEP CONST CONTR JOB SUPRT
WTS CONST CONTR P/E
CONST CONTR QA

AGL/JMN

ERDA Rep.
ERDA QA
DR Nelson/Vitro
VR Weil/ARHCO

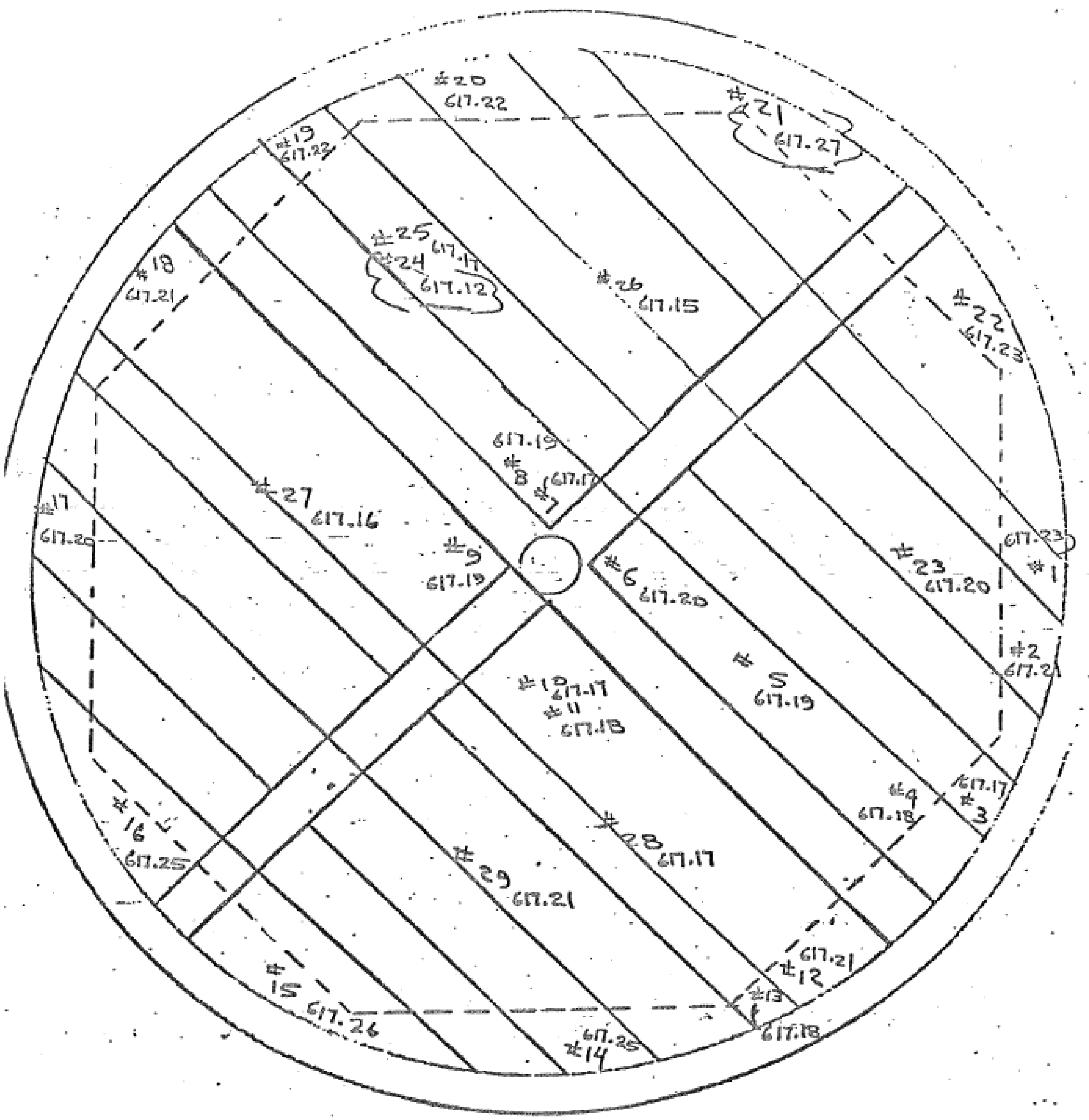
DATE: 3-28-75

Refractory
TK 102

PROJECT B-101

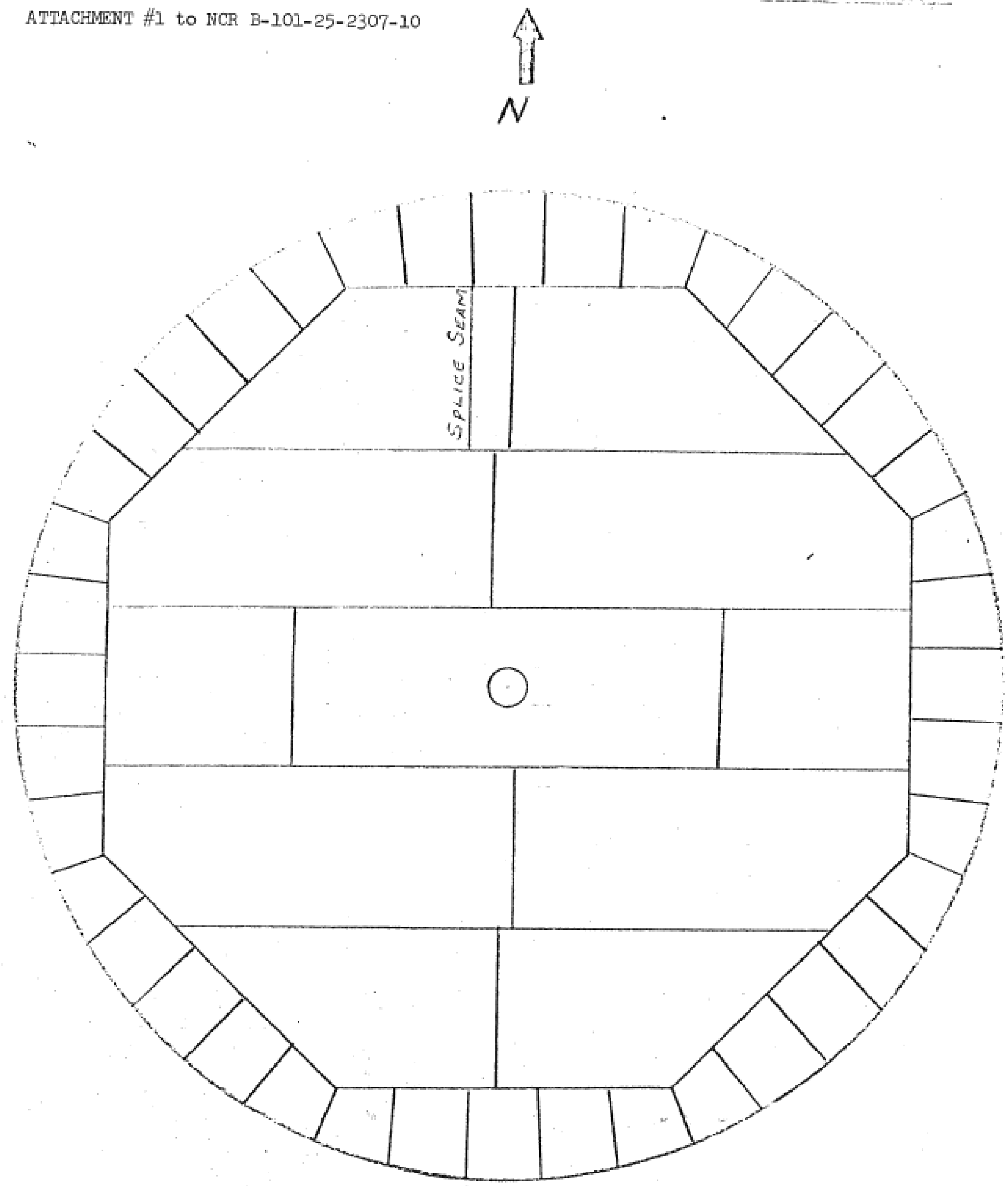
ATTACHMENT TO NCR # B-101-32-2307-17

Plan elev.
617.20



NR No. 101 PRIMARY

ATTACHMENT #1 to NCR B-101-25-2307-10



App Figure C-14. NCR B-101-19-2307-5, 241-SY Tank Farm Salt Cake Storage Facilities

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NONCONFORMANCE REPORT

(1) PROJ/WO NO.	(2) TITLE	(3) NCR NO.
B-101	241-SY TANK FARM SALT CAKE STORAGE FACILITIES	B-101-19-2307-5

(4) DESCRIPTION OF NONCONFORMANCE - REFERENCE - SUGGESTED DISPOSITION AND JUSTIFICATION

Reference: Project Specification B-101-C1
CB & I Tank Bottom Placement Procedure
Attachment - Report by JE Herrin

Discrepancy: Adequate control of the lowering operation (Tank 102 secondary) was not maintained. (See attachment for details)

Suggested Disposition and Justification: "Conditional accept" provided that:

1. the subsequent liquid penetrant examination required after lowering is acceptable.
2. there are no unacceptable permanent distortions.
3. with load of primary tank bottom on refractory and before primary bottom is lowered, inspect and repair refractory cracks and depressions that are greater than the tolerances specified on the drawings and in the construction specifications.

HOLD TAG APPLIED: ☐ YES ☒ NO

(A) DS Mager — INSPECTOR OR ORIGINATOR — DATE 9-19-74

(B) Donald D. Mager — TITLE III SUPERVISOR — DATE 9-19-74 (original date) 10-1-74

(5) VITRO REVIEWING AUTHORITY ACTION

☐ REPAIR ☐ MODIFY ☐ REWORK ☐ REJECT ☐ ACCEPT-AS-IS ☒ CONDITIONAL ACCEPT ☒ OTHER (DESCRIBE) *

* Construction contractor should revise procedure.

(C-1) C. E. Smith — DESIGN ENGINEER — DATE 10-3-74

(C-2) J. M. Garcia — QA MANAGEMENT — DATE 10/3/74

(C) Henderson AWA — PROJECT MANAGER OR ENGR — DATE 10/3/74

(6) CLIENT APPROVAL

☒ APPROVED
☐ DISAPPROVED

(D) Michael J. Fatur — OPERATING CONTRACTOR P/E — ARHCO — DATE 10-4-74

(D-1) A. G. Lassila — AEC — DATE 10/7/74

(7) CAUSE OF NONCONFORMANCE AND CORRECTIVE ACTION TO PREVENT RECURRENCE

On request the lowering procedure was changed to minimize deflections.

(E) F. E. Parsons — SIGNATURE AND TITLE — DATE 10/8/74

(8) VERIFICATION OF ACTION TAKEN: ☐ DISPOSITION EFFECTED AS DIRECTED ☐ RECORD OF FIELD CHANGE NO. ______ INITIATED

☒ OTHER (DESCRIBE) See att. #6

ITEM 1. ACCEPTED 12-3-74
ITEM 2. ACCEPTED 1-10-75
ITEM 3. ACCEPTED 1-10-75

(F) Donald D. Mager — INSPECTOR — DATE 1-10-75

(9) DISTRIBUTION: (G) NCR CONTROL DESK — DATE: 2-12-75

DSM TITLE III SUPRV
AWA PROJ MGR/ENGR
CNZ QA MGR
EES DESIGN ENGR
VITRO CENTRAL FILE

MJF OPER CONTR. P/E
RAZ OPER CONTR QA
JEP CONST CONTR JOB SUPRT
AP CONST CONTR P/E
CONST CONTR QA

AGL/JMN ERDA Rep.
ERDA QA
DR Nelson/Vitro
JD Galbraith/ARHCO

AUTOMATION INDUSTRIES, INC.
VITRO ENGINEERING DIVISION

INTER – OFFICE MEMORANDUM

DATE September 21, 1974

TO D. S. Mager — Vitro Trailer, 200-W Area (LOCATION OR DEPARTMENT)

FROM J. E. Herrin — Vitro Trailer, 200-W Area (LOCATION OR DEPARTMENT)

SUBJECT PROJECT B-101 - PLACEMENT OF 102 SECONDARY TANK BOTTOM

On 9-19-74 the construction contractor lowered the 102 secondary tank bottom. As prescribed in CB & I's procedure, eight hydraulic jacks were set equally spaced around the tank bottom. Two manifolds were used, each controlling four jacks. These four jacks were independently operated by one man. (See attachment #1.)

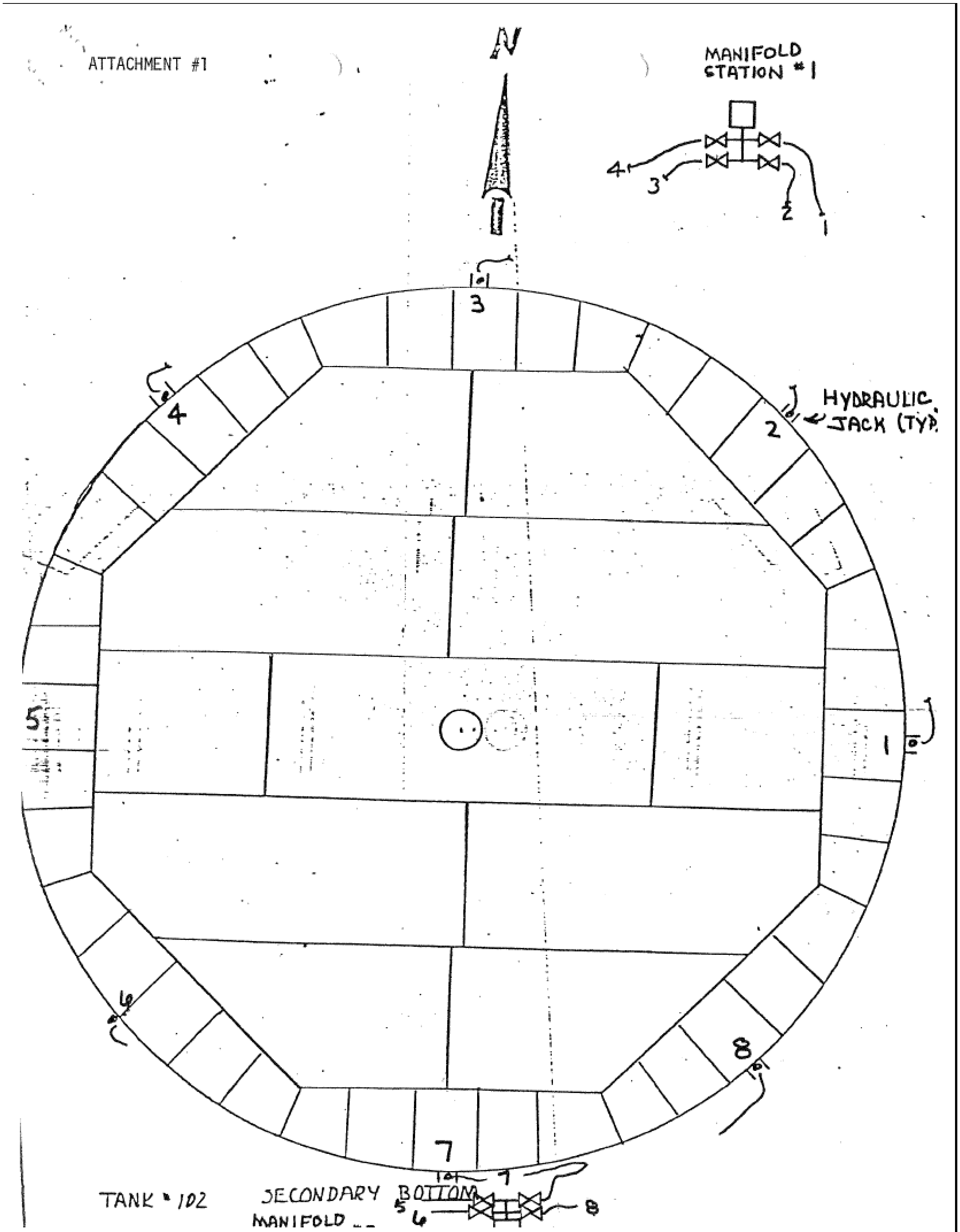
At approximately 10:00 AM the tank was elevated by the two manifold operators, but not simultaneously. After the first tier of cribbing was removed, the Station 1 manifold operator lowered his jacks to the next tier (approximately 8"). The jacks controlled at Station 2 remained fully extended. This produced a scallop effect on the South and West sides of the tanks. The Station 2 manifold operator released his jacks bringing the tank to rest on the next tier. (See attachments 2 & 3.)

At that time, Don Mager, Vitro Field Engineer, informed Don Anderson, Vitro Project Engineer, of the situation. Don Anderson decided the operation could continue if CB & I lowered each jack in one inch increments starting at one point and circling the tank. This method was attempted throughout the lowering operation. However, with each lowering operation, the tank deflected as shown on Attachments 4 & 5.

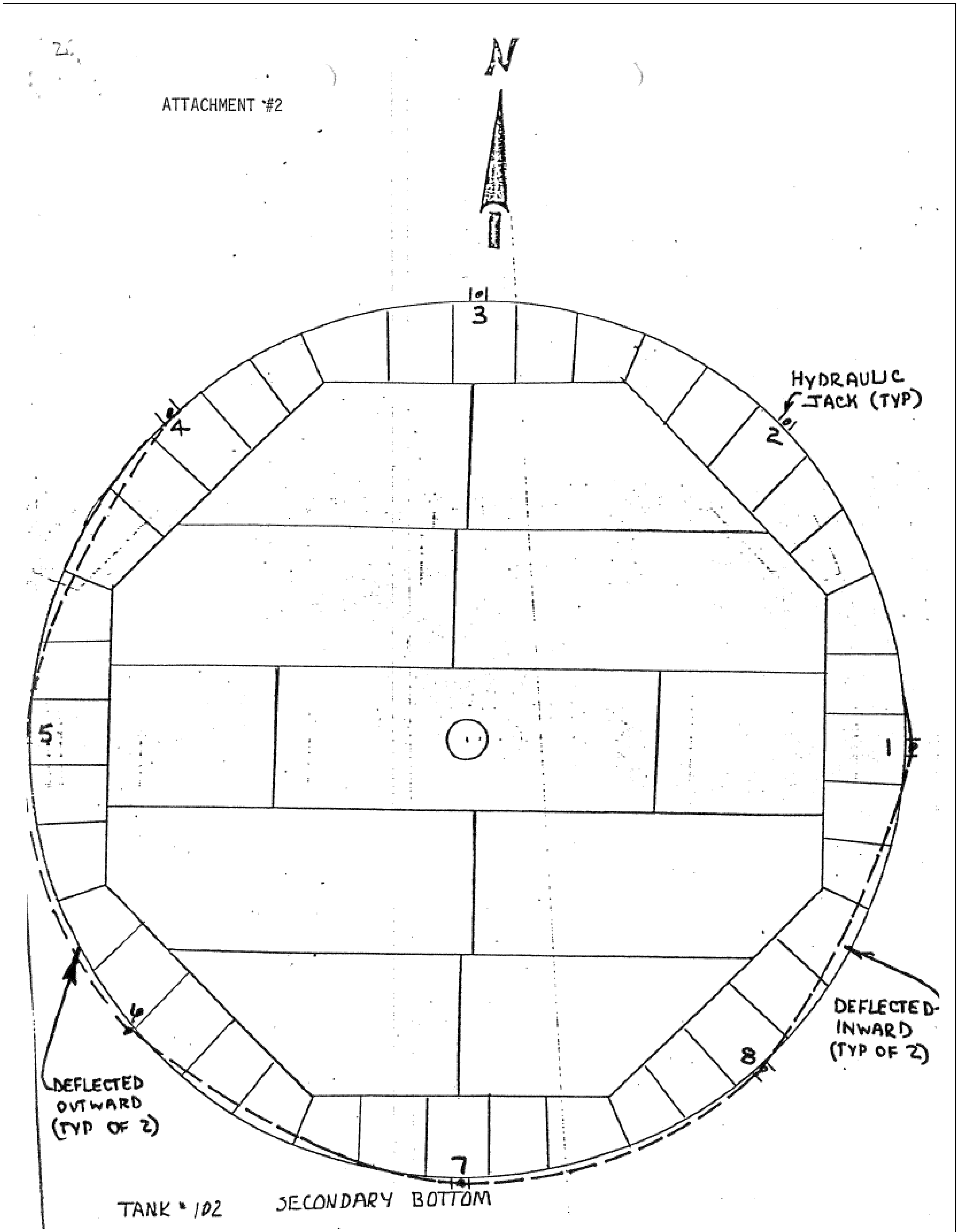
The lowering operation was completed at approximately 2:30 PM.

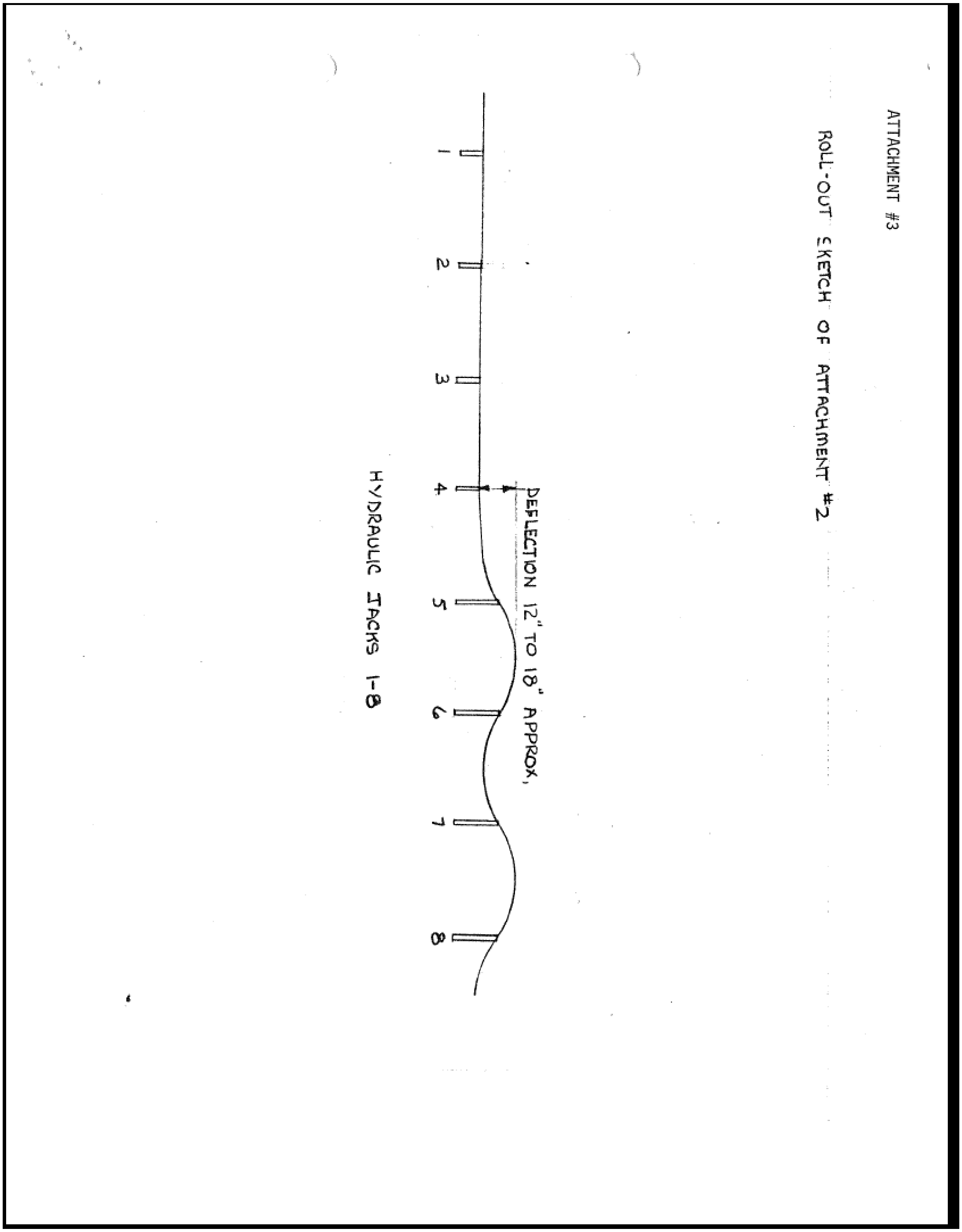
Joe Herrin
J. E. Herrin

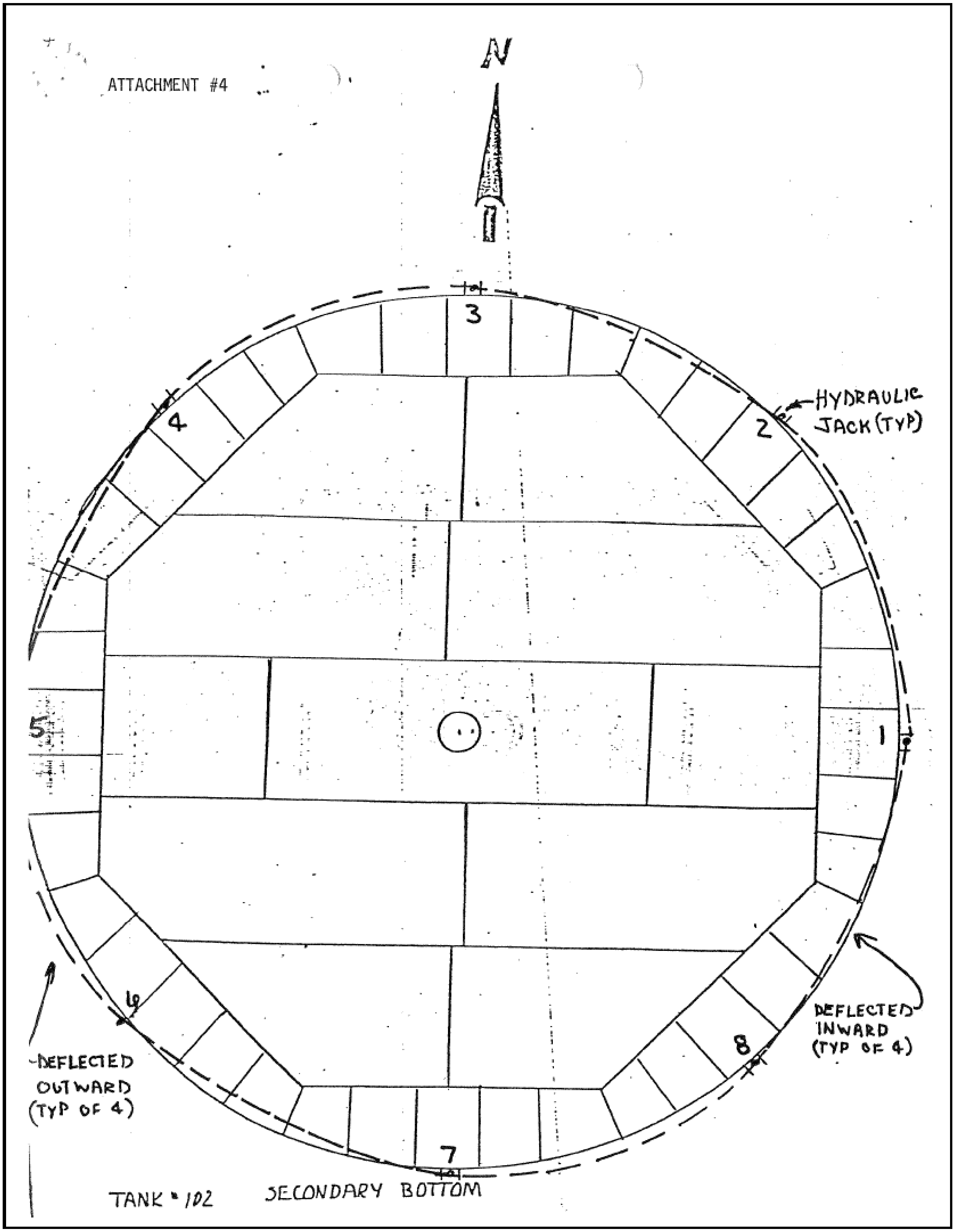
JEH:jf

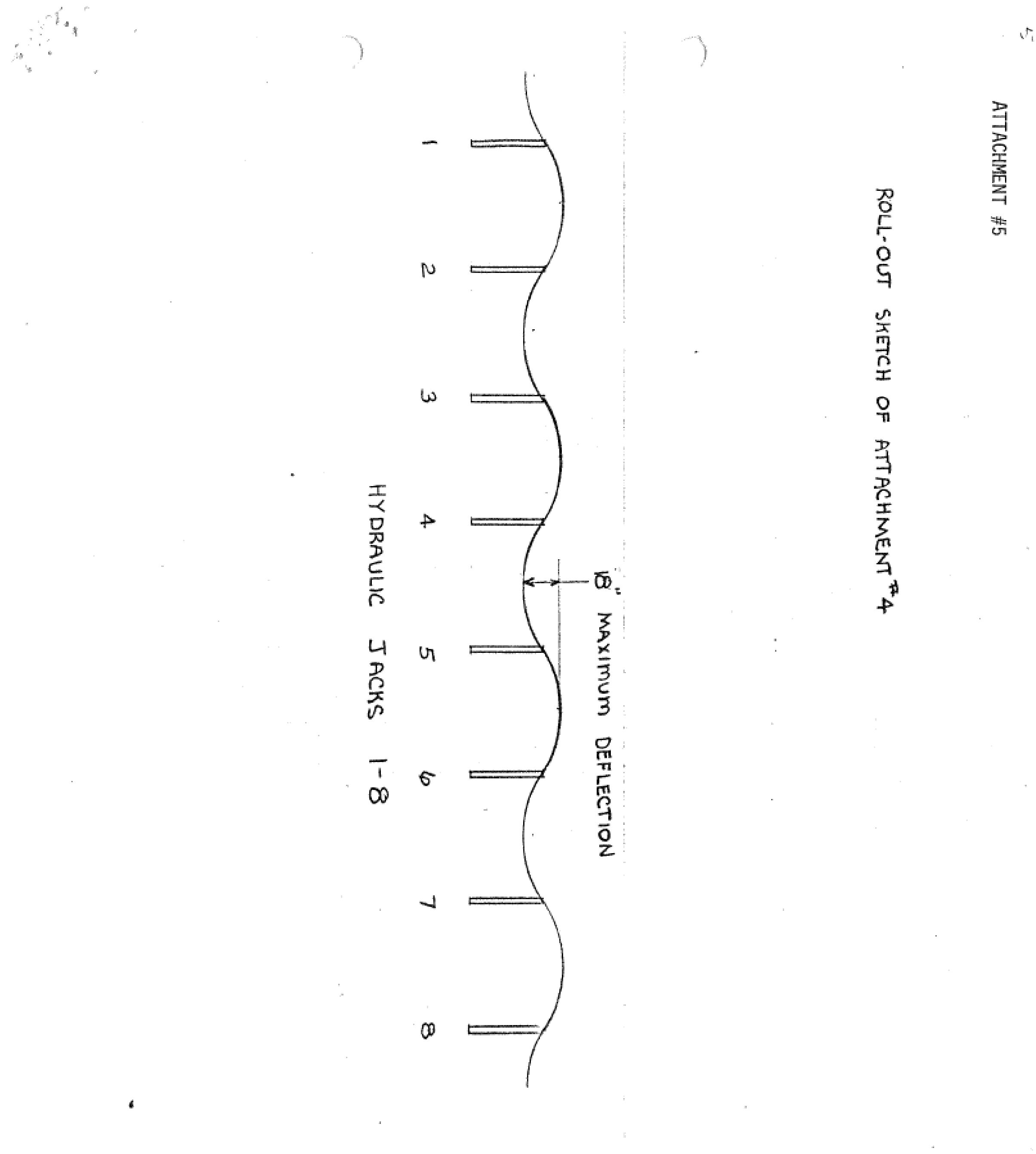


ATTACHMENT #1
N
MANIFOLD STATION #1
4
3
2
1
HYDRAULIC JACK (TYP.
5
6
7
8
TANK # 102
SECONDARY BOTTOM MANIFOLD


ATTACHMENT #2
N
3
HYDRAULIC JACK (TYP)
2
4
5
1
6
8
DEFLECTED INWARD (TYP OF 2)
DEFLECTED OUTWARD (TYP OF 2)
7
TANK # 102
SECONDARY BOTTOM


ATTACHMENT #3
ROLL-OUT SKETCH OF ATTACHMENT #2
DEFLECTION 12" TO 18" APPROX,
1
2
3
4
5
6
7
8
HYDRAULIC JACKS 1-8


ATTACHMENT #4
N
3
4
2
HYDRAULIC JACK (TYP)
5
1
6
8
7
DEFLECTED INWARD (TYP OF 4)
DEFLECTED OUTWARD (TYP OF 4)
TANK # 102 SECONDARY BOTTOM


ATTACHMENT #5
ROLL-OUT SKETCH OF ATTACHMENT #4
18" MAXIMUM DEFLECTION
1
2
3
4
5
6
7
8
HYDRAULIC JACKS 1-8

ATTACHMENT #6 to NCR B-101-19-2307-5, Item #3 DATE: 1-10-75
ATTACHMENT #2 NCR B-101-20-2307-6, Item #2
ATTACHMENT #3 to NCR B-101-21-2307-7, Item #2

(8) Verification of Action Taken: Statement of Condition of Refractory

The condition of the refractory was carefully examined prior to lowering of the Tank 102 Primary Bottom. One area (approximately 4' x 6'), was found to be sunken under the loading of a cribbing stack, and was subsequently repaired on February 8, 1975. The repaired area and the remainder of the foundation appeared to be in very satisfactory condition. During the examination of the refractory by E. S. Davis (Vitro) and me, small patches of ice were visible on the surface. Hammer testing of these and other areas provided no indication of frozen or defective material. Minor cracks were noted over the air supply piping and around other cribbing stacks, but were not considered detrimental. Thus, I informed J. E. Parsons (JAJ) and M. J. Fatur (ARHCO) that the condition was considered satisfactory, and that lowering may commence.

For historical purposes, it appears at this time that the product used for the refractory foundation may contain superior qualities with respect to cold weather tolerance than those previously experienced.

App Figure C-15. NCR B-101-25-2307-10, 241-SY Tank Farm Salt Cake Storage Facilities

Box #63445

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NONCONFORMANCE REPORT

(1) PROJ/WO NO.	(2) TITLE	(3) NCR NO.
B-101	241-SY TANK FARM SALT CAKE STORAGE FACILITIES	B-101-25-2307-10

(4) DESCRIPTION OF NONCONFORMANCE - REFERENCE - SUGGESTED DISPOSITION AND JUSTIFICATION

Reference: Construction Specification B-101-C1, Page 13.0 g Attachment

Discrepancy: In Tank No. 101, Primary bottom, four plates meet at a weld junction, due to a shop splice seam which joins a designed three plate junction. (See attached sketch for location.) Referenced specification permits only three plates to meet at any junction, and weld joint offset shall be 12" minimum.

Suggested Disposition and Justification: "Accept-as-is" since joint is permitted by ASME Section VIII, and all welds will receive visual, liquid penetrant (before and after stress relief), and radiographic examination. In addition, each weld seam shall be liquid penetrant examined on the tank exterior surface for a minimum distance of twelve inches from point of junction.

HOLD TAG APPLIED: ☐ YES ☒ NO

(A) JM Johnston — INSPECTOR OR ORIGINATOR — DATE 1-30-75

(B) Donald J. Moore — TITLE III SUPERVISOR — DATE 2-3-75

(5) VITRO REVIEWING AUTHORITY ACTION

☐ REPAIR ☐ MODIFY ☐ REWORK ☐ REJECT ☐ ACCEPT-AS-IS ☒ CONDITIONAL ACCEPT ☐ OTHER (DESCRIBE)

"Conditional Accept" provided that additional liquid penetrant examination is performed as detailed above.

(C-1) [signature] — DESIGN ENGINEER — DATE 2/4/75

(C-2) [signature] — QA MANAGEMENT — DATE 2/4/75

(C) [signature] — PROJECT MANAGER OR ENGR — DATE 2-4-75

(6) CLIENT APPROVAL

☒ APPROVED ☐ DISAPPROVED

(D) Michael J. Fature (APVCO) — OPERATING CONTRACTOR P/E — DATE 2-6-75

(D-1) [signature] — AEC — DATE 2/6/75

SEE ATTACHED LTR MJF/WAZWEIFEL 2-5-75

(7) CAUSE OF NONCONFORMANCE AND CORRECTIVE ACTION TO PREVENT RECURRENCE

Cause - Failure to adequately inform shop fabrication personnel of specification requirement.

Corrective Action - Shop personnel have been informed and specs reviewed again.

(E) J E Parsons — SIGNATURE AND TITLE — DATE 2/24/75

(8) VERIFICATION OF ACTION TAKEN: ☒ DISPOSITION EFFECTED AS DIRECTED ☐ RECORD OF FIELD CHANGE NO. ______ INITIATED

☐ OTHER (DESCRIBE)

(F) John M. Johnston — INSPECTOR — DATE 2/26/75

(9) DISTRIBUTION: (G) NCR CONTROL DESK

DSM TITLE III SUPRV
AWA PROJ MGR/ENGR
CNZ QA MGR
WSG DESIGN ENGR
TRO CENTRAL FILE

MJF OPER CONTR. P/E
RAZ OPER CONTR QA
JEP CONST CONTR JOB SUPRT
WTS CONST CONTR P/E
CONST CONTR QA

AGL/JMN

ERDA Rep.
ERDA QA
DR Nelson/Vitro
JD Galbraith

DATE: 2-26-75

App Figure C-16. NCR B-101-26-2307-11, 241-SY Tank Farm Storage Facilities

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Box#63493

NONCONFORMANCE REPORT

(1) PROJ/WO NO.	(2) TITLE	(3) NCR NO.
B-101	241-SY TANK FARM SALT CAKE STORAGE FACILITIES	B-101-26-2307-11

(4) DESCRIPTION OF NONCONFORMANCE - REFERENCE - SUGGESTED DISPOSITION AND JUSTIFICATION

Reference: Construction Specification B-101-C1, Page 13.0 g
Attachment

Discrepancy: In Tank 103 Primary bottom, four plates meet at a weld junction, due to a shop splice seam which joins a designed three plate junction. (See attached sketch for location.) Referenced specification permits only three plates to meet at any junction.

Suggested Disposition and Justification: "Accept-as-is" since joint is permitted by ASME Section VIII, and all welds will receive visual, liquid penetrant (before and after stress relief), and radiographic examination. In addition, each weld seam shall be liquid penetrant examined on the tank exterior surface for a minimum distance of twelve inches from point of junction.

(A) JM Johnston — INSPECTOR OR ORIGINATOR — DATE 1-30-75

HOLD TAG APPLIED: (By contractor) ☒ YES ☐ NO

(B) Donald [signature] — TITLE III SUPERVISOR — DATE 2-5-75

(5) VITRO REVIEWING AUTHORITY ACTION

☐ REPAIR ☐ MODIFY ☐ REWORK ☐ REJECT ☐ ACCEPT-AS-IS ☒ CONDITIONAL ACCEPT ☐ OTHER (DESCRIBE)

"Conditional Accept" provided that additional liquid penetrant examination is performed as detailed above.

(C-1) [signature] — DESIGN ENGINEER — DATE 2/4/75

(C-2) Carl V. Zanga — QA MANAGEMENT — DATE 2/4/75

(C) [signature] Alerson — PROJECT MANAGER OR ENGR — DATE 2-4-75

(6) CLIENT APPROVAL

☒ APPROVED ☐ DISAPPROVED

(D) Michael J. Fatur (ARHCO) — OPERATING CONTRACTOR P/E — DATE 2-6-75

(D-1) [signature] — AEC — DATE 2-6-75

SEE ATTACHED LTR MJF/LKA? WEIFEL, 2-5-75

(7) CAUSE OF NONCONFORMANCE AND CORRECTIVE ACTION TO PREVENT RECURRENCE

Cause - Failure to adequately inform shop fabrication personnel of specification requirement.

Corrective Action - Shop personnel have been informed and specs reviewed again.

(E) F E Parsons — SIGNATURE AND TITLE — DATE 2-24-75

(8) VERIFICATION OF ACTION TAKEN: ☒ DISPOSITION EFFECTED AS DIRECTED ☐ RECORD OF FIELD CHANGE NO. ______ INITIATED

☐ OTHER (DESCRIBE)

(F) John M. Johnston — INSPECTOR — DATE 3/6/75

(9) DISTRIBUTION:

DSM TITLE III SUPRV
AWA PROJ MGR/ENGR
CNZ QA MGR
WSG DESIGN ENGR
VITRO CENTRAL FILE

(G) NCR CONTROL DESK
MJF OPER CONTR. P/E
RAZ OPER CONTR QA
JEP CONST CONTR JOB SUPRT
WTS CONST CONTR P/E
CONST CONTR QA

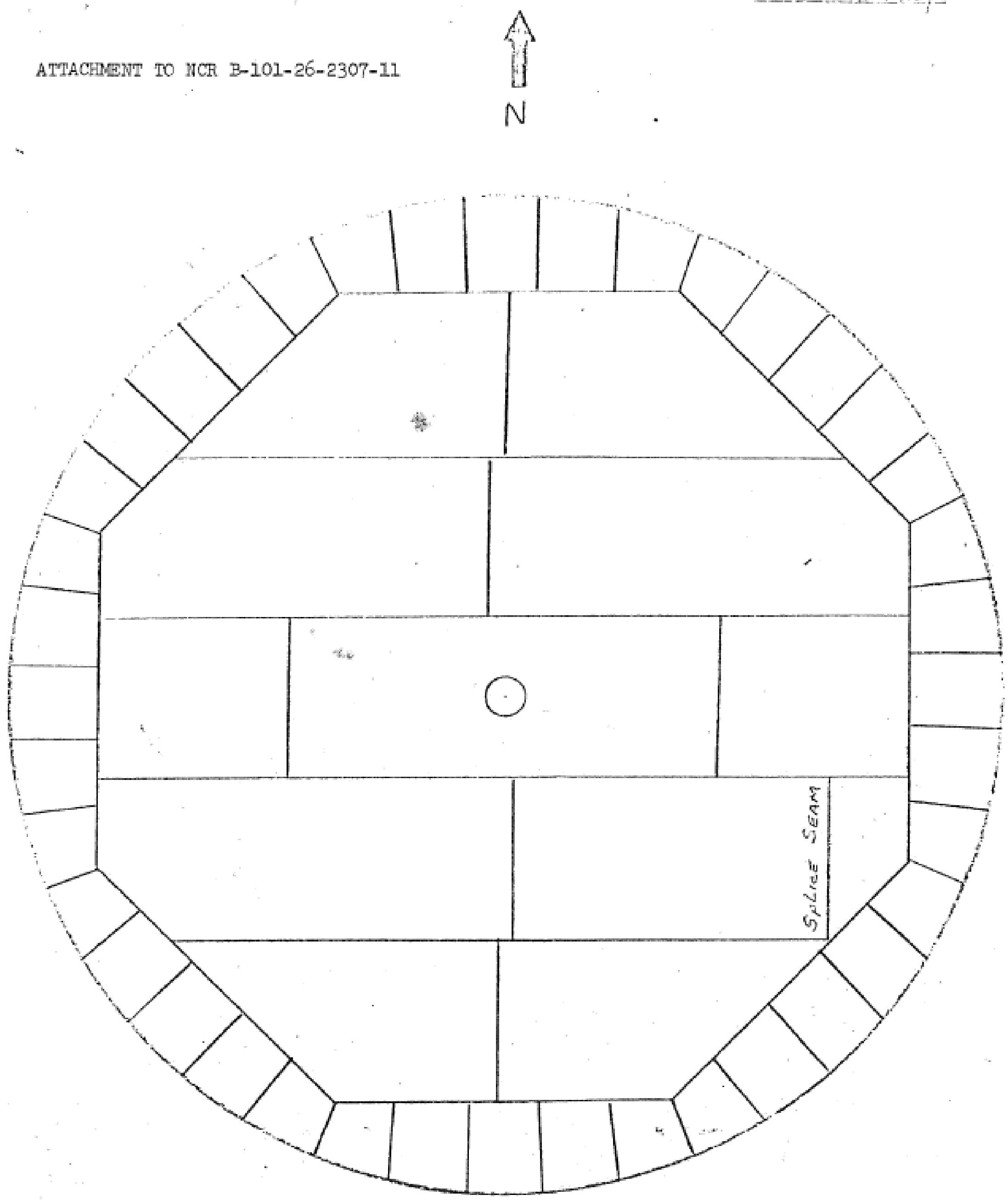
AGL/JMN

ERDA Rep.
ERDA QA
DR Nelson/Vitro
VR Weil/ARHCO

DATE: 3-7-75

TANK No. 103 PRIMARY

ATTACHMENT TO NCR B-101-26-2307-11



App Figure C-17. NCR B-101-33-2307-18, 241-SY Tank Farm Salt Cake Storage Facilities

NONCONFORMANCE REPORT

(1) PROJ/WO NO.	(2) TITLE	(3) NCR NO.
B-101	241-SY TANK FARM SALT CAKE STORAGE FACILITIES	B-101-33-2307-18

(4) DESCRIPTION OF NONCONFORMANCE - REFERENCE - SUGGESTED DISPOSITION AND JUSTIFICATION

Reference: Construction Specification B-101-C1, Rev. 0

Discrepancy: The circumference of the Tank 101 secondary shell ring (1st course) is 251' 1-13/16". Specified circumference is 251' 6-9/32" (theoretical), plus or minus two inches. Thus, the shell ring is 2-15/32" smaller in circumference. This present condition may result in all subsequent shell rings placed on this course to be similarly out of tolerance, as emphasis will be placed on maintaining vertical plumbness.

Suggested Disposition and Justification: "Accept-as-is" - as this condition exists on the secondary shell, permanent storage capacity is not applicable to this situation. Structural integrity and function of the secondary tank as a protective barrier against the release of radioactive material into the environs is not impaired by this condition.

HOLD TAG APPLIED: ☐ YES ☒ NO

(A) DS Mager — INSPECTOR OR ORIGINATOR — DATE 3-13-75

(B) [signature] — TITLE III SUPERVISOR — DATE 3-18-75

(5) VITRO REVIEWING AUTHORITY ACTION

☐ REPAIR ☐ MODIFY ☐ REWORK ☐ REJECT ☒ ACCEPT-AS-IS ☐ CONDITIONAL ACCEPT ☐ OTHER (DESCRIBE)

(C-1) [signature] — DESIGN ENGINEER — DATE 3/19/75

(C-2) I. M. A. Garcia — QA MANAGEMENT — DATE 3/19/75

(C) A.W. [signature] — PROJECT MANAGER OR ENGR — DATE 3-19-75

(6) CLIENT APPROVAL

☒ APPROVED ☐ DISAPPROVED

(D) Michael J. Fature — OPERATING CONTRACTOR P/E ARHCO — DATE 3-26-75

(D-1) [signature] — AEC — DATE 3-26-75

(7) CAUSE OF NONCONFORMANCE AND CORRECTIVE ACTION TO PREVENT RECURRENCE

Cause - The tolerance discrepancy was caused by the shop fabricated knuckle having more than a 90° bend.

Corrective action - Subsequent sections had vertical section installed in field.

(E) [signature] Parsons — SIGNATURE AND TITLE — DATE 3-28-75

(8) VERIFICATION OF ACTION TAKEN: ☒ DISPOSITION EFFECTED AS DIRECTED ☐ RECORD OF FIELD CHANGE NO. ______ INITIATED

☐ OTHER (DESCRIBE)

(F) [signature] — INSPECTOR — DATE 3/28/75

(9) DISTRIBUTION:

DSM TITLE III SUPRV
AWA PROJ MGR/ENGR
CNZ QA MGR
WSG DESIGN ENGR
VITRO CENTRAL FILE

(G) NCR CONTROL DESK
MJF OPER CONTR. P/E
RAZ OPER CONTR QA
JEP CONST CONTR JOB SUPRT
WTS CONST CONTR P/E
CONST CONTR QA

AGL/JMN

ERDA Rep.
ERDA QA
DR Nelson/Vitro
VR Weil/ARHCO

DATE: 3-28-75

App Figure C-18. NCR B-101-35-2307-20, 241-SY Tank Farm Salt Cake Storage Facilities

Box #63493

VITRO ENGINEERING • a division of AUTOMATION INDUSTRIES, INC.

NONCONFORMANCE REPORT

(1) PROJ/WO NO.	(2) TITLE	(3) NCR NO.
B-101	241-SY TANK FARM SALT CAKE STORAGE FACILITIES	B-101-35-2307-20

(4) DESCRIPTION OF NONCONFORMANCE - REFERENCE - SUGGESTED DISPOSITION AND JUSTIFICATION

Reference: Construction Specification B-101-C1, Rev. 0, 14.2e Attachment

Discrepancy: On the Tank 101 secondary shell, areas exist where the maximum deviation of the line of intersection from a true straightline exceeds 1/2 inch in a five foot length. (Actual maximum measurement in areas shown is 1-1/16 inches, see attachment.) These deviations, a result of distortions in the shell plate, were fabricated to achieve a plate-to-skirt fit-up, then were locally aggravated by weld repairs. This condition contributed to the smaller circumference of the first shell course. (See NCR B-101-33-2307-18.)

Suggested Disposition and Justification: "Accept-as-is" - as the length distortion around the periphery is relatively short, the loading of additional shell is insignificant. Subsequently, the concrete tank cylinder placed against the secondary tank will provide additional support of the shell, due to the embedment of the studs and stiffener rings. These are welded to the tank shell prior to concrete placement. Therefore, the function and integrity of the secondary shell remains unaffected.

HOLD TAG APPLIED: ☐ YES ☒ NO

(A) JM Johnston — INSPECTOR OR ORIGINATOR — DATE 4-1-75

(B) Donald J. Moore — TITLE III SUPERVISOR — DATE 4-3-75

(5) VITRO REVIEWING AUTHORITY ACTION

☐ REPAIR ☐ MODIFY ☐ REWORK ☐ REJECT ☒ ACCEPT-AS-IS ☐ CONDITIONAL ACCEPT ☐ OTHER (DESCRIBE)

(C-1) [signature] — DESIGN ENGINEER — DATE 4/4/75

(C-2) [signature] — QA MANAGEMENT — DATE 4/4/75

(C) A.W. Akerson — PROJECT MANAGER OR ENGR — DATE 4-4-75

(6) CLIENT APPROVAL

☒ APPROVED ☐ DISAPPROVED

(D) Michael J. Fatur — OPERATING CONTRACTOR P/E — DATE 4-16-75

(D-1) [signature] — AEC — DATE 4-16-75

(7) CAUSE OF NONCONFORMANCE AND CORRECTIVE ACTION TO PREVENT RECURRENCE

Cause - The tolerance discrepancy was caused by the shop fabricated knuckle having more than a 90° bend.

Corrective Action - Subsequent sections had vertical section installed in field.

(E) [signature] — SIGNATURE AND TITLE — DATE 4-23-75

(8) VERIFICATION OF ACTION TAKEN:

☒ DISPOSITION EFFECTED AS DIRECTED ☐ RECORD OF FIELD CHANGE NO. ______ INITIATED

☐ OTHER (DESCRIBE)

(F) R. G. Johnston — INSPECTOR — DATE 4/23/75

(9) DISTRIBUTION:

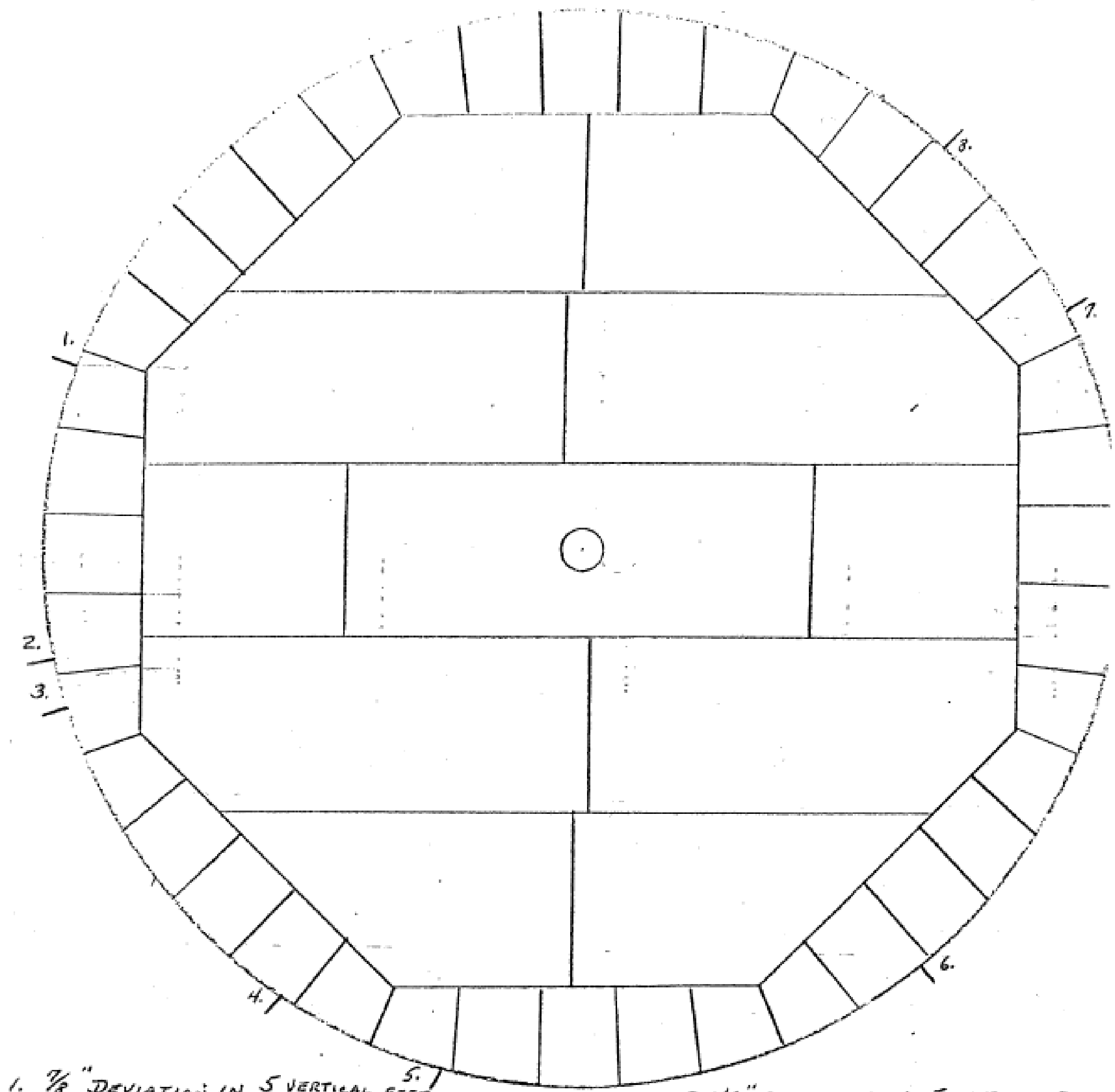
(G) NCR CONTROL DESK

M TITLE III SUPRV	MJF OPER CONTR. P/E	ALG/JMN	ERDA Rep
PROJ MGR/ENGR	RAZ OPER CONTR QA		ERDA QA
A MGR	JEP CONST CONTR JOB SUPRT		DR Nelson/VITRO
IGN ENGR	CONST CONTR P/E		VR Weil/ARHCO
RAL FILE	CONST CONTR QA		

DATE: 4-22-75

TANK No. 101 SECONDARY

ATTACHMENT TO NCR B-101-35-2307-20



1. 7/8" DEVIATION IN 5 VERTICAL FEET
2. 13/16" " " " "
3. 13/16" " " " "
4. 3/4" " " " "
5. 1 1/16" DEVIATION IN 5 VERTICAL FEET
6. 13/16" " " " "
7. 13/16" " " " "
8. 3/4" " " " "

App Figure C-19. Tank SY-101 Secondary Liner Circumference Deficiency Report

DEFICIENCY REPORT

Date Initiated 3-21-75
Initiated By R. FORD

Report No. 23
Page 1 of 1

PART A:
DESCRIPTION: THE CIRCUMFERENCE OF THE SECONDARY TANKS #101 & 103 IS 3 1/2" LESS THAN THE THEORETICAL CIRCUMFERENCE. THIS EXCEEDS THE TOLERANCE ALLOWANCE IN THE DIMENSIONAL CONTROL PROCEDURE BY 1 1/2" (ALLOWABLE DEVIATION = ± 2".

CAUSE: BOTTOM KNUCKLE IS SLIGHTLY TIPPED IN & FIRST RING HAD TO BE TRIMMED 3+ INCHES.

PART B:
CORRECTIVE ACTION:

1. LEAVE SECONDARY CIRCUMFERENCES ON TK. 101 & 103 AS IS FOR ALL SHELL RINGS.
2. CUSTOMER TO EVALUATE THE CONSEQUENCES OF (1) ABOVE BASED ON THEIR REQUIREMENTS.
3. CUSTOMER TO ALLOW OR REJECT THE "LEAVE AS IS" RESOLUTION BASED ON (2) ABOVE

REFER TO FTM # 42

Deficiency has been resolved:
Richard Ford
Quality Control

5/14/75
Date

App Figure C-20. NCR B-101-29-2307-14, 241-SY Tank Farm Salt Cake Storage Facilities

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Box #63493

NONCONFORMANCE REPORT

(1) PROJ/WO NO.	(2) TITLE	(3) NCR NO.
B-101	241-SY TANK FARM SALT CAKE STORAGE FACILITIES	B-101-29-2307-14

(4) DESCRIPTION OF NONCONFORMANCE - REFERENCE - SUGGESTED DISPOSITION AND JUSTIFICATION

Reference: Construction Specification B-101-C1

Discrepancy: The circumference of the Tank 102 secondary shell ring (1st course) is 251' 3-3/8". Specified circumference is 251' 6-9/32" (theoretical), plus or minus two inches. Thus, the shell ring is 29/32 inches smaller in circumference. This present condition may result in all subsequent shell rings placed on this course to be similarly out of tolerance, as emphasis will be placed on maintaining vertical plumbness.

Suggested Disposition and Justification: "Accept-as-is" - as this condition exists on the secondary shell, permanent storage capacity is not applicable to this situation. Structural integrity and function of the secondary tank as a protective barrier against the release radioactive material into the environs is not impaired by this condition.

HOLD TAG APPLIED: ☐ YES ☒ NO

(A) DS Mager — INSPECTOR OR ORIGINATOR — DATE 2-25-75

(B) [signature] — TITLE III SUPERVISOR — DATE 2/25/75

(5) VITRO REVIEWING AUTHORITY ACTION

☐ REPAIR ☐ MODIFY ☐ REWORK ☐ REJECT ☒ ACCEPT-AS-IS ☐ CONDITIONAL ACCEPT ☐ OTHER (DESCRIBE)

(C-1) [signature] — DESIGN ENGINEER — DATE 3/4/75

(C-2) [signature] — QA MANAGEMENT — DATE 3/4/75

(C) [signature] — PROJECT MANAGER OR ENGR — DATE 3-4-75

(6) CLIENT APPROVAL

☒ APPROVED ☐ DISAPPROVED

(D) Michael J. Fetter 3/6/75 — OPERATING CONTRACTOR P/E — DATE — ARHCO

(D-1) [signature] — AEC — DATE 3-6-74

(7) CAUSE OF NONCONFORMANCE AND CORRECTIVE ACTION TO PREVENT RECURRENCE

Cause - The tolerance discrepancy was caused by the shop fabricated knuckle having more than a 90° bend.

Corrective Action - Subsequent sections had vertical section installed in field.

(E) [signature] Parsons — SIGNATURE AND TITLE — DATE 3-11-75

(8) VERIFICATION OF ACTION TAKEN: ☒ DISPOSITION EFFECTED AS DIRECTED ☐ RECORD OF FIELD CHANGE NO. ______ INITIATED

☐ OTHER (DESCRIBE)

(F) [signature] — INSPECTOR — DATE 3/11/75

(9) DISTRIBUTION:

DSM TITLE III SUPRV	(G) NCR CONTROL DESK	AGL/JMN	ERDA Rep.
AWA PROJ MGR/ENGR	MJF OPER CONTR. P/E		ERDA QA
CNZ QA MGR	RAZ OPER CONTR QA		DR Nelson/Vitro
WSG DESIGN ENGR	JEP CONST CONTR JOB SUPRT		VR Weil/ARHCO
VITRO CENTRAL FILE	WTS CONST CONTR P/E		
	CONST CONTR QA		

DATE: 3-12-75

App Figure C-21. Tank SY-102 Secondary Liner Circumference Deficiency Report

CHICAGO BRIDGE & IRON COMPANY

DEFICIENCY REPORT

Date Initiated 2-12-75
Initiated By R. FORD

Report No. 20
Page 1 of 1

PART A:
DESCRIPTION: THE CIRCUMFERENCE OF THE SECONDARY TANK #102 IS 4" LESS THAN THE THEORETICAL CIRCUMFERENCE.
THIS EXCEEDS THE TOLERANCE ALLOWANCE IN THE DIMENSIONAL CONTROL PROCEDURE BY 2" (ALLOWABLE DEVIATION = ± 2"
THE MAXIMUM DIAMETER DEVIATION OF THE TANK IS 4"
THIS IS WITHIN THE ALLOWABLE TOLERANCE.
CAUSE: BOTTOM KNUCKLE IS SLIGHTLY TIPPED IN & FIRST RING HAD TO BE TRIMMED 3+ INCHES.

PART B:
CORRECTIVE ACTION:

1. LEAVE SECONDARY CIRCUMFERENCE AS IS FOR ALL SHELL RINGS.
2. CUSTOMER TO EVALUATE THE CONSEQUENCES OF (1) ABOVE BASED ON THEIR REQUIREMENTS.
3. CUSTOMER TO ALLOW OR REJECT THE "LEAVE AS IS" RESOLUTION BASED ON (2) ABOVE.

Deficiency has been resolved:
Richard Ford — Quality Control
3/6/75 — Date

REFER TO J.A.J. FTM ##34

App Figure C-22. NCR B-101-31-2307-16, 241-SY Tank Farm Salt Cake Storage Facilities

VITRO ENGINEERING • architects • engineers
a division of AUTOMATION INDUSTRIES, INC.

NONCONFORMANCE REPORT

(1) PROJ/WO NO.	(2) TITLE	(3) NCR NO.
B-101	241-SY TANK FARM SALT CAKE STORAGE FACILITIES	B-101-31-2307-16

(4) DESCRIPTION OF NONCONFORMANCE - REFERENCE - SUGGESTED DISPOSITION AND JUSTIFICATION

Reference: Construction Specification B-101-C1, Rev. 0, 14.2e Attachment

Discrepancy: On the Tank 102 Secondary shell, areas exist where the maximum deviation of the line of intersection from a true straight line exceed 1/2 inch in 5 feet length. (Actual measurements in areas shown are 1-1/16 inch maximum in 5 vertical feet.) These deviations (see attachment), a result of distortions in the shell plate, were fabricated to achieve a plate-to-skirt fit-up. This condition primarily contributed to the smaller circumference of the first shell course (see NCR B-101-29-2307-14).

Suggested Disposition and Justification: "Accept-as-is" ... as the length distortion around the periphery is relatively short, the loading of additional shell courses is insignificant. Subsequently, the concrete tank cylinder placed against the secondary tank will provide additional support of the shell itself, due to the embedment of the studs and stiffener ring. These are welded to the tank shell prior to concrete placement. Therefore, the function and integrity of the secondary shell remains unaffected.

HOLD TAG APPLIED: ☐ YES ☒ NO

(A) JM Johnston — INSPECTOR OR ORIGINATOR — DATE 2-26-75

(B) Donald D. Mayer — TITLE III SUPERVISOR — DATE 3/6/75

(5) VITRO REVIEWING AUTHORITY ACTION

☐ REPAIR ☐ MODIFY ☐ REWORK ☐ REJECT ☒ ACCEPT-AS-IS ☐ CONDITIONAL ACCEPT ☐ OTHER (DESCRIBE)

(C-1) [signature] — DESIGN ENGINEER — DATE 3-7-75

(C-2) I.M.A. Garcia — QA MANAGEMENT — DATE 3/7/75

(C) A.W. Akerson — PROJECT MANAGER OR ENGR — DATE 3-7-75

(6) CLIENT APPROVAL

☒ APPROVED ☐ DISAPPROVED

(D) Michael J. Fatur — OPERATING CONTRACTOR P/E — ARHCO — DATE 3/18/75

(D-1) A.J. Lassila — AEC — DATE 3-20-75

(7) CAUSE OF NONCONFORMANCE AND CORRECTIVE ACTION TO PREVENT RECURRENCE

Cause - The tolerance discrepancy was caused by the shop fabricated knuckle having more than a 90° bend. This was due to the shop not being able to hold the 1 foot ring section vertical over the knuckle arc length. Corrective action - This condition existed to some degree on 3 secondary tank knuckles. On primary tank the first rings were installed in the field correcting the problem.

(E) F.E. Parsons — SIGNATURE AND TITLE — DATE 3-24-75

(8) VERIFICATION OF ACTION TAKEN: ☒ DISPOSITION EFFECTED AS DIRECTED ☐ RECORD OF FIELD CHANGE NO. ______ INITIATED

☐ OTHER (DESCRIBE)

(F) John M. Johnston — INSPECTOR — DATE 3/24/75

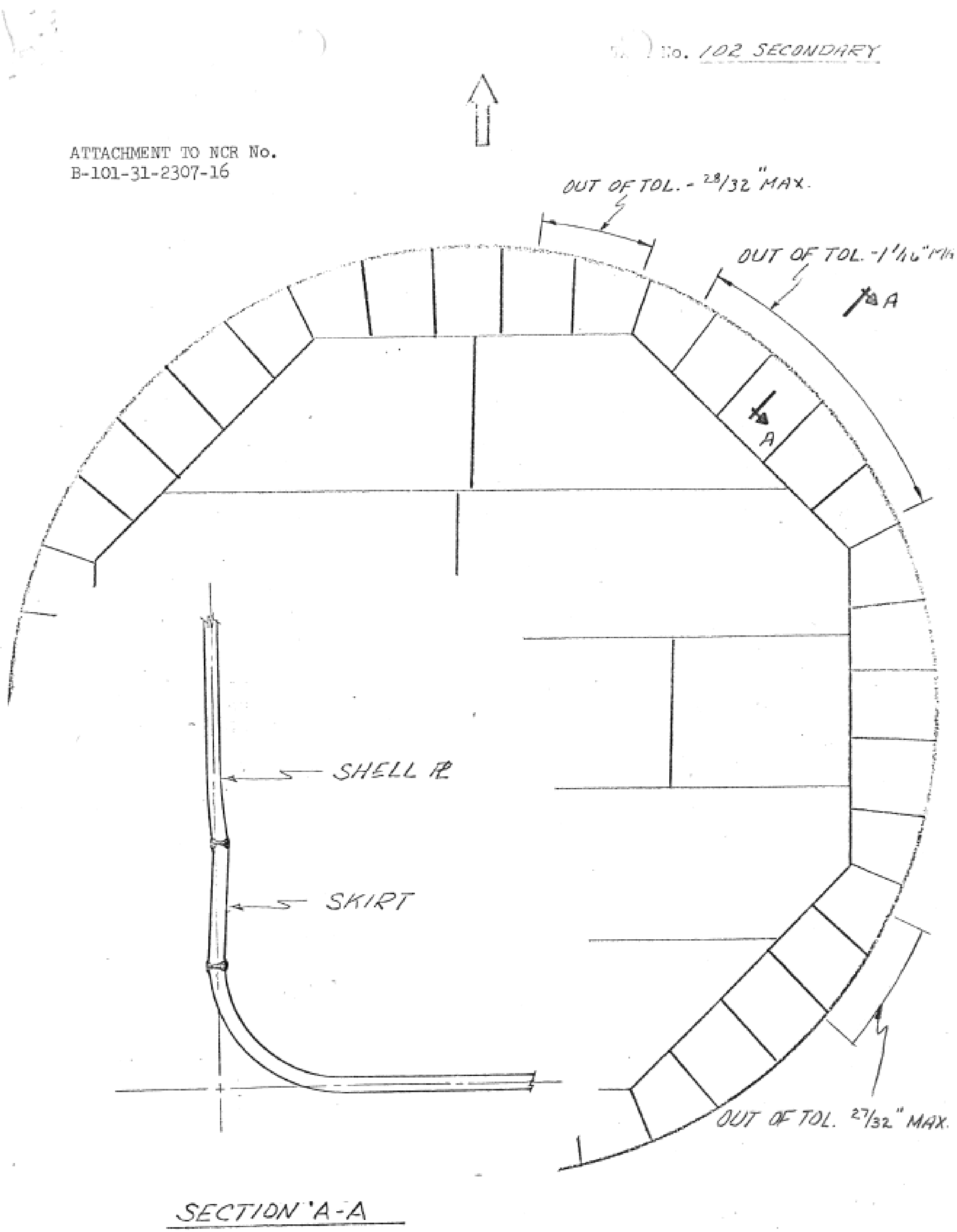
(9) DISTRIBUTION: (G) NCR CONTROL DESK — DATE: 3-24-75

DSM TITLE III SUPRV
AWA PROJ MGR/ENGR
CNZ QA MGR
WSG DESIGN ENGR
VITRO CENTRAL FILE

MJF OPER CONTR. P/E
RAZ OPER CONTR QA
JEP CONST CONTR JOB SUPRT
WTS CONST CONTR P/E
CONST CONTR QA

AGL/JMN

ERDA Rep.
ERDA QA
DR Nelson/Vitro
VR Weil/ARHCO


No. 102 SECONDARY
ATTACHMENT TO NCR No.
B-101-31-2307-16
OUT OF TOL. - 28/32" MAX.
OUT OF TOL. - 1 1/16" MA
A
A
SHELL PL
SKIRT
OUT OF TOL. 27/32" MAX.
SECTION 'A-A

App Figure C-23. Tank SY-103 Primary Local Distortion Deficiency Report

DEFICIENCY REPORT

Date Initiated 6-27-75
Initiated By R. FORD

Report No. 31
Page 1 of 2

TK 103

PART A:
DESCRIPTION: LOCAL AREA NOTED ON ATTACHED SKETCH EXCEEDS LOCAL DISTORTION TOLERANCES OF 1/2" NOTED IN VITRO SPECIFICATIONS B-101-C1 PAR. # 14.2-E.

CAUSE: DUE TO THE PRESSURE CREATED WHILE FITTING & WELDING MAKE UP ROOF PLATE.

THIS AREA WAS CHECKED FOR TOLERANCES BEFORE ROOF PLATES WERE ERECTED & THEY CHECKED OUT OK.

PART B:
CORRECTIVE ACTION:
1. PLACE AREA ON HOLD.
2. CB&I RECOMENDS TO CUSTOMER TO LEAVE AREA AS IS FOR THE FOLLOWING REASONS.

A. ASME DOES NOT ADDRESS ITSELF TO LOCALIZED DEFORMATIONS.
B. ASME, SECTION VIII, DIVISION 1, SECTION UG-80 DOES ADDRESS ITSELF TO PRESSURE VESSEL OUT OF ROUNDNESS OF CYLINDRICAL SHELLS. TOLERANCES GIVEN ARE 1% OF DIAMETER WHICH IS MET. ALLOWABLE FOR THIS TANK WOULD BE APPROXIMATELY 8".
C. SPECIFICATION DIAMETER TOLERANCES ARE MET.
D. SHELL SWEEP BOARD TOLERANCES ARE MET.
E. WITH THE EXISTING LOCALIZED DEFORMATION THE TANK REMAINS STRUCTURALLY SOUND AND WILL NOT HAVE ANY DETRIMENTAL EFFECTS DURING OR AFTER FURTHER FABRICATION OPERATIONS (STRESS RELIEF & DOME CONCRETING).
F. ANY COSMETIC VALUE WILL BE LOST AFTER THE TANK IS ENCLOSED.
G. REPAIR OF THE AREA WOULD ENTAIL CUTTING VERTICAL AND HORIZONTAL SEAMS, WITH EXTRA BUILDUP OF PLATE EDGES AND REWELDING, WHICH BASED ON PREVIOUS SIMILAR REPAIRS WOULD CREATE GREATER DISTORTIONS THAN EXIST.

3. CUSTOMER TO ALLOW OR REJECT THE LEAVE AS IS RESOLUTION BASED ON 2. ABOVE.

Deficiency has been resolved: REFER TO J.A.J. F.T.M. # 53

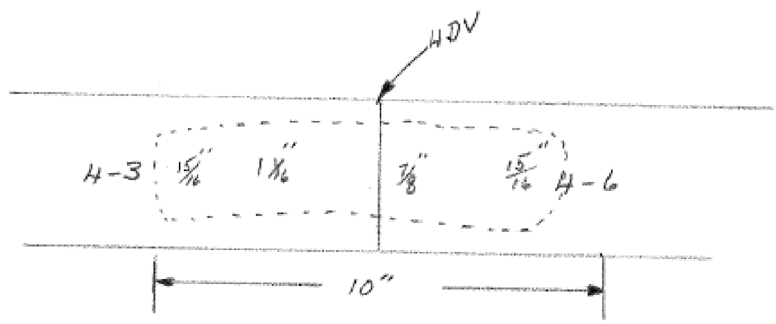
Richard Ford
Quality Control

8-6-75
Date

Chicago Bridge & Iron Company

PAGE 2

TK-103
4TH RING



App Figure C-24. NCR B-101-38-2307-22, 241-SY Tank Farm Salt Cake Storage Facilities

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NONCONFORMANCE REPORT

(1) PROJ/WO NO.	(2) TITLE	(3) NCR NO.
B-101	241-SY TANK FARM SALT CAKE STORAGE FACILITIES	B-101-38-2307-22

(4) DESCRIPTION OF NONCONFORMANCE - REFERENCE - SUGGESTED DISPOSITION AND JUSTIFICATION

Reference: Construction Specification B-101-C1 Attachment

Discrepancy: On Primary Tank #103, a local area as noted on attached sketch exceeds vertical distortion tolerances of specification B-101-C1, Paragraph 14.2.e.

Suggested Disposition and Justification: (See Attached Sheet)

(A) JM Johnston — INSPECTOR OR ORIGINATOR — DATE 7-7-75

HOLD TAG APPLIED: ☐ YES ☒ NO

(B) [signature] — TITLE III SUPERVISOR — DATE 7/7/75

(5) VITRO REVIEWING AUTHORITY ACTION

☐ REPAIR ☐ MODIFY ☐ REWORK ☐ REJECT ☒ ACCEPT-AS-IS ☐ CONDITIONAL ACCEPT ☐ OTHER (DESCRIBE)

(C-1) [signature] — DESIGN ENGINEER — DATE 7/14/75

(C-2) J. M. A. Garcia — QA MANAGEMENT — DATE 7/14/75

(C) [signature] — PROJECT MANAGER OR ENGR — DATE 7-14-75

(6) CLIENT APPROVAL

☒ APPROVED
☐ DISAPPROVED

(D) [signature] — OPERATING CONTRACTOR P/E — DATE 7/17/75

(D-1) [signature] — ERDA — DATE 7-22-75

(7) CAUSE OF NONCONFORMANCE AND CORRECTIVE ACTION TO PREVENT RECURRENCE

Cause: Distortion was the result of bad fit and weld sequence.
Corrective Action: Future seams are to be fit closer and tacked completely prior to final welding.

(E) [signature] — SIGNATURE AND TITLE — DATE 8-5-75

(8) VERIFICATION OF ACTION TAKEN: ☒ DISPOSITION EFFECTED AS DIRECTED ☐ RECORD OF FIELD CHANGE NO. ______ INITIATED

☐ OTHER (DESCRIBE)

(F) [signature] — INSPECTOR — DATE 8/5/75

(9) DISTRIBUTION:

DSM TITLE III SUPRV
AWA PROJ MGR/ENGR
CNZ QA MGR
WSG DESIGN ENGR
TRO CENTRAL FILE

(G) NCR CONTROL DESK
JFA OPER CONTR. P/E
RAZ OPER CONTR QA
JEP CONST CONTR JOB SUPRT
CONST CONTR P/E
CONST CONTR QA

AGL/JMN

ERDA Rep.
ERDA QA
DR Nelson/VITRO
VR Weil/ARHCO

DATE: 8-6-75

ATTACHMENT TO NCR No. B-101-38-2307-22

Suggested Disposition and Justification:

"Accept-as-is" for the following reasons:

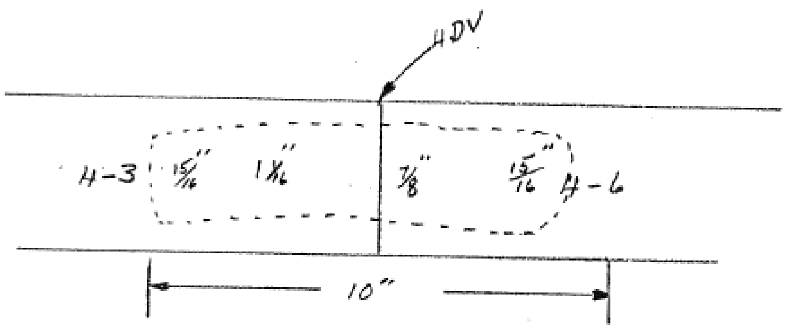
1. ASME Codes do not address themselves to localized deformations.
2. ASME, Section VIII, Division I, Section UG-80 does address itself to pressure vessel out of roundness of cylindrical shells. Tolerance given is 1% of diameter, which has been met. Allowable for this tank would be 8".
3. Specification diameter tolerances have been met.
4. With the existing localized deformation, the tank remains structurally sound, and should suffer no detrimental effects during or after further fabrication operations. (Stress relief and dome concreting.)
5. Any cosmetic value will be lost when tank is enclosed.
6. Repair would entail cutting vertical and horizontal seams, with extra build-up of plate edges and rewelding, which based on similar repair attempts would create greater distortions than presently exist.

ATTACHMENT TO NCR B-101-38-2307-22

Chicago Bridge & Iron Company

PAGE 2

TK-103
4TH RING



App Figure C-25. NCR B-101-37-2307-21, 241-SY Tank Farm Salt Cake Storage Facilities

Box# 63493

TRO ENGINEERING • architects • engineers
division of AUTOMATION INDUSTRIES, INC.

NONCONFORMANCE REPORT

(1) PROJ/WO NO.	(2) TITLE	(3) NCR NO.
B-101	241-SY TANK FARM SALT CAKE STORAGE FACILITIES	B-101-37-2307-21

(4) DESCRIPTION OF NONCONFORMANCE - REFERENCE - SUGGESTED DISPOSITION AND JUSTIFICATION

Reference: Construction Specification B-101-C1, 14.4
CB & I Drawing HT 9, Rev. 2
Attachment

Discrepancy: Two areas of 102 Primary tank dome exhibit flat spots and reverse curvature (see attached sketch for location). Maximum deformation from theoretical curvature does not exceed 1".

Suggested Disposition and Justification: "Accept-as-is" since dome plate will be restrained by installation of 6" x 4" x 3/8" angle to be welded to roof for temporary support during stress relieving. Installation of these angles are shown on contractor drawing HT 9, Rev. 2.

HOLD TAG APPLIED: ☐ YES ☒ NO

(A) JM Johnston — INSPECTOR OR ORIGINATOR — DATE 6/18/75

(B) Donald O'Mazer — TITLE III SUPERVISOR — DATE 6/18/75

(5) VITRO REVIEWING AUTHORITY ACTION

☐ REPAIR ☐ MODIFY ☐ REWORK ☐ REJECT ☒ ACCEPT-AS-IS ☐ CONDITIONAL ACCEPT ☐ OTHER (DESCRIBE)

(C-1) E E Smith — DESIGN ENGINEER — DATE 6/23/75

(C-2) M. A. Garcia — QA MANAGEMENT — DATE 6/23/75

(C) [signature] — PROJECT MANAGER OR ENGR — DATE 6-23-75

(6) CLIENT APPROVAL

☒ APPROVED
☐ DISAPPROVED

(D) Michael J. Fatur — OPERATING CONTRACTOR P/E — DATE 6/30/75

(D-1) [signature] — AEC — DATE 7/8/75

(7) CAUSE OF NONCONFORMANCE AND CORRECTIVE ACTION TO PREVENT RECURRENCE

Deformation caused by welding sequence and insufficient restraints while welding last roof closure seams. Future seams to have additional strong backs prior to welding.

(E) [signature] — SIGNATURE AND TITLE — DATE 7/16/75

(8) VERIFICATION OF ACTION TAKEN: ☒ DISPOSITION EFFECTED AS DIRECTED ☐ RECORD OF FIELD CHANGE NO. ______ INITIATED

☐ OTHER (DESCRIBE)

(F) [signature] — INSPECTOR — DATE 8/13/75

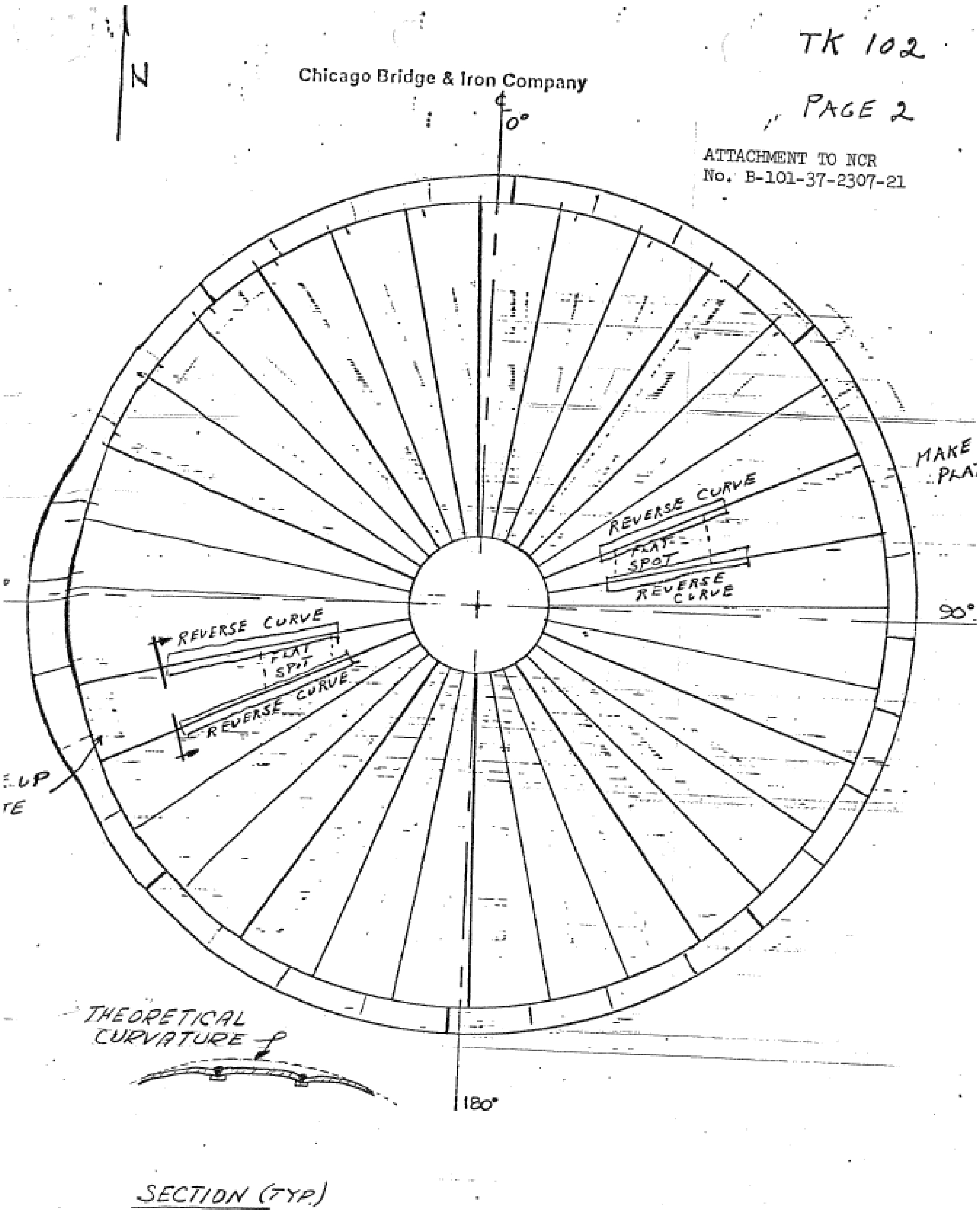
(9) DISTRIBUTION:

DSM TITLE III SUPRV
AWA PROJ MGR/ENGR
CNZ QA MGR
EES DESIGN ENGR
TRO CENTRAL FILE

(G) NCR CONTROL DESK
JFA OPER CONTR. P/E
RAZ OPER CONTR QA
JEP CONST CONTR JOB SUPRT
CONST CONTR P/E
CONST CONTR QA

AGL/JMN ERDA Rep.
ERDA QA
DR Nelson/Vitro
VR Weil/Arhco

DATE: 8-13-75


N
Chicago Bridge & Iron Company
TK 102
PAGE 2
ATTACHMENT TO NCR
No. B-101-37-2307-21
0°
REVERSE CURVE
FLAT SPOT
REVERSE CURVE
90°
REVERSE CURVE
FLAT SPOT
REVERSE CURVE
THEORETICAL CURVATURE
180°
SECTION (TYP.)

App Figure C-26. NCR B-101-39-2307-23241-SY Tank Farm Salt Cake Storage Facilities

40850

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a division of AUTOMATION INDUSTRIES, INC

NONCONFORMANCE REPORT

(1) PROJ/WO NO.	(2) TITLE	(3) NCR NO.
B-101	241-SY TANK FARM SALT CAKE STORAGE FACILITIES	B-101-39-2307-23

(4) DESCRIPTION OF NONCONFORMANCE - REFERENCE - SUGGESTED DISPOSITION AND JUSTIFICATION

Reference: Construction Specification B-101-C1, 14.4
NCR B-101-37-2307-21
Attachments (3)

Discrepancy: Suggested disposition, as called out on NCR B-101-37-2307-21, did not accomplish desired purpose. Although temporary angles provided support during stress relief, the dome sagged upon their removal. Deviation from theoretical curvature is now approximately 2-1/2". Without correction, further deflection could be expected when concrete and reinforcing steel is installed.

Suggested Disposition and Justification: Disposition as per attached contractor's suggestion. The present deflection results in no unworkable problems. Operation of completed facility will not be impaired. The proposed additional support will prevent any additional deflection.

HOLD TAG APPLIED: ☐ YES ☒ NO

(A) JM Johnston — INSPECTOR OR ORIGINATOR — DATE 8/19/75
(B) [signature] — TITLE III SUPERVISOR — DATE 8-22-75

(5) VITRO REVIEWING AUTHORITY ACTION
☐ REPAIR ☒ MODIFY ☐ REWORK ☐ REJECT ☐ ACCEPT-AS-IS ☐ CONDITIONAL ACCEPT ☐ OTHER (DESCRIBE)

MODIFY PER ATTACHED CONTRACTOR'S SUGGESTION.

(C-1) [signature] — DESIGN ENGINEER — DATE 8/28/75
(C-2) I.M.A. Garcia — QA MANAGEMENT — DATE 9/4/75
(C) [signature] — PROJECT MANAGER OR ENGR — DATE 9-3-75

(6) CLIENT APPROVAL
☒ APPROVED
☐ DISAPPROVED

(D) [signature] — OPERATING CONTRACTOR P/E ARHCO — DATE 10/2/75
(D-1) G.J. Lassila — ERDA — DATE 10-2-75

(7) CAUSE OF NONCONFORMANCE AND CORRECTIVE ACTION TO PREVENT RECURRENCE
Approved on the basis of Letter, D.R. Evans to Mark Marlin, 9/18/75

See NCR B101-37-2307-27
corrective action attached.

(E) J.E. Parsons — SIGNATURE AND TITLE — DATE 10-2-75

(8) VERIFICATION OF ACTION TAKEN: ☒ DISPOSITION EFFECTED AS DIRECTED ☐ RECORD OF FIELD CHANGE NO. ______ INITIATED
☐ OTHER (DESCRIBE)

(F) R. Em. Johnston — INSPECTOR — DATE 10/3/75

(9) DISTRIBUTION: (G) NCR CONTROL DESK — DATE: 10-6-75

DSM TITLE III SUPRV	JFA OPER CONTR. P/E	AGL/JMN ERDA Rep.	
AWA PROJ MGR/ENGR	RAZ OPER CONTR QA	ERDA QA	
IMAG QA MGR	JEP CONST CONTR JOB SUPRT	DRN	
CAF DESIGN ENGR	CONST CONTR P/E	VRW	
itro CENTRAL FILE	CONST CONTR QA		

39-2307-23

cc: N. Johnson - Houston Construction Services
R.J. Browning - New Castle Engineering
C.R. Patterson/T. Fraser - OB Operations
RWM/BER/OSE 74-2409U
SCL

July 2, 1975

Bob Evans
Fremont Construction

RE: Contract 74-2409U
Rad Waste Storage Tanks
Richland, Washington

This letter will confirm information we discussed by phone today concerning the flat spot in the roof of Tank #1. The following is the sequence to be used for stiffening the roof adjacent to penetration 20-1 at 270° centerline:

1. Install and weld complete the dollar plate.

2. Leave all stiffening presently in place until flat spot has been pulled up and secured.

3. Refer to attached Sheet #1 for stiffening details. Install circumferential stiffeners and weld complete. If depressed area extends inside 17'-6" radius or outside 22'6" radius, additional circumferential stiffeners will be required.

4. Install all radial stiffeners required and weld them to circumferential angles.

5. Pull roof plate up to radial stiffeners and weld. If additional circumferential angles are required, span between them with additional radial stiffeners.

6. If above system stabilizes the roof in this area, remove all other stiffening from roof.

7. Stiffening at depressed spot must remain in place through concreting. If customer will not accept this, then we will have to stiffen the underside of the roof and remove this stiffening after concrete is set up.

Since the other 20-1 penetration at 90° centerline is not having similar problems, we assume that the cause of the settlement

INTEROFFICE CORRESPONDENCE

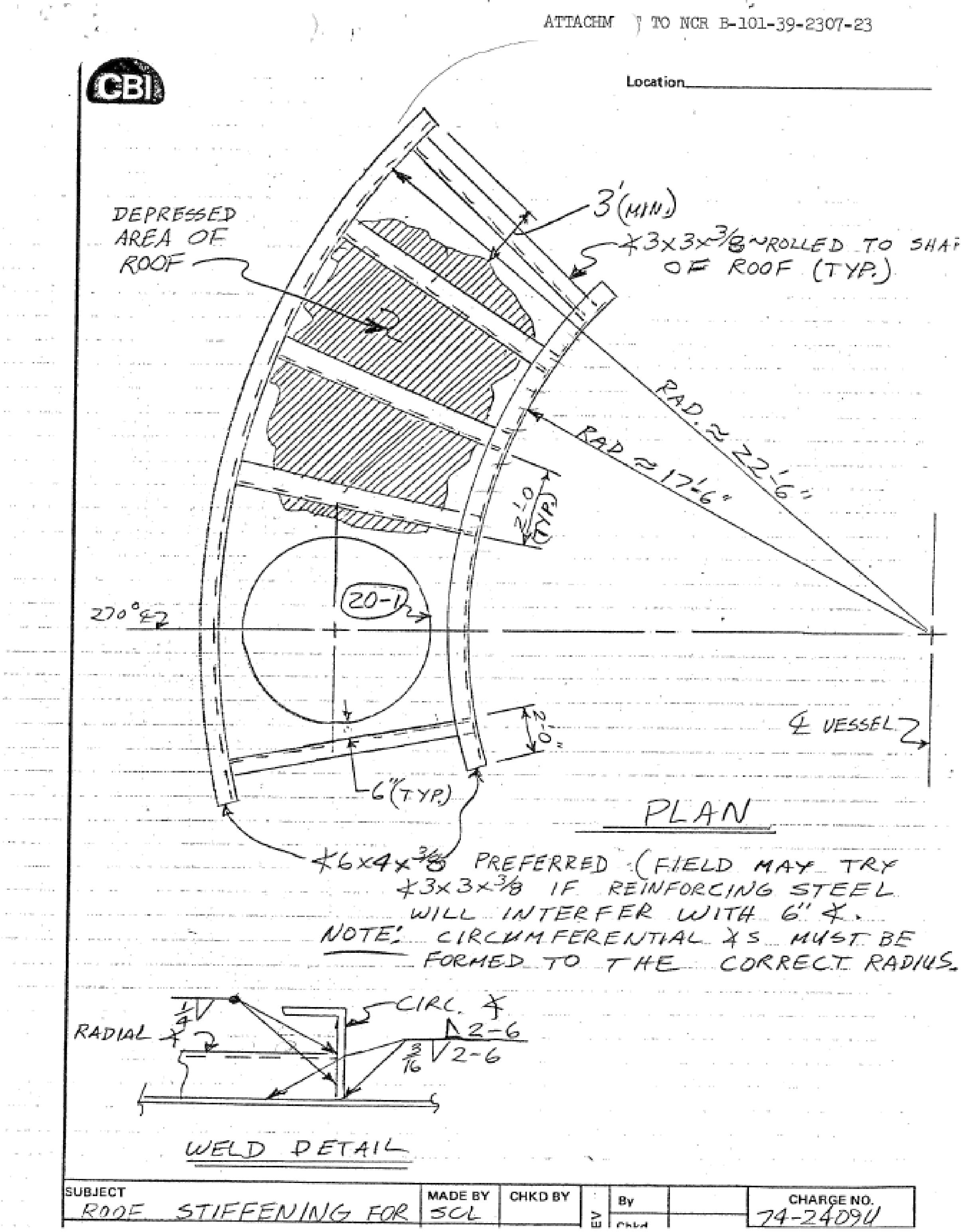
ATTACHMENT TO NCR B-101-39-2307-23

Page 2
July 2, 1975
Bob Evans

at 270° is due to the initial flat spot in the roof. Therefore, we do not anticipate similar problems with Tanks #2 and #3 unless they have similar flat spots before PWHT. If there are problem areas on these tanks, we advise stiffening these areas locally <u>before</u> PWHT and leave stiffening on through concreting. Also, we emphasize the requirement for installing the dollar plate <u>before</u> removing any roof stiffeners.

S.C. Leventry
OB Engineering
Special Structures Design

SCL/jm


ATTACHM TO NCR B-101-39-2307-23
CBI
Location
DEPRESSED AREA OF ROOF
3' (MIN.)
∠3x3x3/8 ~ROLLED TO SHA
OF ROOF (TYP.)
RAD. ≈ 22'-6"
RAD ≈ 17'-6"
2'-0" (TYP.)
(20-1)
270° ℄
℄ VESSEL
2'-0"
6" (TYP.)
PLAN
∠6x4x3/8 PREFERRED (FIELD MAY TRY
∠3x3x3/8 IF REINFORCING STEEL
WILL INTERFER WITH 6" ∠.
NOTE: CIRCUMFERENTIAL ∠S MUST BE
FORMED TO THE CORRECT RADIUS.
CIRC. ∠
RADIAL ∠
1/4
2-6
3/16 2-6
WELD DETAIL
SUBJECT
ROOF STIFFENING FOR
MADE BY
SCL
CHKD BY
REV
By
Chkd
CHARGE NO.
74-2409U