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DPSPU 83-11-9

HISTORY OF WASTE TANK 3 1956 THROUGH 1974

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DATE DISTRIBUTED

December 1983

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

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CONTENTS

INTRODUCTION

Alkaline radioactive wastes resulting from the chemical separation of fission products from plutonium and uranium at the Savannah River Plant are stored underground in 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 results from purification processes and from dissolving aluminum cladding from reactor fuels. Some tanks equipped with cooling coils are for storage of high heat waste while other tanks without cooling coils are for low heat waste.

Tank 3 is a 750,000 gallon, type I tank in F Area and used for HW storage (figure 1). It is 75 ft in diameter, 24 1/2 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 ASTM type A-285B steel, with nonstress-relieved welds and is inside a concrete vault with an annular space surrounding the tank. Lining the bottom of the vault is a 5-ft-high steel annulus pan (secondary container) to collect leakage from the tank. Eight risers provide access to the tank interior and four risers to the annulus.

Events in the history of tank 3 are listed chronologically in figure 2 and 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 March 1956 through December 1974.

SUMMARY

Tank 3 was placed in service as a fresh HW receiver in March, 1956. The tank was filled to 265 inches by March 1961, and remained full until the supernate was decanted in August 1967. The sludge was slurried and transferred to tank 7 in June 1968. Tank 3 was then placed in salt storage service. Since then the tank has been filled and the supernate decanted several times to fill the tank with salt.

The tank interior and annulus were inspected by direct observation and by using a 40-ft optical periscope. Samples of the sludge, salt, supernate, and vapor were analyzed and tank temperature profiles were taken. There have been several equipment modifications and repairs. The cooling water has been valved off three times, twice to study thermal effects and once to warm the tank contents. The cooling water has also been restricted several times using 1/8-in. orifices. One tank 3 cooling coil leaked in 1972.

DISCUSSION

OVERALL CHRONOLOGY

In March 1956, tank 3 was placed in service as a receiver of HW from the Building 221-F Purex Process. The tank was filled to 265 inches by March 1961, and remained full until the supernate was decanted in August 1967. To prepare tank 3 for salt storage, sludge was removed in June 1968 using high pressure water jets to slurry the sludge. The tank was placed in use as a salt storage tank with receipt of the first evaporator concentrate in June 1968.

Significant events, including all entries in the chronology, are shown in figure 2 along with the sludge and supernate temperatures.

Chronology

Mar 1956 Tank 3 began receiving HW waste from the Purex process in Building 221-F.

Jul 1956 Cooling water flow was increased because the sludge temperature was rising.

Aug 1956 The cooling water was accidentally valved off for two days. The sludge temperature rose rapidly to 107°C, then decreased after the water was valved back on (see figure 3).

Sep 1956 Tank purge ventilation was begun.

The tank vapor was analyzed for H_2.

Oct 1956 A hydrogen buildup to 1.3 volume % occurred during a five-day purge blower outage.

Mar 1957 The vapor was sampled.

The supernate was sampled.

The purge exhaust filter activity and exhaust air activity increased to values above acceptable operating levels. The purge blower was shut down, the purge filter replaced, and the blower operated only as necessary to purge H_2 from the vapor space.

Apr 1957 The vapor space and supernate were sampled. Caustic additions were started to provide sufficient hydroxide to inhibit corrosion.

May 1957 Caustic additions, both from the outside facilities by way of the waste headers and through the tank risers, were completed.

Aug 1957 Temperature profiles were taken.

The supernate was sampled.

Caustic additions resumed. Caustic depletion appeared to be caused by radiolytic decomposition of organic materials in the tank.

Sep 1957 The second set of caustic additions was completed.

Nov 1957 The supernate was sampled.

Jul 1958 The sludge and supernate were sampled.

Jun 1959 1/8-in. orifices were installed in the auxiliary vertical cooling coils.

Sep 1959 A low voltage relay was installed in the necklace alarm system to reduce sensitivity.

May 1960 The reel tape was recalibrated.

Jun 1960 The reel tape was recalibrated.

Dec 1962 The reel tape was replaced.

May 1963 The supernate was sampled and analyzed (table 3).

Sep 1963 1/8-in. orifices were installed in the main vertical cooling coils.

Feb 1964 The purge blower malfunctioned. No hydrogen buildup was noted.

Oct 1964 A pressure gage and alarm were installed to indicate blower failure or abnormal tank pressures.

Mar 1966 Rainwater inleakage activated the annulus necklace alarm.

Aug 1967 About 380,000 gallons of supernate was transferred to tank 7.

Dec 1967 12 vertical cooling coils were blanked off.

Jun 1968 About 70,000 gallons of sludge was slurried by using high pressure water jets; the slurry was transferred to tank 7. 320,000 gallons of water were used to slurry the sludge (figure 8).

Receipt of evaporator bottoms began.

Aug 1968 About 118,000 gallons of supernate was transferred to tank 7.

The salt levels were measured.

Sep 1968 About 125,000 gallons of supernate was transferred to tank 7.

Salt soundings were used to estimate the salt volumes (table 4).

Jun 1969 About 355,000 gallons of supernate was transferred to tank 7.

The tank interior was periscopically inspected and photographed (figure 10).

Mar 1969 About 288,000 gallons of supernate was transferred to tank 7.

Apr 1969 About 235,000 gallons of supernate was transferred to tank 7.

Salt accumulation in tank 3 was estimated (figure 9).

May 1969 About 136,000 gallons of supernate was transferred to tank 7.

Jun 1969 About 226,000 gallons of supernate was transferred to tank 7 in two transfers.

Jul 1969 About 184,000 gallons of supernate was transferred to tank 7.

Aug 1969 About 125,000 gallons of supernate was transferred to tank 7.

Sep 1969 The radiation in the tank was measured.

Oct 1969 About 171,000 gallons of supernate was transferrd to tank 7.

Jan 1970 About 128,000 gallons of supernate was transferred to tank 7.

May 1970 About 107,000 gallons of supernate was transferred to tank 7.

The tank salt was sampled.

Jun 1970 Cooling coil salt loading was studied (figures 11 and 12).

About 123,000 gallons of supernate was transferred to tank 7.

Aug 1970 The blanks were removed from the 12 blanked cooling coils and replaced by 1/8-in. orifices.

Jan 1971 About 97,000 gallons of supernate was transferred to tank 7.

Feb 1971 Salt soundings were taken under the transfer jet riser.

Salt encrustation interfered with transfer jet operation.

Mar 1971 The reel tape was replaced.

Feb 1972 Four vertical cooling coils were blanked off.

Vertical cooling coil 13 began leaking. It and two additional coils were blanked off, bringing the number of blanked coils to seven (figure 13).

Mar 1972 The annulus was periscopically inspected and photographed under the north annulus riser.

May 1972 The annulus was periscopically inspected and photographed under the south annulus riser.

Jul 1972 The annulus was periscopically inspected and photographed under the east and west annulus risers.

Sep 1972 The CTS drawoff valve was found to be leaking.

Oct 1972 A radiation profile was taken under the south annulus riser.

The leaking CTS drawoff valve was removed.

Nov 1972 The salt depth was measured under the transfer jet riser.

Jan 1973 About 83,000 gallons of supernate was transferred to tank 7.

A crossover jumper was installed in place of the CTS drawoff valve.

Feb 1973 A new CTS drawoff valve was installed.

About 43,000 gallons of supernate was transferred to tank 7.

Mar 1973 About 185,000 gallons of supernate was transferred to tank 7 in two transfers.

The annulus leak detection probe was inspected.

Jul 1973 About 5,000 gallons of supernate was transferred to tank 7.

The annulus was periscopically inspected and photographed.

The primary tank wall thickness was measured beneath all four annulus risers (figure 7).

Sep 1973 About 22,000 gallons of supernate was transferrd to tank 7.

Oct 1973 The reel tape was recalibrated.

The cooling water was valved off to study tank heatup.

About 15,000 gallons of supernate was transferred to tank 7.

The tank interior was periscopically inspected and photographed.

A temperature profile was taken (figure 6).

Nov 1973 The reel tape was recalibrated.

Jan 1974 A temperature profile was taken (figure 5).

Feb 1974 The tank interior was periscopically inspected and photographed.

Liquid level dip tubes were installed in the annulus.

Mar 1974 A temperature profile was taken.

The horizontal cooling coils were valved back on.

Apr 1974 About 22,000 gallons of supernate was transferred to tank 7.

May 1974 A new reel tape was installed.

Jun 1974 The tank was periscopically inspected and photographed to investigate reel tape problems. The old reel tape was interfering with the new reel tape.

Jul 1974 The horizontal cooling coils were valved off to allow the tank contents to heat to a temperature adequate to keep the steel wall above the nil-ductility transition temperature.

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

Contamination found in the steam supply lines to the tank 3 transfer jet indicated either airborn migration of contamination or suckback from previous transfers.

Oct 1974 The reel tape malfunctioned.

Nov 1974 The reel tape was returned to service.

INSPECTIONS OF TANK INTERIOR AND ANNULUS

Monthly visual observations of the annulus began in May 1962. The annulus was periscopically inspected and photographed in 1972 and 1973. The tank interior was periscopically inspected and photographed in January 1969 and October 1973. All inspections are shown in figure 2.

Available color transparencies are listed in table 1.

Chronology of Events Related to Inspection

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

Jan 1969 The tank interior was periscopically photographed and inspected.

May 1972 The annulus was periscopically photographed and inspected under the north riser.

May 1972 The annulus was periscopically photographed and inspected under the south riser.

Jul 1972 The annulus was periscopically photographed and inspected under the east and west risers.

Mar 1973 The annulus leak detection probe was inspected.

Jul 1973 The annulus was periscopically photographed and inspected under the west riser.

Oct 1973 The tank interior was periscopically photographed and inspected. A thin salt crust was observed over most of the supernate surface.

SAMPLES OF TANK CONTENTS

The tank 3 contents were sampled several times between February 1957 and April 1970. The sludge was sampled in July 1965 for SRL sludge removal studies and in February 1968 for zirconium recovery studies. All sampling is shown in figure 2 and all available analytical results are shown in tables 2 and 3.

Chronology of Events Related to Sampling

Mar 1957 The vapor space was sampled.

The supernate was sampled.

Apr 1957 A supernate sample showed inadequate caustic in the tank liquid to prevent corrosion.

Aug 1957 A supernate sample showed continued caustic depletion.

Nov 1957 A supernate sample indicated sufficient caustic in the tank liquid.

Jul 1958 The sludge and supernate were sampled.

May 1963 The supernate was sampled.

Jul 1965 The sludge was sampled for sludge removal studies by SRL.

Feb 1968 The sludge was sampled for ^{93}Zr recovery studies.

Mar 1970 15 to 20 cc of salt was scraped from a thermowell. The sample of pale yellow-green crystals radiated 2000 mrad/30mR at one foot.

PHYSICAL MEASUREMENTS

Vertical temperature profiles were taken in the tank in 1956, 1957, 1973, and 1974. A vertical radiation profile was taken in September 1969. Salt soundings were taken in 1971 and 1972. The primary wall thickness was measured in 1973. These measurements are shown in figure 2.

Chronology of Events Related to Physical Measurements

Aug 1957 Temperature profiles taken in November 1956, March 1957, and July 1957 were reported.

Aug 1968 The salt depth was measured and was 10 in. below riser 1 and 2-3/4 in. below riser 8.

Sep 1968 The salt depth was measured and the salt volume estimated (table 4).

Sep 1969 The radiation in the tank was measured to be 360 R/hr.

Jun 1970 Settling of simulated vertical coils at risers 1 and 8 was measured. The settling was interpreted in terms of force on nearby vertical coils embedded in the salt to obtain an estimated force per coil loop (two vertical pipes). The forces ranged up to a maximum of 1020 pounds, reached on May 14, 1969. The maximum permissible load on the tank roof is 2800 pounds per coil loop. Additional test coil settling data and corresponding liquid levels in tank 3 are given in figure 11. Figure 12 is a diagram of a simulated vertical coil.

Feb 1971 Salt soundings taken under the jet riser showed the salt level to be 160 inches above the tank bottom.

Oct 1972 The radiation in the annulus was measured (table 5). The maximum radiation was 200 R/hr at 22 ft from the annulus floor.

Nov 1972 The salt depth was measured under the jet riser. A thin crust was encountered at the 228 inch level, and solid salt at the 168 inch level.

Jul 1973 The primary tank wall thickness was measured under the four annulus risers (figure 7).

Oct 1973 A temperature profile was taken (figure 6).

Jan 1974 A temperature profile was taken under riser 1 (figure 5).

Mar 1974 A temperature profile was taken under riser 1 (figure 5).

COOLING COIL FAILURE

One cooling coil was found to be leaking during the annual pressure test of relief valves on coils (figure 13). This is the only known cooling coil leak in tank 3. Figure 2 and the following chronology show events related to cooling coil failures.

Chronology of Events Related to Cooling Coil Failures

Aug 1956 The cooling water was accidentally valved off for two days. The sludge temperature rose rapidly to 107°C, then decreased after the water was valved back on.

Apr 1957 Caustic additions were started to provide sufficient hydroxide to inhibit corrosion.

May 1957 Caustic additions were completed.

Aug 1957 Caustic additions were resumed. Caustic depletion appeared to be caused by radiolytic decomposition of organic materials in the tank.

Sep 1957 The second caustic addition was completed.

Nov 1957 The supernate was sampled.

Jun 1959 1/8-in. orifices were installed in the auxiliary vertical cooling coils.

Sep 1963 1/8-in. orifices were installed in the main vertical cooling coils.

Dec 1967 12 vertical cooling coils were blanked off.

Jun 1968 About 70,000 gallons of sludge was removed by slurrying with about 320,000 gallons of water.

Receipt of evaporator bottoms began.

Jun 1970 Cooling coil salt loading was studied. (Chronology of Events Related to Physical Measurements gives more details.)

Aug 1970 The blanks were removed from the 12 blanked cooling coils and replaced by 1/8-in. orifices.

Feb 1972 Four vertical cooling coils were blanked off.

Vertical cooling coil 13 began leaking. It and two additional coils were blanked off, bringing the number of blanked coils to seven (figure 13).

Oct 1973 The cooling water was valved off.

Mar 1974 The horizontal cooling coils were valved back on.

Jul 1974 The horizontal cooling coils were valved off.

TESTS CONDUCTED

In 1970, salt loadings on cooling coils were measured using a simulated cooling coil. In October 1973, all cooling water to tank 4 was valved off to study heating of the salt and supernate in the absence of cooling water flow in the cooling coils. These events are shown here and in figure 2.

Chronology of Events Related to Tests Conducted

Jun 1970 Cooling coil salt loading was measured.

Oct 1973 Cooling water was valved off to study heating of the tank contents.

EQUIPMENT MODIFICATIONS AND REPAIRS

Several reel tape replacements and repairs occurred after November 1962. In October 1964, a pressure indicator and alarm were installed to warn of blower failures and abnormal tank pressures. In September 1972, the drawoff valve began leaking and was subsequently replaced. An emergency transfer jet was installed in the annulus in September 1974. Liquid level dip tubes were installed in the annulus in February 1974. These and other equipment modifications and repairs are shown here and in figure 2.

Chronology of Events Related to Equipment Modifications and Repairs

Sep 1959 A low voltage relay was installed on the necklace alarm system.

May 1960 The reel tape was recalibrated.

Jun 1960 The reel tape was recalibrated.

Dec 1962 The reel tape was replaced.

Feb 1964 The purge blower failed and was repaired.

Oct 1964 A pressure indicator and alarm were installed to warn of blower failure or abnormal tank pressures.

May 1968 Equipment for sludge removal was installed.

Mar 1971 The reel tape was replaced.

Sep 1972 The CTS drawoff valve leaked.

Oct 1972 The CTS drawoff valve was removed.

Jan 1973 A crossover jumper was intalled in place of the CTS drawoff valve.

Feb 1973	A new CTS drawoff valve was installed.
Mar 1973	An annulus leak detection probe was installed.
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.
Jun 1974	An old reel tape in the tank interfered with operation of the new reel tape.
Sep 1974	An emergency transfer jet was installed in the annulus.
Oct 1974	The reel tape malfunctioned.
Nov 1974	The reel tape was returned to service.

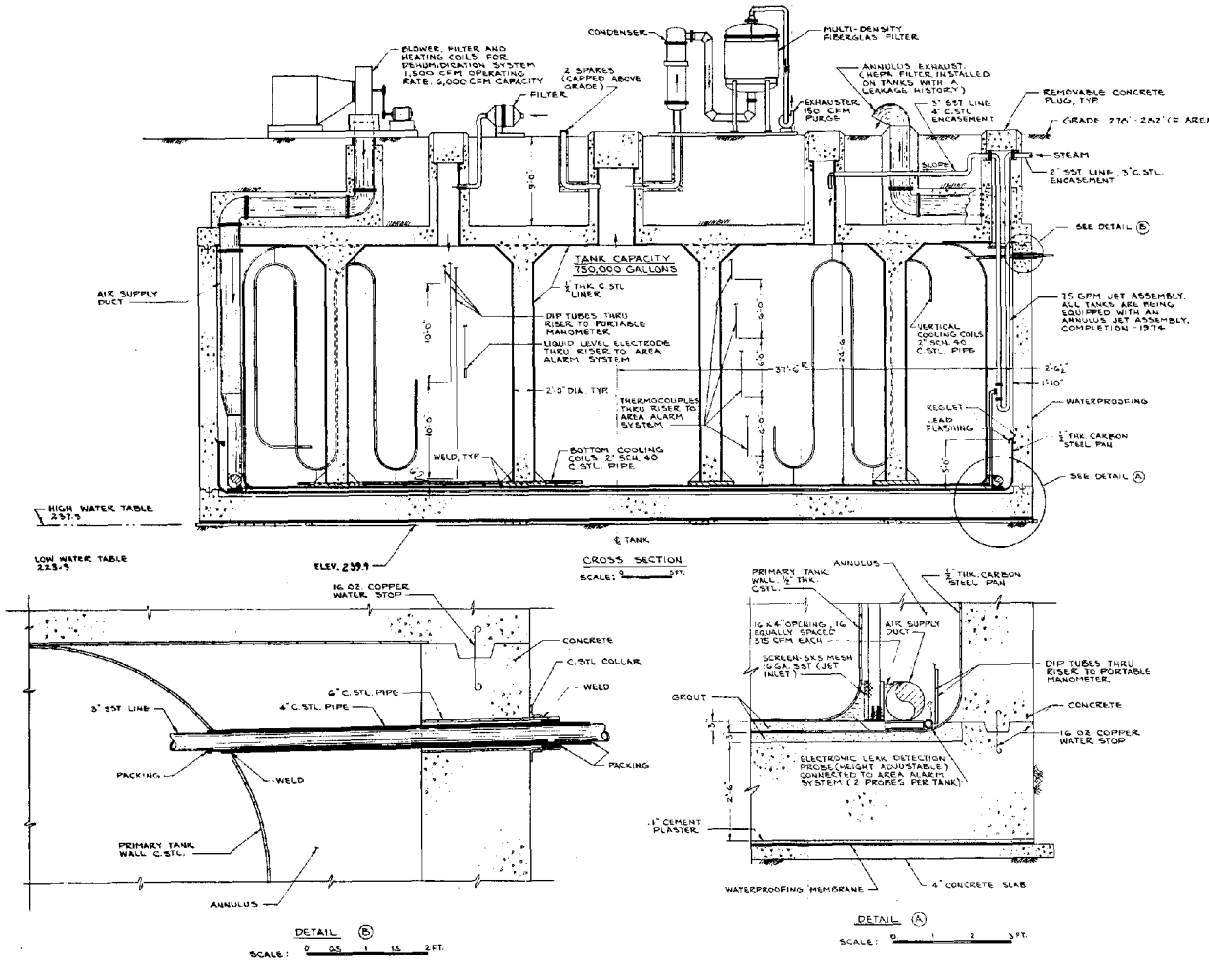

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FIGURE 1. WASTE STORAGE TANK 3

FOR REFERENCE ONLY NOT FOR CONSTRUCTION

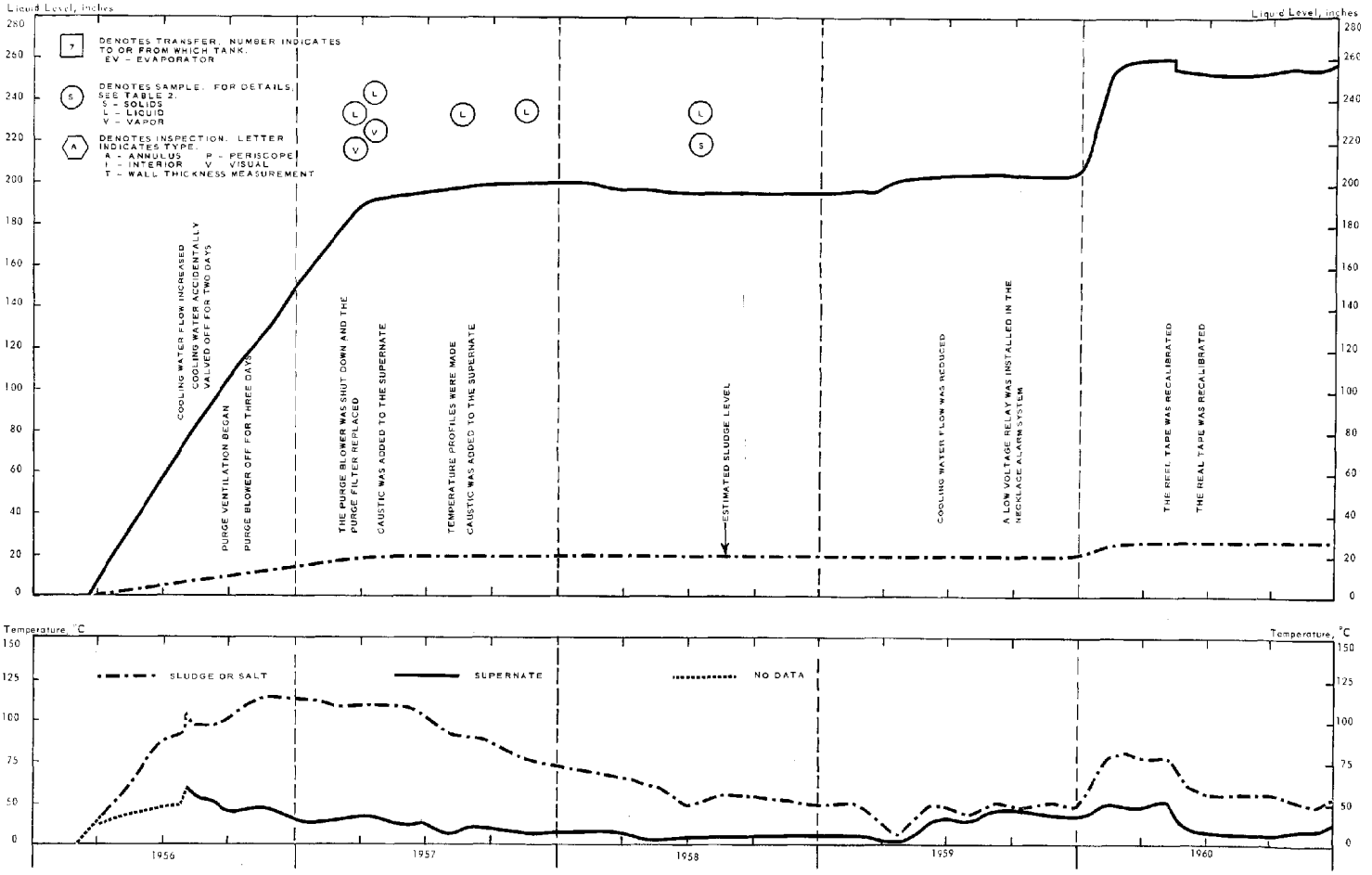

FIGURE 2. TANK 3 LIQUID LEVELS AND TEMPERATURES

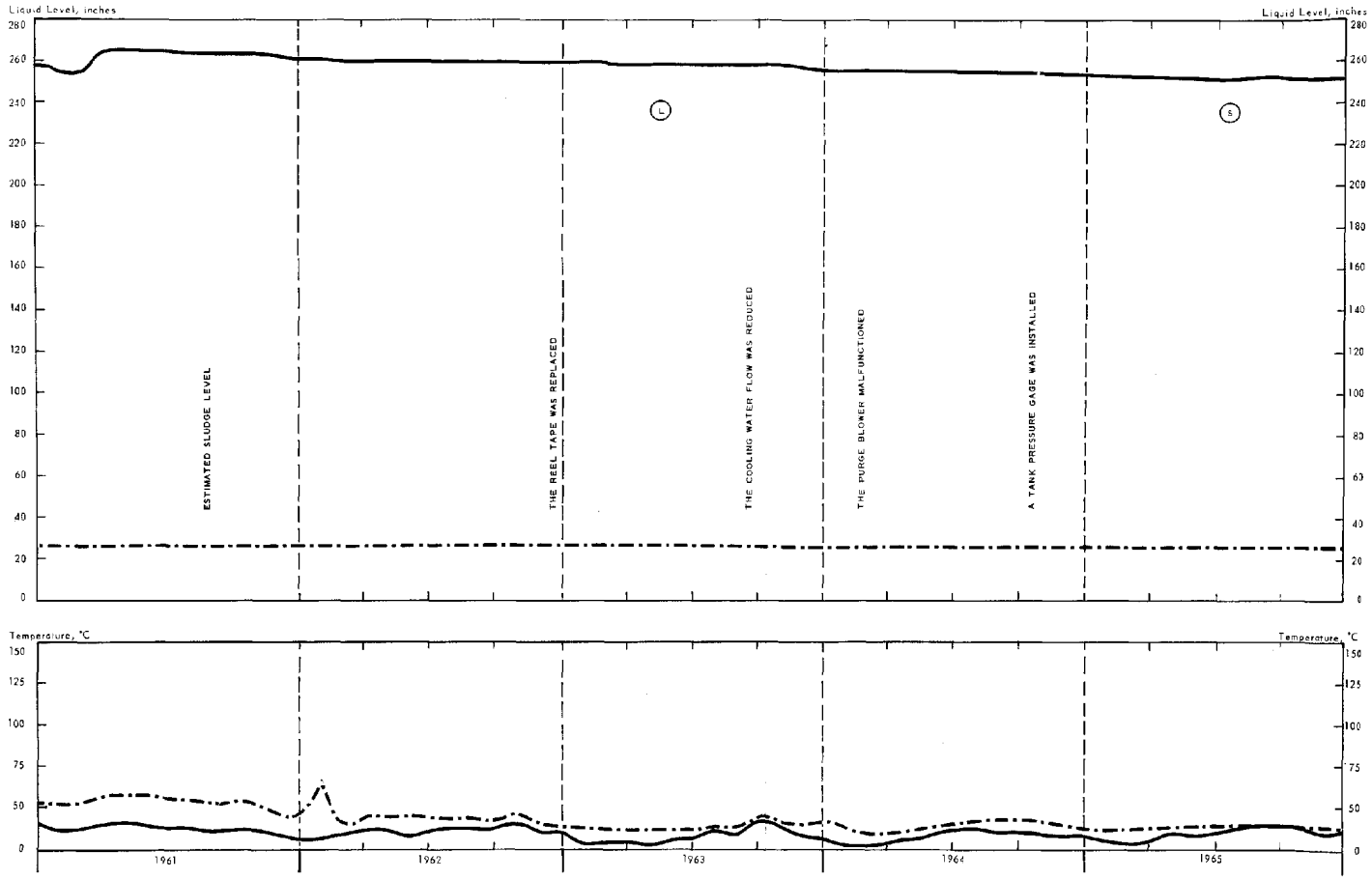

FIGURE 2 (cont'd)

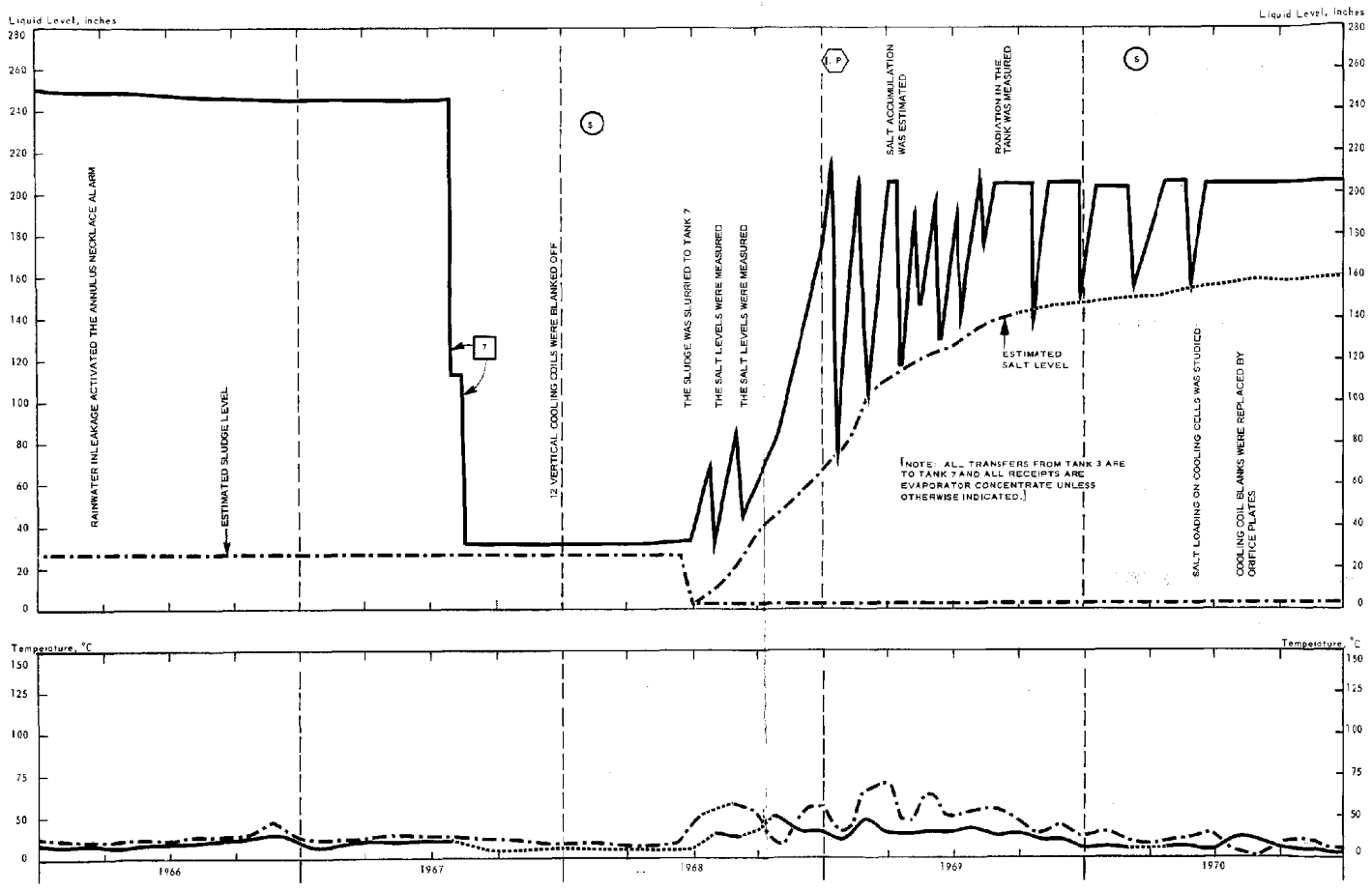

FIGURE 2 (contd)

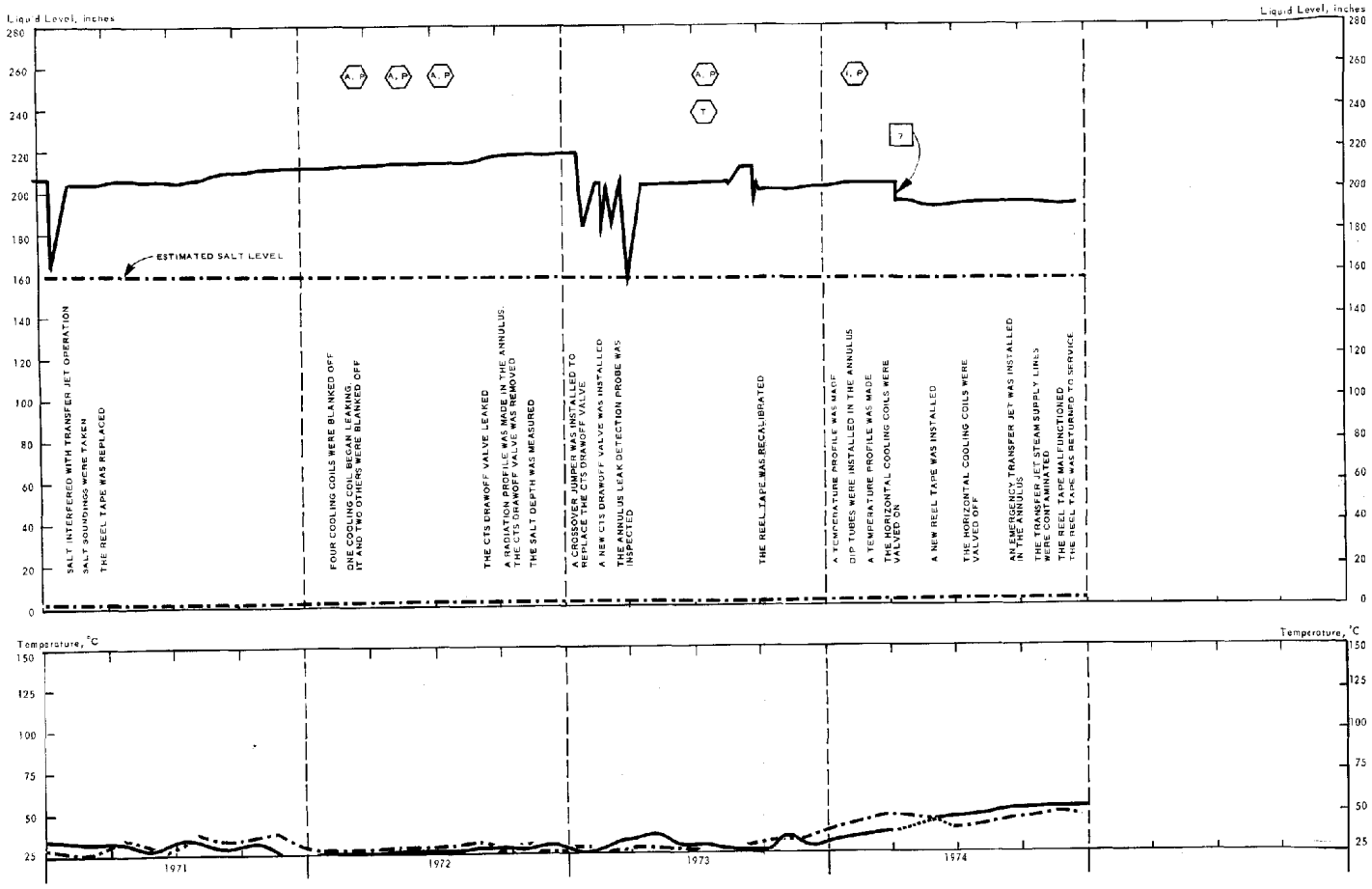

FIGURE 2 (contd)

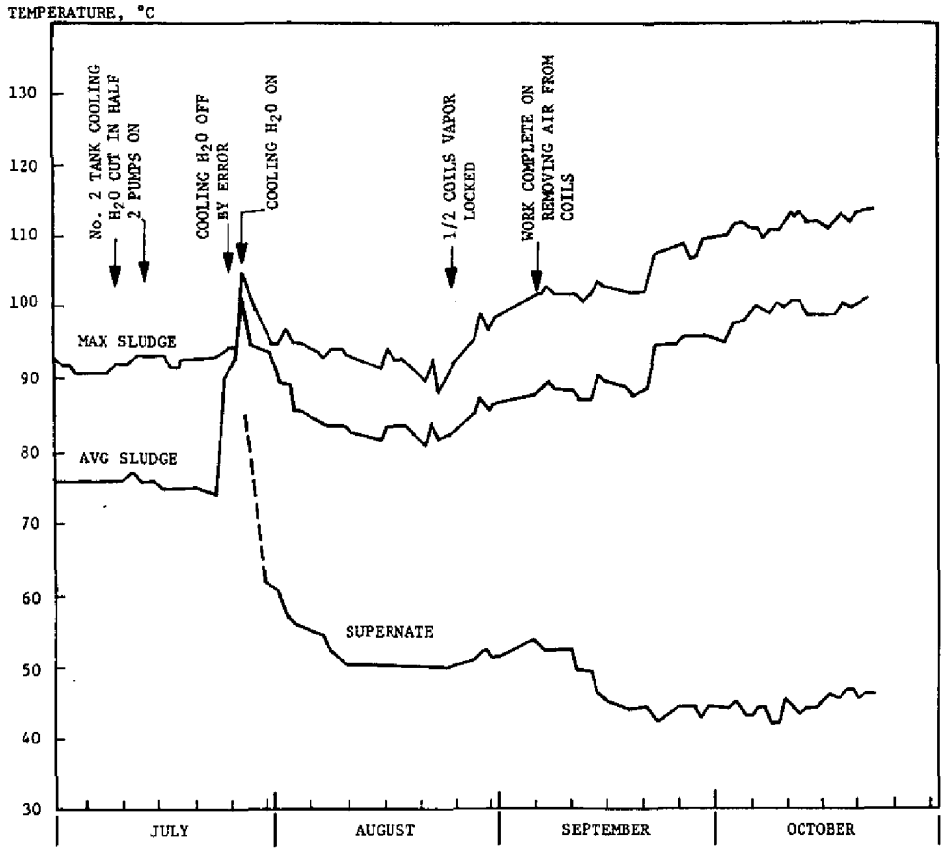

FIGURE 3. TANK 3 TEMPERATURE, 1956

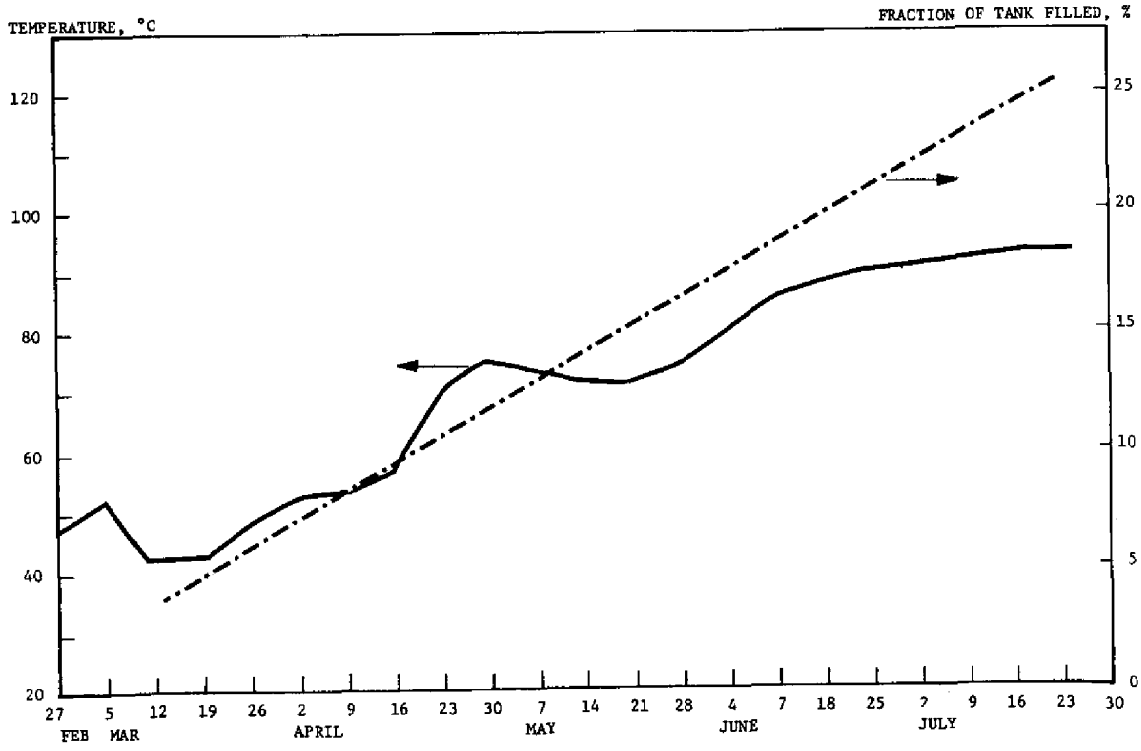

FIGURE 4. TANK 3 SLUDGE TEMPERATURE, 1956

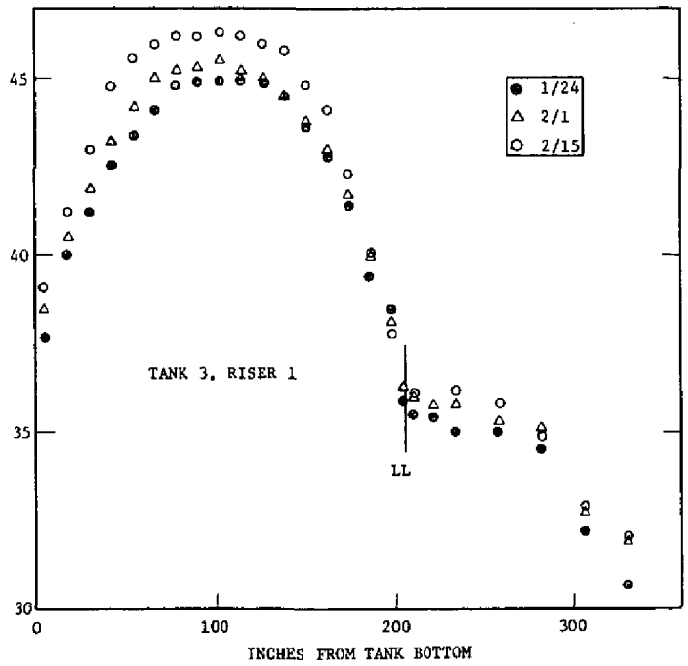

FIGURE 5. TANK 3 TEMPERATURE PROFILES, 1974

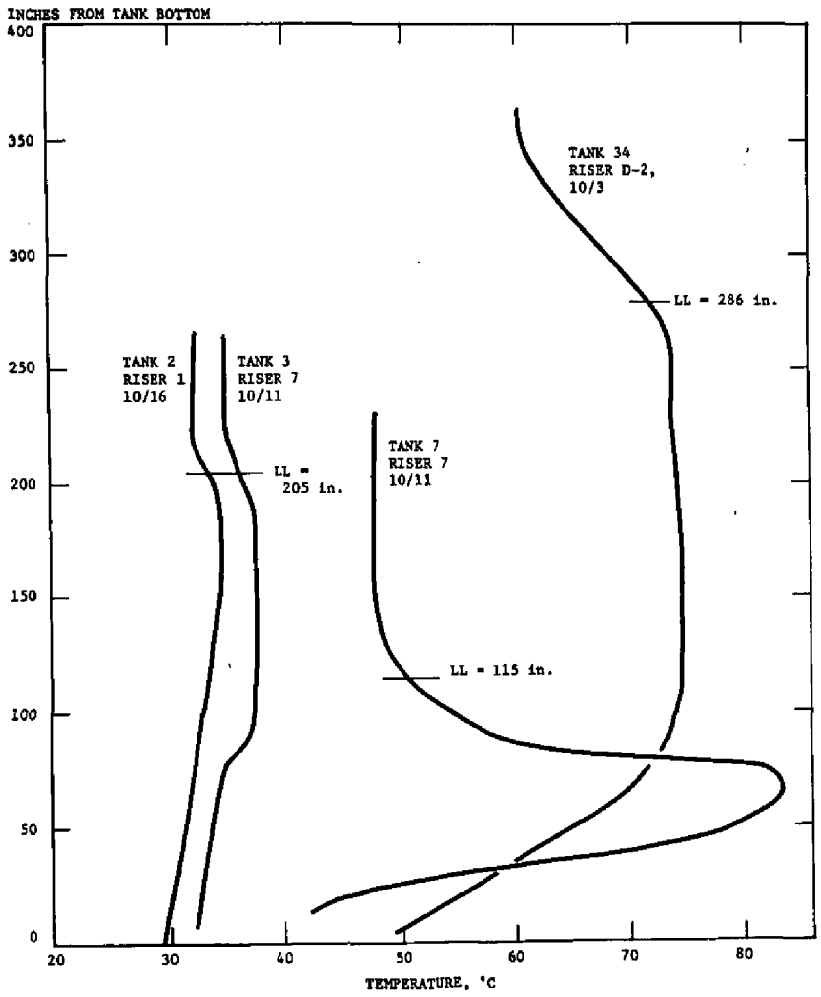

FIGURE 6. TEMPERATURE PROFILES OF F-AREA TANKS, 1973

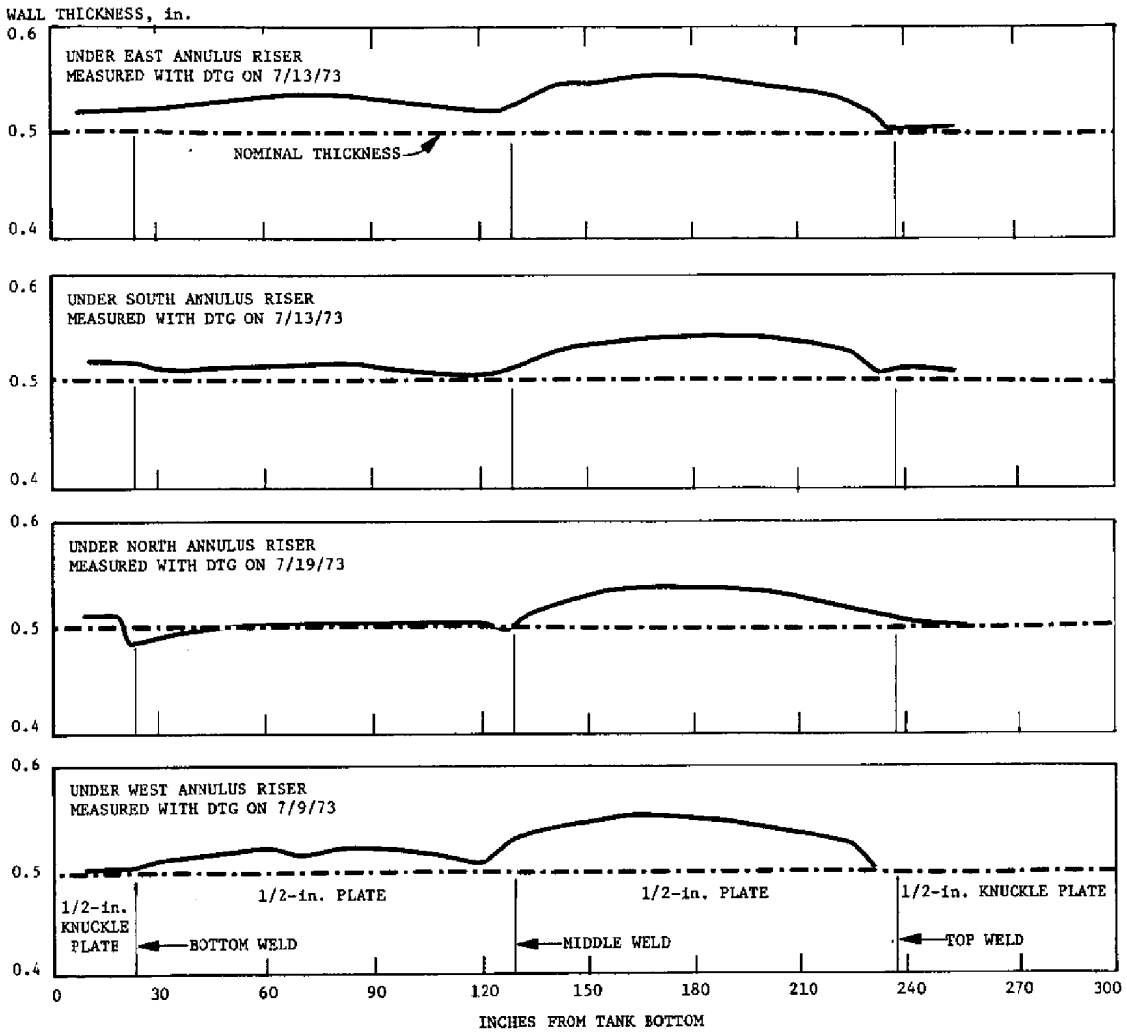

FIGURE 7. TANK 3 WALL THICKNESS MEASUREMENTS

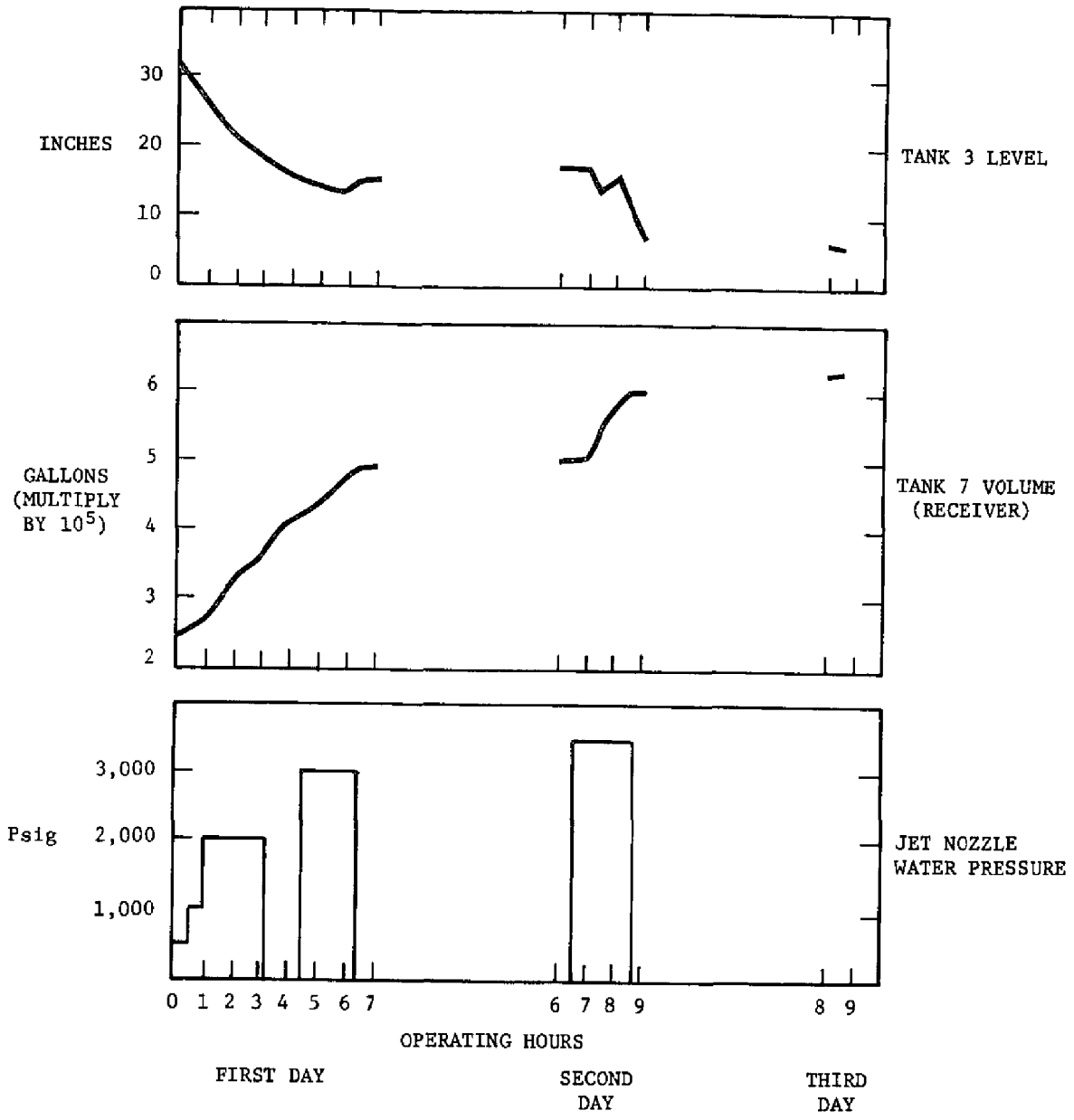

FIGURE 8. SLUDGE REMOVAL, TANK 3, JUNE 4 & 5, 1968

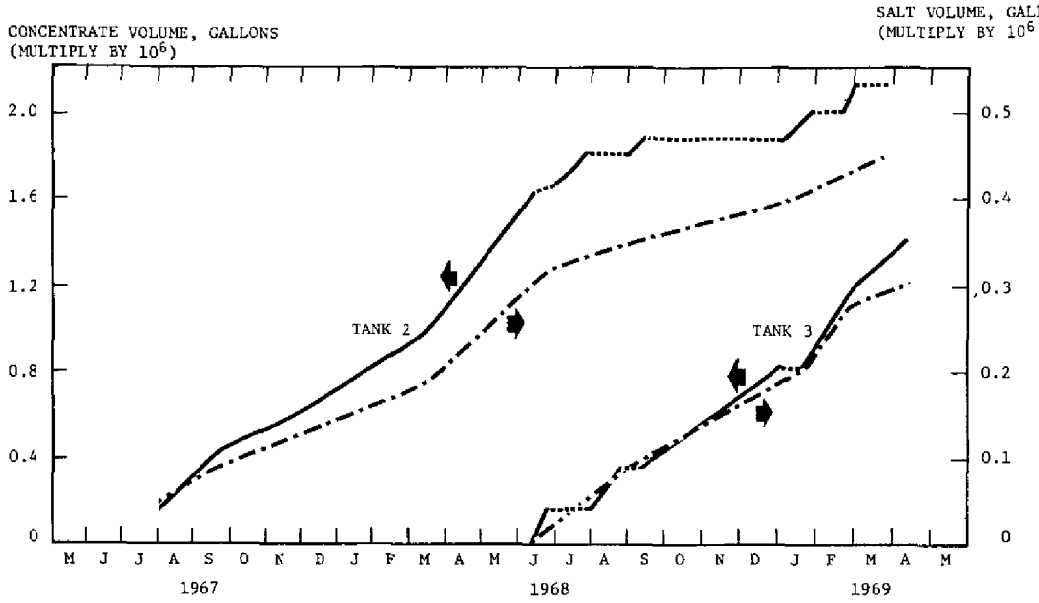

FIGURE 9. SALT ACCUMULATION, TANKS 2 & 3

FIGURE 10. SALT DEPOSITS UNDER THE CONCENTRATE INLET RISER AT TANK 3. Pipes are 2-3/8-in. OD. DPSPF 13177-11, -12.

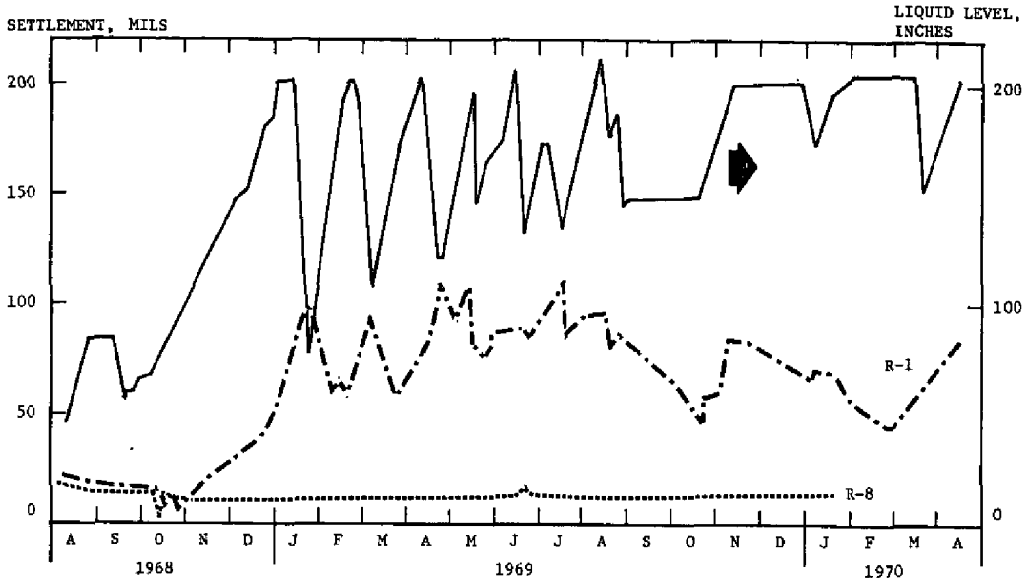

FIGURE 11. TEST COIL SETTLEMENT -- TANK 3 RISERS 1 AND 8

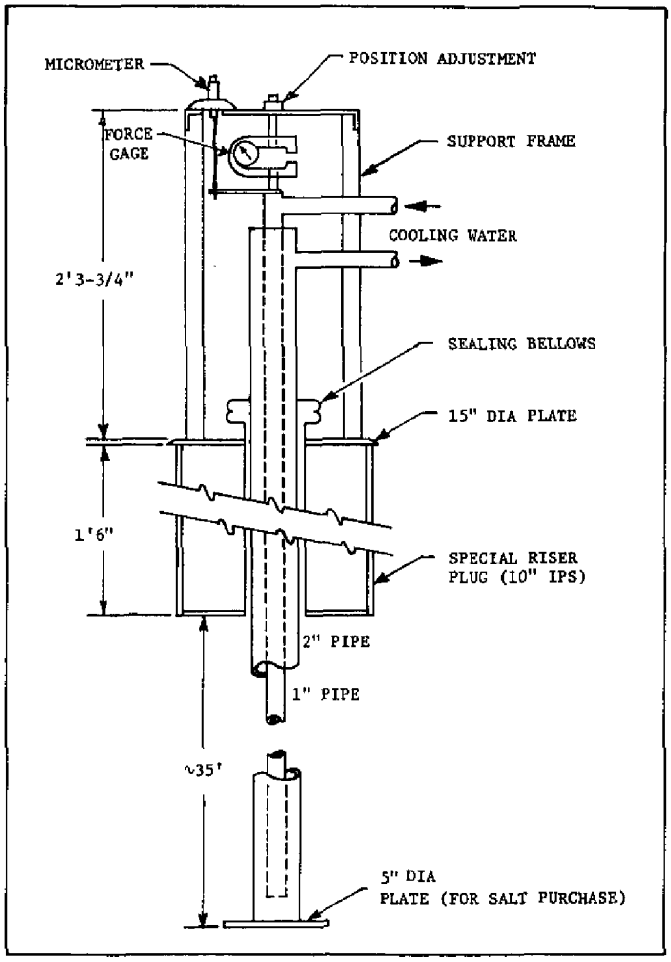

FIGURE 12. SIMULATED VERTICAL COOLING COIL

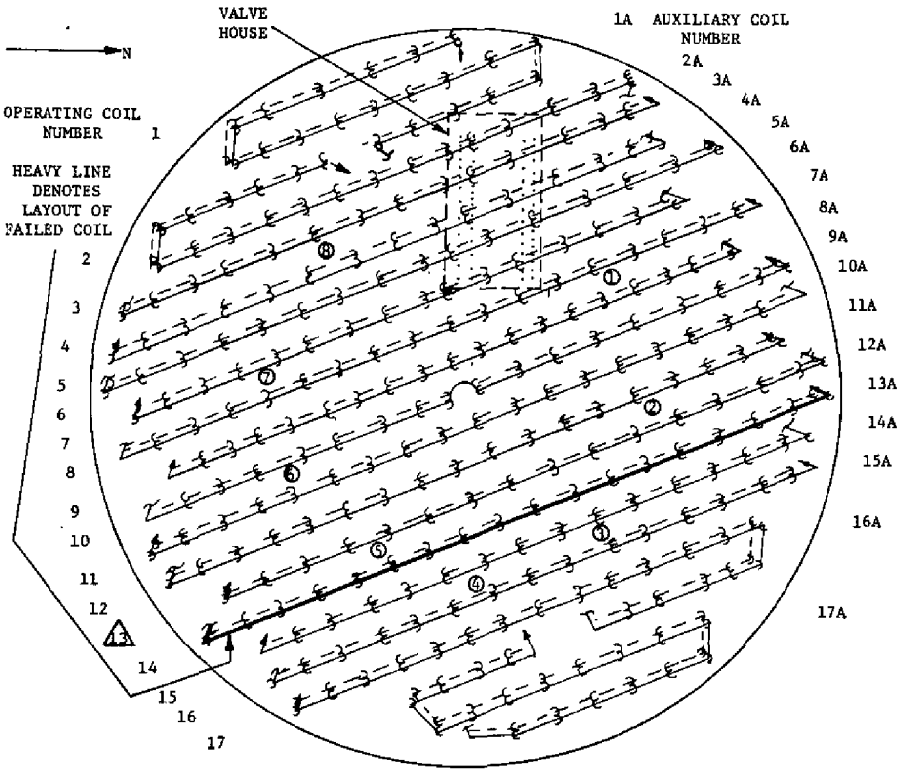

FIGURE 13. TANK 3 VERTICAL COOLING COIL LAYOUT

TABLE I

TANK 3 COLOR PHOTOGRAPHS

Date	Access Riser	Object of Photograph	PRD Number	WMT File Box or Tray	Location Slots
6/13/67	3	Tank interior	12743-1/12743-12	Box 10	100-111
6/6/68	7	Tank interior	12744-1/12744-10	Box 9	141-150
6/6/68	7	Tank interior	12744-11/12744-26	Box 10	1-16
9/6/68	3	Tank interior	12934-1/12934-12	Box 11	17-28
1/21/69	3	Tank interior	13191-1/13191-12	Box 11	104-115
3/3/69	3	Tank interior	13242-1/13242-12	Box 12	66-77
9/23/69	3	Tank interior	13643-1/12643-12	Box 13	61-72
3/20/72	North	Annulus, welds	15742-1/15742-23	Box 19	1-23
5/17/72	South	Annulus, welds	15914-1/15914-25	Box 21	1-25
7/18/72	East	Annulus, welds	16134-1/16134-30	Tray 5	25-54
7/19/72	West	Annulus, welds	16103-1/16103-24	Tray 5	1-24
7/11/73	West	Annulus, welds	17169-1/17169-23	Tray 5	55-77
9/20/73	3	Tank wall, cooling coils, and reel tape	17334-1/17334-13	Tray 5	78-90
10/16/73	West	Annulus, welds	34907-1/34907-27	Tray 46	1-27
5/31/74	5	Interior, salt	18041-1/18041-8	Box 52	60-67
5/31/74	5	Interior, reel tape	18041-9/18041-12	Box 52	68-71

TABLE 2

TANK 3 VAPOR SAMPLE ANALYSES
(March 1957)

Riser	1	3	6
% H_2	0.5	0.1	0.4
% CO_2	6.4	0.1	6.4
% O_2	19.1	18.3	18.9
% N_2	73.1	80.6	73.4

TABLE 3

TANK 3 SOLID AND LIQUID SAMPLE ANALYSES

Date Sample Type	4/57 Supernate	7/25/57 Supernate	11/11/57 Supernate	7/58 Supernate	5/9/63 Supernate	3/70 Salt
Specific gravity	1.23-1.25[a]		1.29	1.18	1.295	2.12
Total salt, wt%	31.8		33.1	34	35.0	96.5
pH				>11	11	
$NaHCO_3$, g/l	31-51[a]	12	0	0		
Na_2CO_3, g/l	9-31[a]	89	106	107		
NaOH g/l	0	0	15.9	12		
U g/l	0.68	.096		0.02		
Na^+ wt%						26.3
Fe^{3+} ppm						<50
NO_3^- wt%					14.8	64.4
NO_2^- wt%						4.9
OH^- wt%					2.3	0.223
CL^- wt%						<0.005
SO_4^{2-} wt%					1.9	<1.0
ALO_2^- wt%					0.09	
CO_3^{2-} wt%					6.0	0.516
PO_4^{3-} wt%						0.013
Gross alpha, d/m/ml	$1.3X10^5$		$2.78X10^4$	$2.05X10^4$		
Pu alpha, d/m/ml	$6.7X10^4$		$6.13X10^3$	$1.5X10^3$	440	
Gross beta, c/m/ml	$1.1X10^9$		$1.25X10^8$	$1.01X10^8$	$9.44X10^7$	$1.17X10^7$
Gross gamma c/m/ml	$6.1X10^8$	$6.9X10^7$	$5.07X10^7$	$4.22X10^7$	$4.68X10^7$	$1.63X10^7$
$^{89-90}Sr$ c/m/ml	$6.7X10^6$		$2.86X10^4$	$2.47X10^4$	$6.2X10^5$ d/m/ml	$4.9X10^5$c/m/ml
$^{95}Nb-^{95}Zr$ c/m/ml	$4.5X10^8$		$1.25X10^6$	$4.85X10^5$	ND	
$^{103-106}Ru$ c/m/ml	$6.7X10^7$		$1.27X10^7$	$4.98X10^6$	$2X10^7$ d/m/ml	
^{106}Ru d/m/ml						$3.8X10^7$
^{134}Cs d/m/ml					$4X10^7$	$1.3X10^7$
^{137}Cs d/m/ml					$2.5X10^9$	$8.3X10^8$
^{144}Ce c/m/ml	$1.5X10^8$		$4.07X10^5$		ND	

[a] Differing values from two separate samples.

TABLE 4

TANK 3 SALT ACCUMULATION, gal

Date	On Walls	On Coils	In Mound	On Bottom	Total
9/6/68	1,200	1,000	600	89,000	92,000
1/21/69				168,000	202,000
2/25/69					274,000
4/11/69					302,000

TABLE 5

TANK 3 EAST ANNULUS RISER RADIATION PROFILE
(1969)

Distance from Annulus Floor, ft	Radiation Intensity, R/hr
27	20
22	200
17	190
12	120
7	120
2	90

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