DPSPU 80-11-9

HISTORY OF WASTE TANK 4
1959 THROUGH 1974

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DATE DISTRIBUTED
January 1981

PREPARED FOR THE U.S. DEPARTMENT OF ENERGY UNDER CONTRACT DE-AC09-76SR00001

INTRODUCTION

Alkaline radioactive wastes resulting from the chemical separation of fission products from plutonium and uranium at the Savannah River Plant are stored in underground carbon steel tanks having capacities that range from 0.75 to 1.3 million gallons. The waste falls into two general categories: high heat waste (HW) which contains the majority of the fission products, and low heat waste (LW) which is generated by purification processes and the dissolving of aluminum cladding from reactor fuels. Some tanks, equipped with cooling coils, are for storage of HW, while other tanks, without cooling coils, are for LW.

Tank 4 is a 750,000 gal type I tank in F Area. It is used for HW storage (figure 1). It is 75 ft in diameter and 24½ ft high, and has 34 vertical cooling coils. At the bottom, where sludge and most of the fission products concentrate, there are four horizontal cooling coils. The tank is constructed of type ASTM A-285B steel, with nonstress-relieved welds; it is inside a concrete vault with an annular space surrounding it. A 5 ft high steel annulus pan (secondary container to collect leakage from the tank) lines the bottom of the vault. Eight risers provide access to the tank interior and four risers provide access to the annulus.

Events in the history of tank 4 are listed chronologically in figure 2 and are discussed briefly in this report. Listing of a date by month and year at any place in this report serves as a reference to the Works Technical Report for that month.

This history covers the period from September 1959 to December 1974.

SUMMARY

Tank 4 was placed in service as a fresh HW receiver from the Purex process in Building 221-F in April 1961. About 60% of the supernate was decanted in February 1971. Tank 4 then began receiving evaporator bottoms. The supernate was transferred in July 1971, June 1972, and March 1974. Fresh high heat waste was transferred into the tank three times between July 1971 and September 1972 to dilute the evaporator bottoms and avoid salt accumulation on top of the sludge in the tank. Tank 4 has no known leaks.

The tank interior and annulus have been inspected by direct observation and by using an optical periscope. Samples of sludge and supernate were analyzed and tank temperature profiles were taken. There have been several equipment modifications and repairs.

DISCUSSION

OVERALL CHRONOLOGY

In April 1961, tank 4 was placed in service as a receiver of HW from the Building 221-F Purex process. The tank was filled to 265 inches by April 1963, then to 267 inches by additional HW receipts in December 1966 and January 1967. The tank remained at this level until about 60% of the supernate was decanted in February 1971. Receipt of evaporator bottoms began in March 1971 and continued intermittently until September 1972. The supernate was decanted three times during this period and high heat waste supernate was received in tank 4 following each decantation. Also during this period, the vertical cooling coils were blanked off. These steps were taken to avoid salt buildup on the sludge in the tank bottom.

During the period of evaporator bottoms receipt, about 34,000 gal of soft salt accumulated on top of the sludge. By October 1974, the salt had redissolved in the fresh waste receipts.

Significant events, including all entries discussed in the following paragraphs, are shown on the tank liquid level plot in figure 2 along with the sludge and supernate temperatures.

Chronology of Events

Apr 1961 Tank 4 began receiving HW from the Purex process in Building 221-F.

Apr 1962 Level probes were installed in the north and south annulus risers to replace the necklace alarm.

May 1962 The annulus was periscopically inspected and photographed.

Jul 1962 Vertical temperature profiles showed hot spots in the sludge. Corrosion samples were suspended under riser 4.

Aug 1962 Airborne activity escaped around the riser plugs and contaminated a small area around each riser. The risers were caulked and decontaminated.

Apr 1963 Fresh waste receipt was suspended with the tank liquid level at 265 inches.

Aug 1963 Corrosion coupon for SRL was placed in riser 2.

Mar 1966 Rainwater inleakage activated the annulus alarm.

May 1966 Vertical temperature profiles were measured.

Dec 1966 Additional fresh HW receipts began.

Jan 1967 Fresh waste receipts terminated with the tank liquid level at 267 inches.

Jun 1968 Attempts to sample the sludge were unsuccessful because the sludge sampler malfunctioned.

Aug 1968 The sludge was sampled for studies of zirconium and niobium recovery.

May 1970 Measurements showed the sludge load-bearing properties to be inadequate for salt storage in tank 4.

Feb 1971 The sludge depth under riser 6 was four inches.
A transfer jet was installed in riser 6.

Approximately 421,000 gal of supernate were transferred to tank 7.

Mar 1971 The vertical cooling coils were blanked off. Tank 4 began receiving evaporator bottoms.

Apr 1971 Salt thickness and sludge depths were measured. Some soft salt was present.

Jul 1971 About 619,000 gal of supernate were transferred to tank 7.

Approximately 184,000 gal of mixed high h waste supernate were received from tank 7.

Jun 1972 The annulus was periscopically inspected through the north and south risers. The annulus was smeared under the same risers to check for contamination.

Approximately 614,000 gal of supernate were transferred to tank 7.

About 194,000 gal of high heat waste supernate were received from tank 7.

Jul 1972 The annulus was periscopically inspected through the east and west risers. The annulus was smeared under the same risers to check for contamination.

Aug 1972 Approximately 595,000 gal of supernate were transferred to tank 7.

About 191,000 gal of mixed high heat waste supernate were received from tank 7.

The evaporator bottoms drawoff valve began leaking.

Sep 1972 The leaking drawoff valve was removed.

Oct 1972 About 385,000 gal of supernate were transferred to tank 7.

Approximately 391,000 gal of high heat waste supernate were received from tank 18.

Jan 1973 A new drawoff valve was installed.

Feb 1973 The open-circuit electric potential between the tank wall and the supernate was measured.

Mar 1973 The annulus leak detection probes were inspected.

Jul 1973 The primary wall thickness was measured under the east annulus riser.

Aug 1973 The annulus was periscopically inspected.

Sep 1973 The reel tape cable was replaced.

The primary wall thickness was measured under the north, south, and west annulus risers.

Oct 1973 The reel tape was recalibrated.

The horizontal cooling coils were blanked off.

Nov 1973 The reel tape was recalibrated.

The tank interior was periscopically inspected and photographed.

Full cooling water flow was returned to all tank coils.

Feb 1974 About 263,000 gal of supernate were transferred to tank 7.

Liquid level dip tubes were installed in the annulus.

Mar 1974 Approximately 332,000 gal of supernate were transferred to tank 7.

May 1974 A new reel tape was installed. The old reel tape and other debris under the tape riser caused operational difficulties.

Contamination was found in the steam supply lines leading to tanks 3 and 4, indicating possible past suckback of waste solutions or migration of airborne activity into the steam lines.

Jun 1974 Tank 4 began receiving fresh high heat waste.

Sep 1974 A transfer jet was installed in the tank annulus.

The reel tape malfunctioned.

Nov 1974 The reel tape was returned to service.

Dec 1974 Reel tape malfunctions occurred.

Jan 1975 Reel tape operation was restored.

INSPECTIONS OF TANK INTERIOR AND ANNULUS

The tank interior and annulus were inspected in September 1959 and the tank interior was inspected in 1961 prior to waste receipts in the tank. Monthly visual observations of the annulus began in May 1962. The annulus was periscopically inspected and photographed in 1962, 1972, and 1973. The tank interior was periscopically photographed and inspected in November 1973 and May 1974. All inspections are shown in figure 2.

Available color transparencies are listed in table 1.

Chronology of Events Related to Inspection

Sep 1959 The tank and annulus were inspected. Rust covered the tank interior surfaces, and pits up to one sixteenth of an inch deep were noted on the interior tank bottom. Vapor phase inhibitor had been added in 1958.

Mar 1961 The tank was inspected for fabrication defects.

Apr 1961 The tank inspection continued. Two weld defects, a punch mark, and three holes (each less than 0.2 inch deep) that had been burned into the tank floor by a cutting torch were found. The defects were repaired by welding before waste receipt began on April 20, 1961.

May 1962 Monthly visual observations of the tank annulus were initiated.

The annulus was periscopically inspected and photographed beneath the north and west risers.

Mar 1966 The annulus was visually inspected after rainwater activated the necklace alarms.

Jun 1972 The annulus was periscopically inspected and photographed beneath the north and south risers. No unusual conditions were noted. The annulus was smeared under the same risers to check for contamination. Results were inconclusive.

Jul 1972 The annulus was periscopically inspected and photographed beneath the east and west risers. White solids were seen at the junction of the primary steel tank wall and the concrete between the primary tank wall and annulus pan beneath the east riser. The solids were believed to have been leached from the concrete by ground water. The annulus was smeared under the same risers to check for contamination. Results were inconclusive.

Aug 1973 The annulus was periscopically inspected and photographed beneath the east riser. No abnormalities were observed.

Nov 1973 The tank interior was periscopically inspected and photographed. No salt buildup was seen above the 256-inch liquid level.

May 1974 The tank interior was periscopically inspected through riser 4 to determine the cause of reel tape operation problems.

SAMPLES OF TANK CONTENTS

The tank contents were sampled and analyzed three times between July 1968 and July 1972. A sludge sample taken August 1, 1968, was used by the Special Studies Group of Separations Technology to study ^{93}Zr-^{93}Nb recovery. All sampling is shown in figure 2 and all available analytical results are shown in table 2.

Chronology of Events Relating to Sampling

Aug 1968 A sludge sample was taken for use by the Sep Tech Special Studies Group.

Dec 1968 A supernate sample was taken.

Jun 1972 A supernate sample was taken on the 23rd.

PHYSICAL MEASUREMENTS

Temperature profiles were taken in existing thermowells. In 1973 the wall thickness was measured using a digital thickness gage from Automation Industries. No thinning of the wall was detected. Other measurements include salt and sludge depths and the tank open circuit potential. These measurements are shown in figure 2.

Chronology of Events Relating to Physical Measurements

Jul 1962 Vertical temperature profiles were taken (figure 3).

SRL corrosion coupons were suspended under riser 4.

Aug 1963 An SRL corrosion coupon was placed in riser 2.

May 1966 Temperature profiles were taken (figure 4).

May 1970 The sludge load bearing strength was measured and found to be inadequate to support salt cakes (figure 6).

Feb 1971 Sludge depth was measured.

Apr 1971 Salt and sludge depths were measured.

Feb 1973 The open circuit potential between the tank and the supernate was measured. The tank metal was in a passive (noncorroding) state.

Jul 1973 The primary tank wall thickness was measured under the east annulus riser (figure 5).

Sep 1973 The primary tank wall thickness was measured under the north, south, and west annulus risers (figure 5).

TESTS CONDUCTED

In October 1973, all cooling water to tank 4 was valved off to study heating of the sludge and supernate in the absence of cooling water flow in the cooling coils. The water was valved back on in November 1973. In July 1962 and August 1963, corrosion coupons were suspended in the tank. In August 1968, the sludge was sampled for zirconium and niobium recovery studies. These events are shown on figure 2 and in the overall chronology of events.

EQUIPMENT MODIFICATIONS AND REPAIRS

Several reel tape replacements and repairs occurred after September 1973. In April 1962, conductivity probes were installed in the annulus to replace the necklace alarm. A transfer jet was installed in the tank in February 1972, and an emergency transfer jet was installed in the annulus in September 1974. In February 1974, liquid level dip tubes were installed in the annulus. These and other equipment modifications and repairs are shown in the following list and in figure 2.

Chronology of Events Related to Equipment Modifications and Repairs

Apr 1962 Conductivity probes that were installed in the north and south annulus risers replaced the necklace alarm.

Aug 1962 Tank risers which had leaked airborne activity were caulked and decontaminated.

Feb 1971 A transfer jet was installed, with discharge to tank 7.

Sep 1972 A leaking drawoff valve was removed. The valve plug was broken.

Jan 1973 A new drawoff valve was installed.

Sep 1973 The reel tape cable was replaced.

Oct 1973 The reel tape was recalibrated.

Nov 1973 The reel tape was recalibrated.

Feb 1974 Liquid level dip tubes were installed in the annulus.

May 1974 A new reel tape was installed. Debris in the tank interfered with reel tape operation.

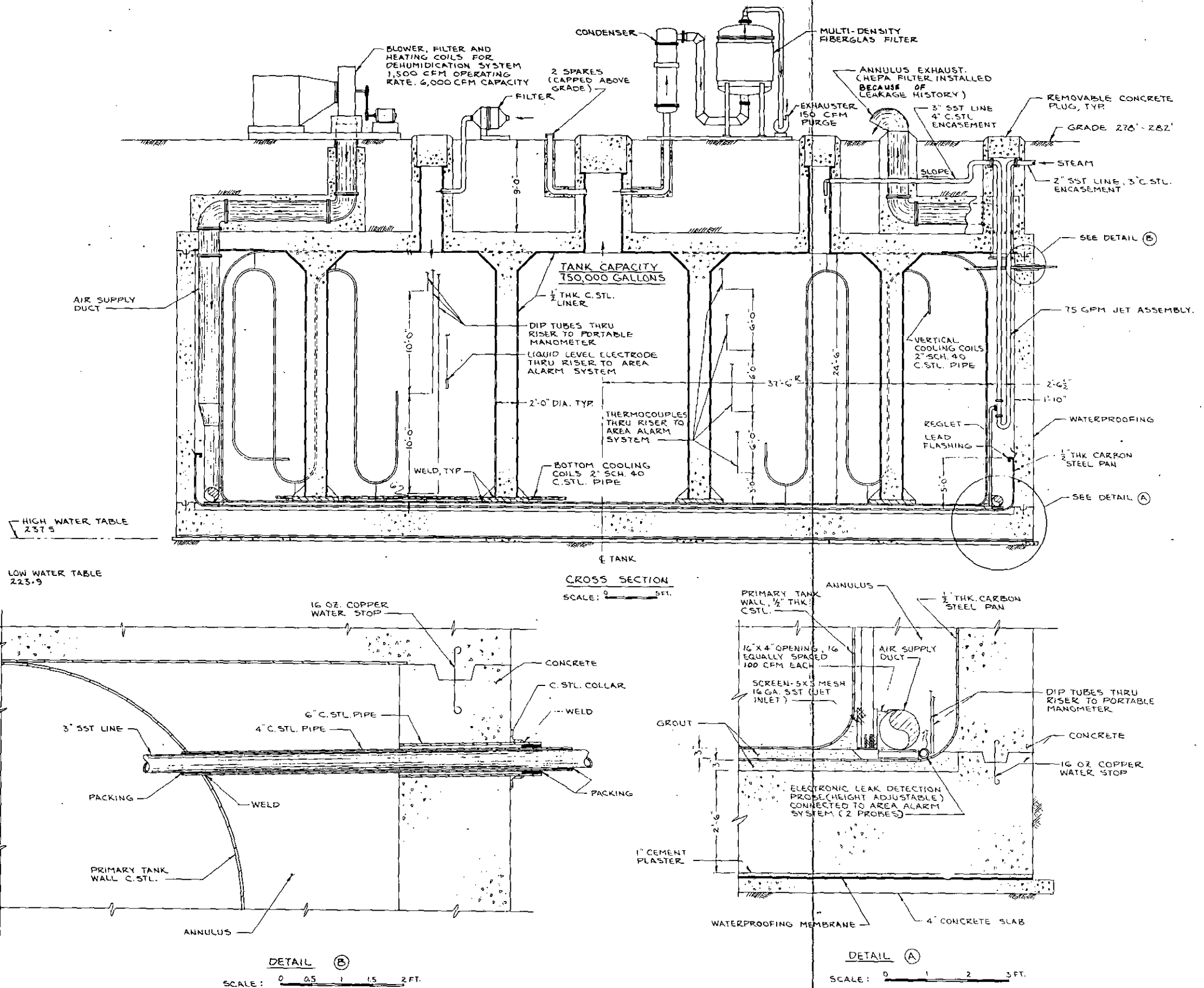
Sep 1974 An emergency transfer jet was installed in the annulus.

The reel tape was removed from service to correct operating problems.

Nov 1974 The reel tape was returned to service.

Dec 1974 The reel tape malfunctioned.

Jan 1975 Reel tape operation was restored.



CROSS SECTION

SCALE: 0 5FT.

LOW WATER TABLE 223.9

DETAIL (B)

SCALE: 0 0.5 1 1.5 2 FT.

DETAIL (A)

SCALE: 0 1 2 3 FT.

FIGURE 1. WASTE STORAGE TANK 4

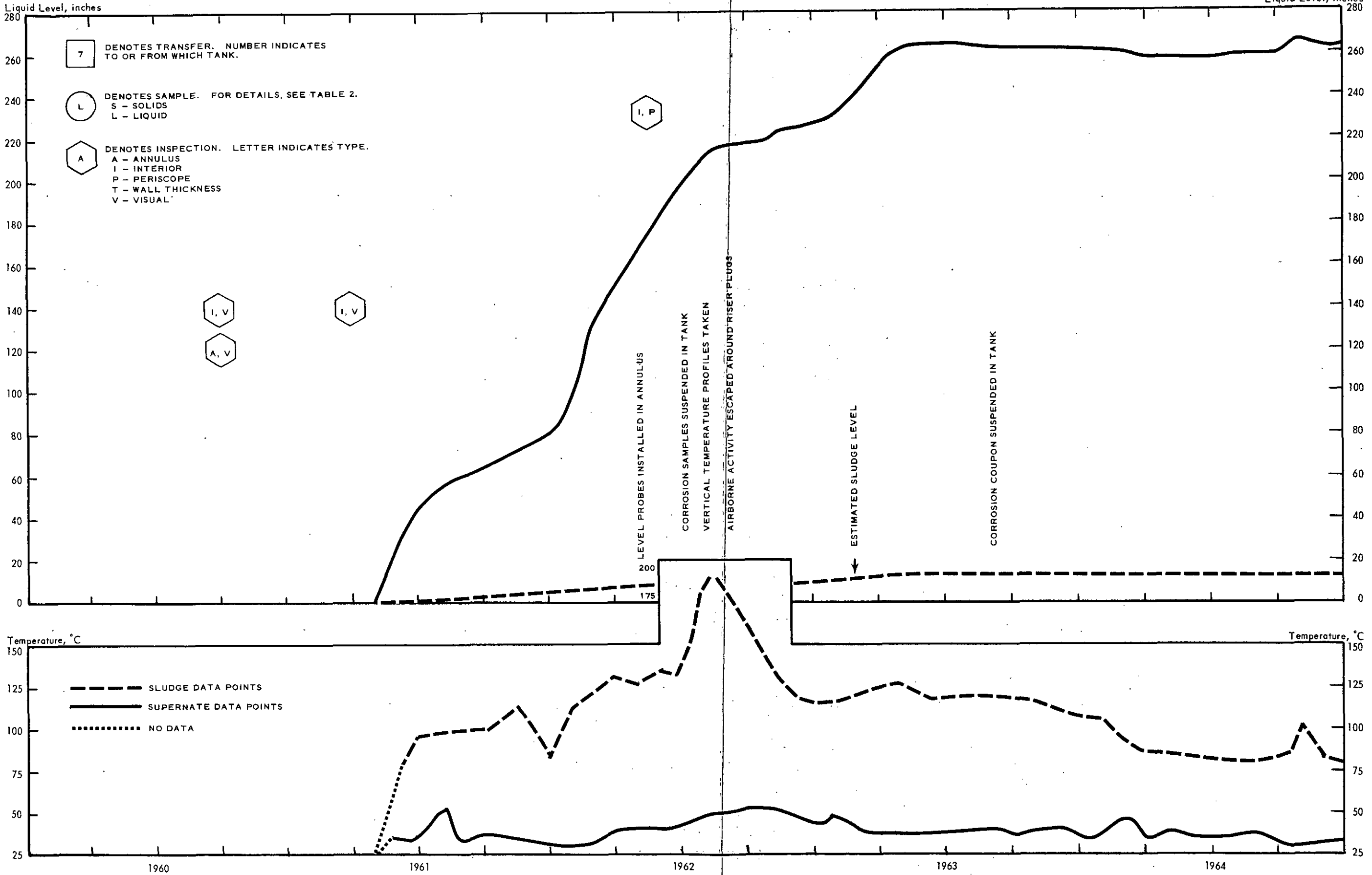


FIGURE 2. TANK 4 LIQUID LEVELS AND TEMPERATURES

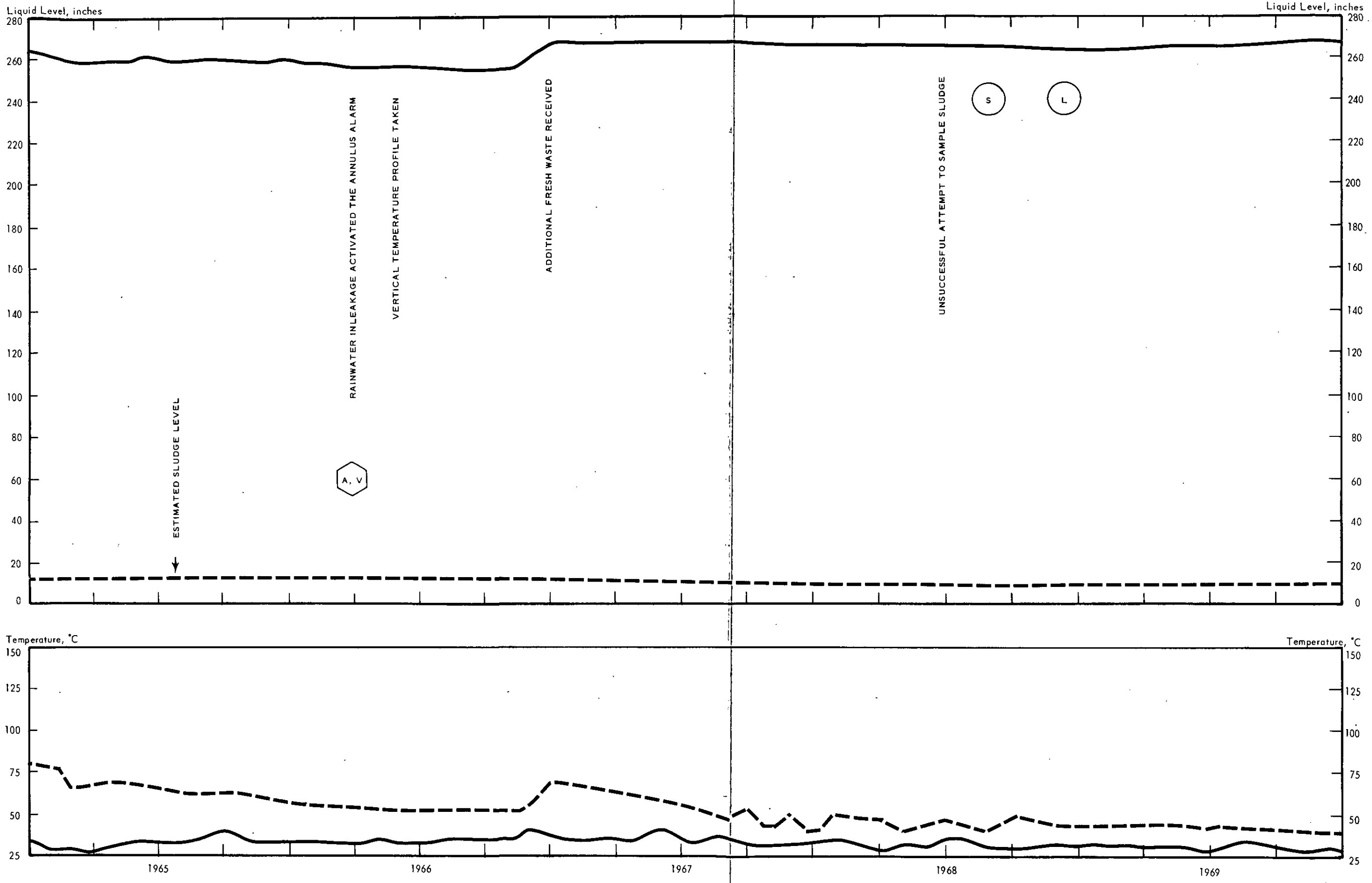


FIGURE 2 (continued)

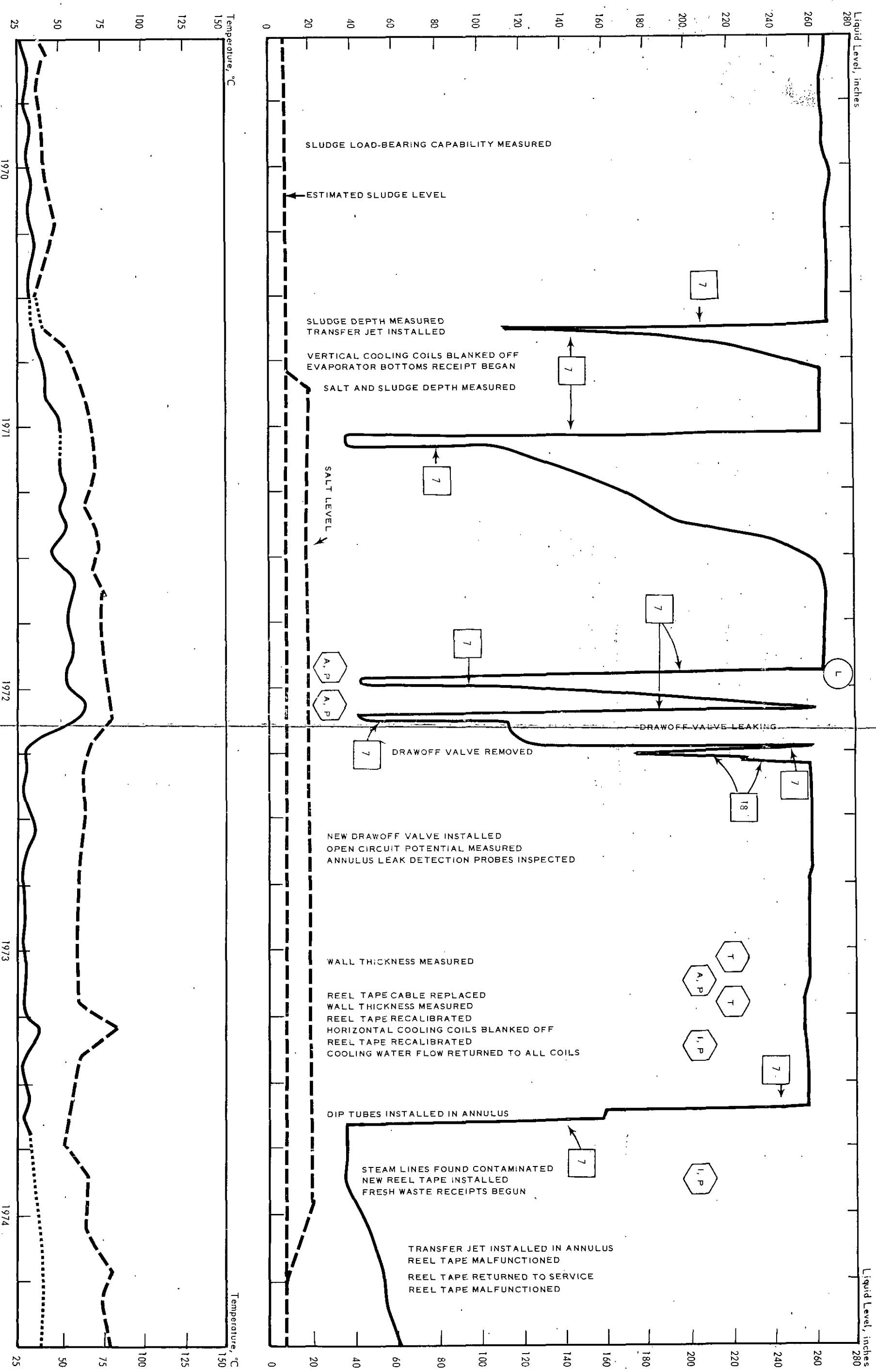


FIGURE 2 (continued)

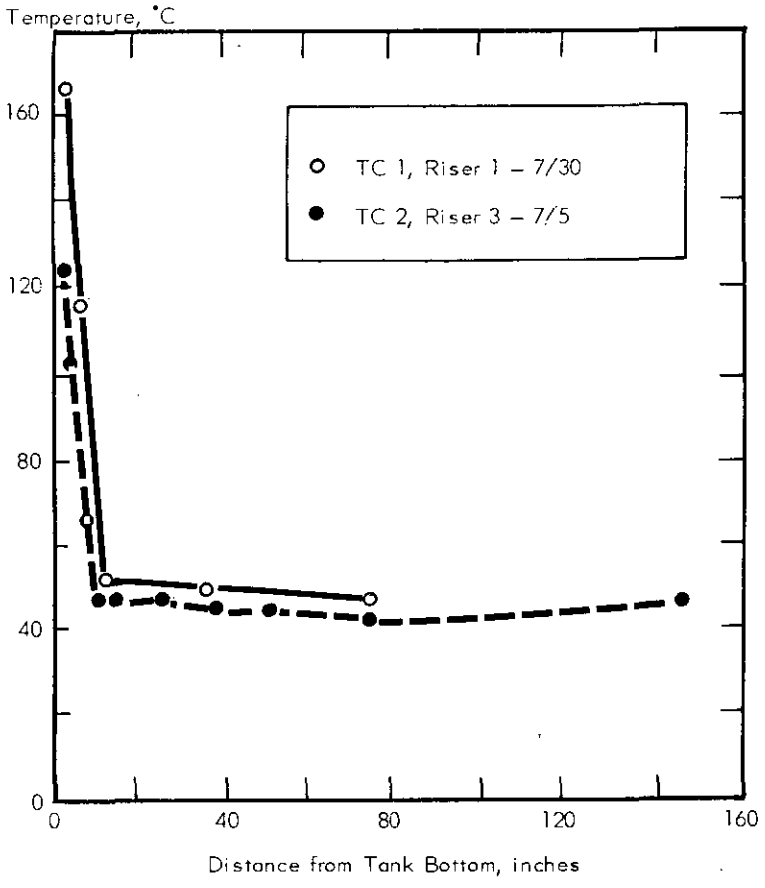


FIGURE 3. TANK 4 VERTICAL TEMPERATURE PROFILE, JULY 1962

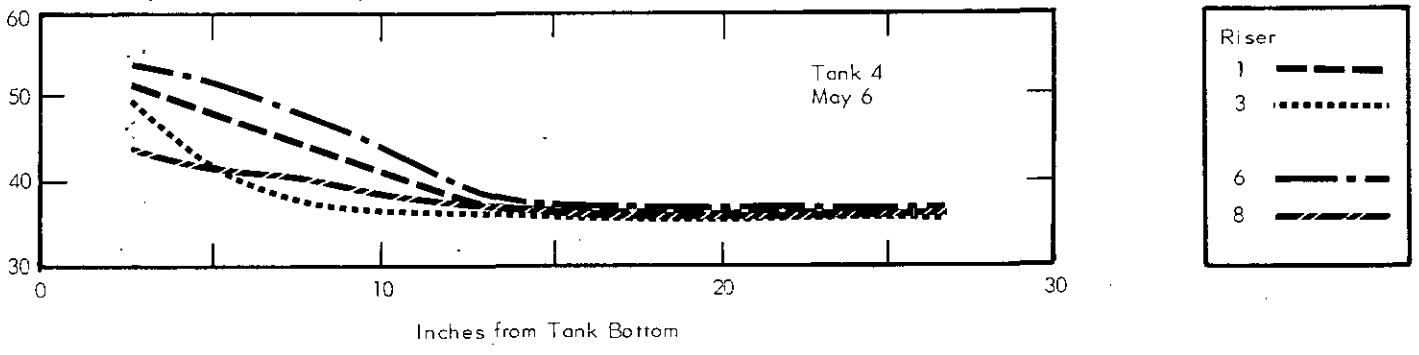


FIGURE 4. TANK 4 VERTICAL TEMPERATURE PROFILE, MAY 1966

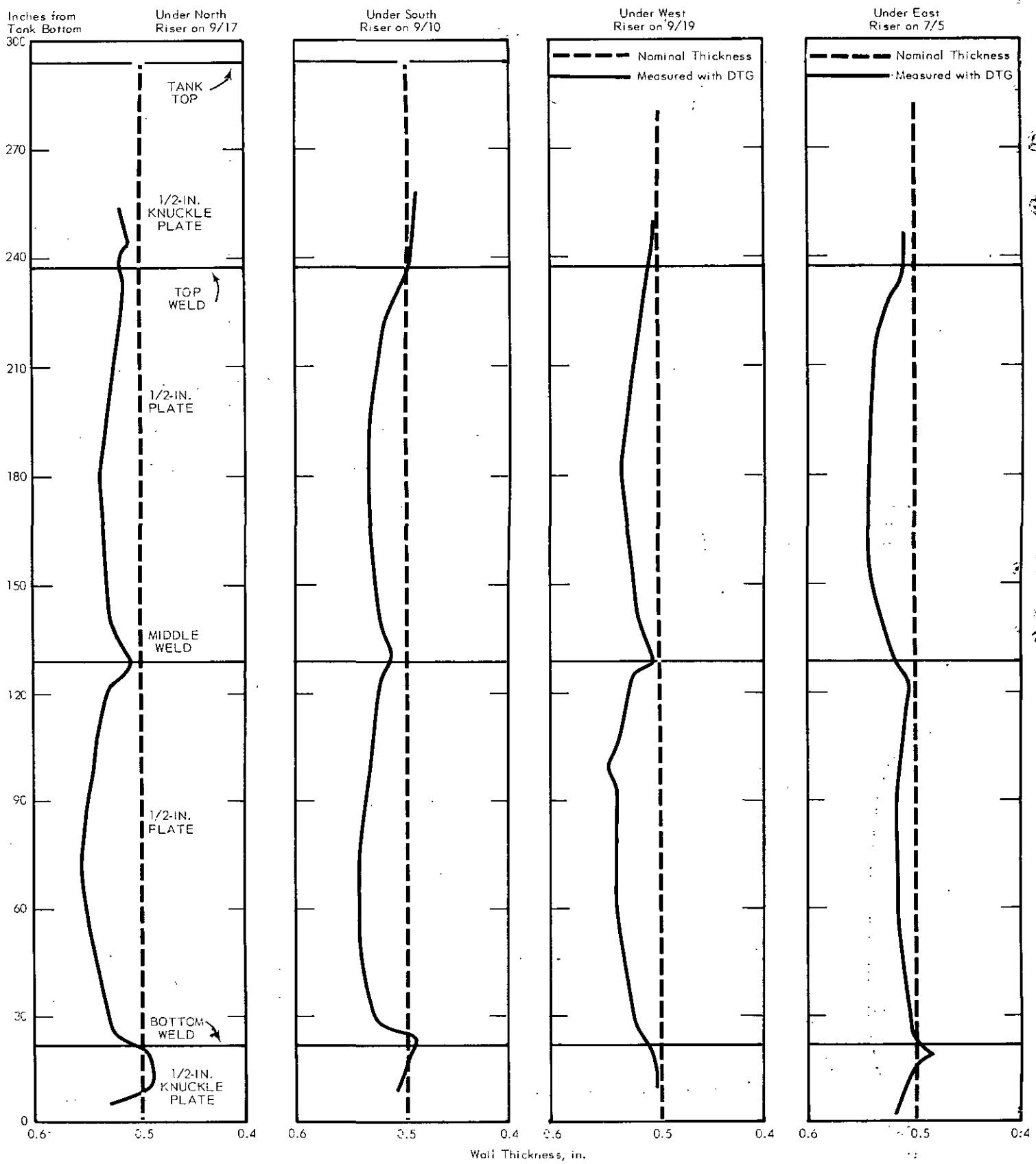


FIGURE 5. TANK 4 WALL THICKNESS MEASUREMENTS

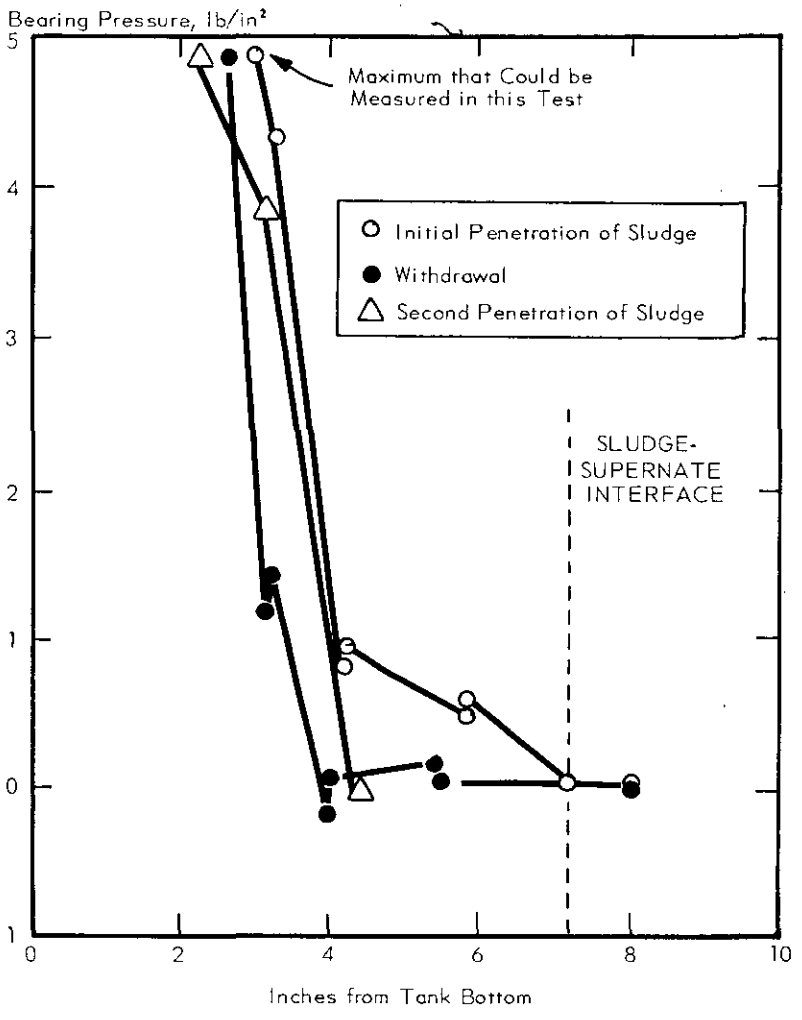


FIGURE 6. LOAD-BEARING STRENGTH OF TANK 4 SLUDGE

Table 1
TANK 4 COLOR PHOTOGRAPHS

Date	Access Port	Object of Photograph	DPSPF	Waste Management Tech. File Location	
				Box or Tray	Slots
4/27/62	North	Annulus, welds	8248-1 thru 28	Box 6	32 - 59
5/1/62	West	Annulus, welds	8245-1 thru 31	Box 6	59 - 87
6/8/72	South	Annulus, welds	15972-1 thru 25	Tray 6	26 - 50
6/12/72	North	Annulus, welds	15999-1 thru 25	Tray 6	1 - 25
7/13/72	West	Annulus, welds	16089-1 thru 31	Tray 6	51 - 80
7/17/72	East	Annulus, welds	16074-1 thru 25	Tray 6	82 - 106
7/24/73	East	Annulus, welds	17190-1 thru 23	Tray 6	107 - 129
10/24/73	7	Interior wall	17468-1 thru 12	Tray 7	1 - 12
5/10/74	4	Reel tape	17962-1	Tray 7	13
5/10/74	4	Tank bottom & wall	17962-2 thru 12	Tray 7	14 - 24

Table 2
TANK 4 SAMPLE ANALYSES

Date Sampled	12/68	6/72
Type of Sample	Supernate	Supernate
Item		
Al^{+++}	2.1 g/l	0.5M
OH^{-}	13.8 g/l	2.8M
CO_3^{--}	2.3 g/l	0.2M
NO_3^{-}	120 g/l	2.4M
NO_2^{-}	68.5 g/l	3.1M
SO_4^{--}	18.4 g/l	0.03M
Cl^{-}	0.1 g/l	0.03M
PO_4^{---}	0.7 g/l	0.04M
CrO_4^{--}		0.009M
Specific gravity	1.284	-
pH	11	-
Gross alpha, d/m/ml	7.1×10^4	$<5 \times 10^4$
Pu, d/m/ml	-	5×10^3
Gross beta, d/m/ml	4.9×10^8	-
Gross gamma, d/m/ml	1.8×10^8	-
^{90}Sr, d/m/ml	3.6×10^5	-
^{95}Zr-^{95}Nb, d/m/ml	ND	-
^{103}Ru, d/m/ml	ND	ND
^{106}Ru, d/m/ml	ND	ND
^{134}Cs, d/m/ml	1.49×10^8	2.7×10^9
^{137}Cs, d/m/ml	9.2×10^9	1.1×10^{10}
^{144}Ce, d/m/ml	ND	-
^{147}Pm, d/m/ml	9.3×10^8	-

ND = none detected.

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