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HISTORY OF WASTE TANK 21
1961 THROUGH 1974

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INTRODUCTION

Alkaline radioactive wastes resulting from the chemical separation of fission products from plutonium and uranium at 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 21 is a 1,300,000 gallon, uncooled, type IV tank located in H Area and is designated for the storage of low heat waste (Figure 1). It is 85 feet in diameter and 34 feet high. It is constructed of ASTM A-285-54-T Grade B steel with non-stress-relieved welds, and is inside a concrete vault with a domed concrete roof. There are six risers providing access to the tank interior. A leak detection sump is provided for the tank bottom and two leak detection sumps 180° apart provide leak detection for the sidewall.

Events in the history of tank 21 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 Works Technical Report for that month. The period this history covers is from October 1961 through December 1974.

SUMMARY

Tank 21 was placed in service in October 1961 receiving LW from Tank 13. The tank was filled in December 1961 with additional LW from tank 11. Tank 21 has served as the evaporator feed tank since April 4, 1963, when the H-Area evaporator began operation. Tank 21 first received HW in June 1964 and has stored both LW and HW since.

In January 1971 an influx of slightly contaminated water in the bottom leak-detection sump was observed. The tank was inspected with an optical periscope and numerous tests and investigations were conducted but the source of the contaminated water was not determined. However, subsequent to this report period a D_2O tracer test provided conclusive evidence of communication between the tank vapor space and the bottom leak-detection sump. The D_2O tracer tests are documented in DPSPU 76-11-19.

In 1970 loud popping detonations occurred while regasketing the 242-H evaporator feed jumper and smaller detonations occurred underfoot during entry into the feed jet pillbox. Investigation revealed the probable cause was silver nitride. Equipment was flushed with nitric acid to remove residual silver compounds and operating procedures were changed to eliminate addition of silver to waste tanks. No further detonations have occurred.

Inspections of the tank interior were performed by direct observation and photography using a 40-foot optical periscope. Samples of sludge and supernate in the tank and liquid collected in the bottom leak detection sump were analyzed, and numerous temperature profiles were taken. Several equipment modifications and repairs were made.

DISCUSSION

OVERALL CHRONOLOGY

In October 1961, tank 21 was placed in service receiving LW from Tank 13. The tank was then filled in December 1961 with additional LW from tank 11. Tank 21 became the H-Area evaporator feed tank when the evaporator began operating on April 4, 1963. Since June 1964, when tank 21 first received aged HW, the tank has contained mixtures of LW and HW. Table 1 is a tabulation of tank 21 waste transfers showing the dates, sources, volumes, and types of waste.

During re-gasketing of the evaporator feed jumper in March 1970, loud detonations occurred as a gasket retaining ring slid down the dip tube portion of the jumper. In June 1970, similar detonations occurred underfoot in the feed-jet pillbox when it was entered to tighten a leaking feed connector. An investigation revealed that the probable cause was silver nitride. Some waste containing silver had been transferred into tank 21 and into the evaporator shortly before these detonations occurred. Operating procedures were changed to eliminate addition of silver to the waste tanks, and the Building 242-H evaporator was flushed with nitric acid to remove any residual silver compounds. No further detonations have occurred.

In January 1971 an influx of low level radioactivity contaminated water (120-230 c/m/ml) into the bottom leak-detection sump was observed. Inleakage varied from < 1 to 15 gallons per day while the concentration of radioactivity remained fairly constant. Extensive investigations including ground water analyses, tracer tests, correlation with environmental and process data, and process stream diversions failed to identify the source of the contaminated water. However, subsequent to this report period (early in 1976), D_2O tracer tests were conducted in tank 21 by continuously vaporizing D_2O into the vapor space and concurrently analyzing condensate from the vapor space and the liquid from the sump. These tests provided conclusive evidence that there was communication between the tank vapor space and the sump and that this was the source of low level contamination in the sump. The sump liquid has been pumped out periodically since early 1971.

Significant events including those listed below are shown on the tank liquid level plot (figure 2). Sludge and supernate temperatures are also shown in figure 2, along with the liquid level in the bottom leak-detection sump.

Chronology of Events

Oct 1961	Tank 21 was placed in service receiving LW from tank 13.
Dec 1961	Tank 21 was filled to capacity with additional LW from tank 11 transferred via tank 13.
Jun 1962	The condensate return and concentrate lines from the evaporator were cut and blanked off to prevent strain on tank 21 since the evaporator building settled 6 to 8 inches.
	Ground water accumulated in the vermiculite filled space (see figure 1) and surrounding soil. A jet pump was used to remove the water via a side wall leak detection well.
Jul 1962	Elevation measurements indicated that the tank had settled about one inch.
Aug 1962	After pumping the accumulated ground water from the side wall sump, the ground water level appeared to be almost a foot above the tank bottom.
Oct 1962	Construction of a diversion box to facilitate transfer of RBOF waste to either tank 21 or 23 was started.
Nov 1962	The diversion box for transfer of RBOF waste to either tank 21 or 23 was completed.
Jan 1963	The condensate lines from the evaporator to tank 21 were reinstalled with modifications to facilitate backflushing the concentrate line.
	A supernate sample was taken.
	Settlement gages were installed on the tank.
	The absolute elevation and slope of the concentrate line was measured to establish maximum fill level for the tank.

Mar 1963 Settlement gage measurements were taken indicating about 0.1 inch settling per week.

Apr 1963 Settlement gage measurements were taken again. The gages recovered most of the drop measured during March, indicating that the apparent weekly change of about $\pm$ 0.1 inch resulted from measurement errors.

The H-Area evaporator began operation on April 4 with tank 21 serving as the feed tank.

May 1963 Pumpout of ground water from the side wall sump was changed from a continuous to a daily operation. Through May 20, 540 gallons of water were removed from the sump.

The results of a heat dissipation study for uncooled waste tanks, including tank 21, were reported.

A supernate sample was taken.

Jun 1963 To minimize uneven loading around the tank, a sand-clay-water grout was injected to fill the voids left primarily around the upper part of the tank by settling of the vermiculite cushion layer.

Tank 21 began receiving RBOF/RRF waste in lieu of tank 23.

Jul 1963 A thermocouple was installed at the bottom of the center settlement gage.

Corrosion coupons of mild steel were placed in tank 21 to study stress-corrosion cracking.

Nov 1963 Consideration was given to a possible leak path from the H-Area uncooled tanks (21-24) to the Savannah River.

Feb 1964 Pumpout of ground water from the side wall sumps changed from a daily to an intermittent operation.

Apr 1964 Pumpout of the side wall sumps of tanks 21, 23, and 24 continued in order to hold the ground water level around tank 23 at least a foot below the tank liquid level.

Thirteen piezometer wells were installed around tanks 21-24 by the Health Physics Department to determine the flow patterns of ground water around the bases of these tanks.

Jun 1964 HW waste received from tank 15 resulted in a calculated ^{137}Cs activity of 3.8 Ci/gallon in tank 21 which was the highest heat load (77,000 Btu/hr) placed in an uncooled tank to date. A program of monitoring the tanks for leakage, hydrogen buildup, and temperature was initiated.

The reel tape electrical circuit was modified.

Jul 1964 Ground water drawn from the side wall sump, which might be highly contaminated if the tank should leak, was diverted from the storm sewer to the seepage basins.

Aug 1964 Monitoring of tank 21 showed no radioactivity in the ground water drawn from the side wall sumps, no hydrogen accumulation, and temperature measurements in the tank have not exceeded 41°C.

Heat dissipation data showed the apparent rate from tank 21 to be 3300 Btu/(hr)($^{\circ}$C).

Sep 1964 Hydrogen concentration increased to 10% of the lower explosive limit (LEL) on September 4. A Coppus blower was installed and the hydrogen concentration fell below the limit of detectability in less than 24 hours. Blower operation was discontinued after 10 days to obtain more data on the rate of hydrogen buildup.

Oct 1964 RBOF/RRF waste was routed back to tank 23 rather than tank 21 which had been receiving this waste since June 1963.

Hydrogen concentration rose to 5% LEL on October 16. Ventilation with the Coppus blower was resumed and the hydrogen concentration decreased to less than the detectable limit.

Nov 1964 Due to the escape of a small amount of contaminated condensate at the reel tape during operation of the Coppus blower, blower operation was reduced to one hour per day.

Water pumped from the side wall sumps of tanks 21, 22, 23, and 24 was monitored daily and no radioactivity was detected. The pumping reduced the level of perched water around tanks 21 and 23, but was less effective around tanks 22 and 24.

Jan 1965 A supernate sample was taken.

Feb 1965 A summary of the quantity of ground water pumped from the side wall sumps was reported.

May 1965 Data on the ground water levels around tanks 21-24 were reviewed. Water levels in the tank leak detection sumps are shown in figure 3. Piezometer well data are shown in table 2 and the well locations are shown in figure 4.

Jun 1965 An underground transfer line was installed between tanks 21 and 22.

During simultaneous transfers of aged HW supernate from tanks 21 to 22 and 13 to 21, the hydrogen in the vapor space of tanks 21 and 22 rose to 15% and 10% LEL, respectively. Purging the tanks reduced the hydrogen level below 5% LEL and caused the tank 21 reel tape to become contaminated.

A permanent ventilation blower was installed at the vent outlet on tank 22. This blower purges by drawing air from 21 through 22. CWS filters were installed at the air inlet of tank 21 and the outlet of tank 22.

Jul 1965 The permanent ventilation blower was placed in service.

Jan 1966 About 1800 gallons of evaporator overheads were returned to tank 21.

Mar 1966 A temperature profile was taken (Figure 5).

Routine measurements of the liquid level in the bottom leak-detection sump showed rises on February 7 and 28. Samples from the sump showed traces of tritium and ^{137}Cesium.

Apr 1966 Ventilation air flow was reduced through tanks 21 and 22 (series flow) from 200 to 27 cfm. The reduction was to eliminate or reduce the contaminated condensate which was dripping from the blower.

The tank 21 feed jet to the evaporator required unusually high operating steam pressure.

The evaporator was flushed to tank 21.

May 1966 The tank 21 feed jet was checked for a steam leak; no leakage was evident.

About 40,000 gallons of evaporator condensate were sent to tank 21.

Aug 1966 The tank bottom thermocouple was relocated to about 100 inches above the bottom.

About 15,000 gallons of cesium removal column (CRC) effluent that exceeded the gamma limit for release to the seepage basins were sent to tank 21.

The specific gravity of the supernate measured 1.36.

A temperature profile was taken (figure 6).

Jan 1967 The evaporator feed jet in tank 21 was tested to determine its maximum delivery rate.

Jun 1967 Temperature profiles were taken before and after receipt of supernate from tank 24 (figure 7). The measurements indicated almost complete mixing of the more dense solution with the supernate in tank 21.

Jul 1967 Temperature and specific gravity profiles were taken periodically after a transfer of supernate from tank 13 (figure 8). The profiles indicate incomplete mixing when the less dense solution was received on the supernate in tank 21.

Mar 1968 Liquid leaked into the pipe jacket of the evaporator feed jet destroying the jacket's insulating quality thereby reducing jet efficiency.

Jan 1969 An unknown quantity of sludge was moved to tank 21 when 362,000 gallons of sludge removal water were transferred from tank 14 to tank 21 via tank 13.

Feb 1969 A transfer was initiated from tank 12 to 21 but it was stopped because sludge was being transferred.

Apr 1969 RBOF/RRF waste too high in radioactivity to feed to the CRC was routed to tank 21.

May 1969 The reel tape failed due to a faulty relay.

A smoke test indicated little or no air flow through the ventilation inlet filter.

Jun 1969 "Freon" tracer was used to verify that the uncooled tanks (21-24) were being adequately ventilated.

Nitric acid used to clean the CRC was neutralized and sent to tank 21.

Aug 1969 A jumper change was made on the evaporator to permit concentrated supernate from the evaporator to be recycled directly to tank 21.

Oct 1969	Concentrated supernate from the evaporator was recycled to tank 21.
Nov 1969	A specific gravity profile was taken (figure 9).
	The temperature of tank 21 increased between October 9 and November 14 due to recycle of hot concentrated supernate from the evaporator.
	About 161,000 gallons of sludge removal waste from tank 14 was received via tank 13.
Dec 1969	Temperature profiles were reported (figure 10).
	A reel tape of a new design was installed in the north riser.
	The evaporator feed jet would not start.
Jan 1970	The evaporator feed jet started after several unsuccessful attempts.
	Supernate samples were taken.
	Temperature profiles were reported (figure 11).
	About 9,800 gallons of RBOF/RRF waste was sent to tank 21 because of high cesium activity.
Feb 1970	The evaporator feed jet was replaced by a new jet with a flexible suction hose.
Apr 1970	An investigation was initiated to determine the cause and potential hazards of loud popping detonations which occurred during the 242-H evaporator feed jumper removal, regasketing, and reinstallation.

Jun 1970 RBOF/RRF waste was temporarily diverted from tank 23 to tank 21.

Samples of solids associated with detonations in the evaporator feed jumper were taken for analyses. The results are shown in table 3.

Jul 1970 Analyses of samples of solids from the tank 21 feed jet pillbox, that were taken to investigate small detonations occurring there, are shown in table 4.

The reel tape failed.

Aug 1970 Investigation revealed that about 120 pounds of silver was transferred into tank 13 recently during acid flushes of the Building 221-H iodine reactor. The flushes occurred between November 10, 1969, and May 13, 1970. Transfers of waste from tank 13 to 21 were made during November, December, and January. The first detonation was observed on January 29 in the evaporator feed jet pillbox. Analyses of additional samples from the pillbox are shown in table 5.

Sep 1970 Samples of tank 21 supernate and Building 242-H evaporator overheads were analyzed for Hg, Ag, and Pb (table 6); concentrations in the feed are far less than in the solids taken from the tank 21 pillbox.

A valved jumper was installed in diversion box 3 to facilitate diverting high activity RBOF/RRF waste to tank 21 and waste suitable for direct CRC processing to tank 23.

Nov 1970 A reel tape of a new design was installed.

Jan 1971 The liquid level in the bottom leak detection sump rose from 42 inches on November 30 to 122 inches on January 13. Samples taken from the bottom sump showed low levels of $^{134,137}Cs$ activity. The source of the water and activity was undetermined.

Feb 1971 The liquid collecting in the bottom leak detection sump was accumulated until it approached an equilibrium level which was compared with the liquid level in the tank and side wall sump to check for communication with these liquid sources. The level stabilized at 138 inches which was 154 inches below the liquid level inside the tank and 70 inches above the side wall sump liquid level.

Radioactivity in the bottom sump water remained nearly constant at 1200-1500 d/m/ml ^{137}Cs.

Mar 1971 Water accumulated in the bottom leak detection sump at a rate of 36 gallons per day. On March 25 the ^{137}Cs concentration was 1600 d/m/ml and the pH of the water was 11.8.

Apr 1971 Supernate samples were taken.

Efforts to determine the source of water to the bottom leak detection sump were unsuccessful. Evidence generally supports the premise that condensate from the underside of the tank roof is reaching the sump.

May 1971 Chemical analyses, attempted correlation of sump-water collection rate and activity history with operation, and a heavy-water-tracer test failed to identify the source of contaminated water collecting in the bottom leak detection sump.

The impeller of the bottom sump pump failed and was replaced.

Jun 1971 Contaminated water was being pumped from the bottom leak detection sump daily. The influx rate decreased.

Jul 1971 Contaminated water was pumped from the bottom leak detection sump daily.

Aug 1971 The source of contaminated water being pumped daily from the bottom leak detection sump remained unknown.

The evaporator feed line was blanked at the tank 21 pillbox to prevent siphoning during flushing of the failed evaporator.

Sep 1971 Daily pumpout of the bottom leak detection sump continued. Cumulative radioactivity removed totals about 0.008 Ci.

Oct 1971 Daily pumpout of the bottom leak detection sump continued.

Nov 1971 Daily pumpout of the bottom leak detection sump continued.

Dec 1971 Daily pumpout of the bottom leak detection sump continued.

Periscopic inspection and photography of the tank interior below the northeast riser revealed no significant rusting of the steel (figure 12) and no degradation of the concrete roof (figure 13).

Jan 1972 Periscopic inspection and photography of the tank interior below the southwest riser showed the tank was in good condition.

Contaminated water was pumped from the bottom leak detection sump at irregular intervals.

The evaporator feed jet was backflushed with water.

Feb 1972 Contaminated water was pumped from the bottom leak detection sump at irregular intervals.

Mar 1972 Pumpout of the bottom leak detection sump was stopped on March 5 to observe the sump level change.

Apr 1972 Water was not pumped from the bottom leak detection sump to allow the sump liquid level to stabilize; it fluctuated between 35 and 41 inches.

May 1972 The liquid level in the bottom leak detection sump varied between 26 and 36 inches. The sump was sampled; the pH and radioactivity level remain essentially unchanged.

Two 10 ml supernate samples were taken for Savannah River Laboratory (SRL).

Aug 1972 Three [illegible] ml supernate samples were taken for SRL.

The influx rate of contaminated water into the bottom leak detection sump, in a test conducted from June through December 1971, was found to correlate best with the volume of water discharged to seepage basins from Building 242-H condensate hold tanks (figure 14). A test program, bypassing (in the vicinity of tank 21) that portion of the sewer line through which the condensate is discharged to the seepage basins, was planned to establish if water could be reaching tank 21 bottom leak detection sump from leaks in the sewer line.

Sep 1972 Installation was started of a plastic line to bypass the suspected leaking section of the seepage basin sewer from Building 242-H.

Temperature profiles were taken (figure 15).

Oct 1972 The sludge level measured 28 inches under the southwest riser.

Temperature profiles were taken (figure 16).

Daily pumpout of the bottom leak detection sump was resumed to establish a base period influx rate before bypassing the seepage basin sewer from Building 242-H.

Nov 1972 The seepage basin sewer from Building 242-H suspected of leaking was bypassed on November 7. The rate of water influx and the ^{137}Cs concentrations remain essentially unchanged.

Temperature profiles were taken (figure 17).

Jan 1973 The test failed to confirm that leakage from the seepage basin sewer was the source of contaminated water entering tank 21 bottom leak detection sump. Figure 18 shows sump pumpout rates during the test.

Mar 1973 A second test was initiated bypassing that portion of the seepage basin line suspected of leaking to check the effect on water influx to tank 21 bottom leak detection sump.

Samples of CRC effluent and the bottom leak detection sump water both showed 0.10 μCi ^{3}H/ml but the fission products present did not correspond.

Apr 1973 The second test confirmed that the seepage basin sewer was not a likely source of water to the tank 21 bottom leak detection sump (figure 19).

Steel thickness measurements were made under the northeast riser. Five measurements obtained from a small area averaged 0.392 inch.

May 1973 Spectrochemical analyses of samples taken April 13 of the sump water, the evaporator overheads, the CRC effluent, and the perched and regional ground water were reported (tables 7 & 8). No conclusions as to the source of contaminated water in the sumps could be drawn from these data.

Drilling was begun for twelve additional piezometer wells around the uncooled tanks (21-24) for hydrology studies.

Jun 1973 The twelve new wells around the uncooled tanks (21-24) were completed.

Pumpout of the bottom leak detection sump was resumed on a semiweekly basis.

The evaporator feed jet was replaced with a feed pump.

Jul 1973 Semiweekly pumpout of the bottom leak detection sump continued.

The evaporator feed pump was replaced due to a leaking seal.

Aug 1973 Water influx to the bottom leak detection sump continued at a rate of 0.05 to 2 gallons per week.

The evaporator feed pump was replaced due to a leaking seal.

Sep 1973 The water influx to the bottom leak detection sump continued at a rate of less than a gallon per week. Based on available data, condensate from the tank roof was believed to be the source of the water.

The evaporator feed pump was replaced due to a leaking seal.

Oct 1973 Water influx to the bottom leak detection sump continued at a very low rate.

Nov 1973 A new correction factor was determined for the reel tape.

Water influx to the bottom leak detection sump continued at a very low rate. Weekly determinations of ^{3}H, ^{134}Cs, and ^{137}Cs concentration were initiated for evaporator overheads and water from the bottom leak detection sump to gain a better knowledge of tank waste, tank vapor, and sump relationship.

Dec 1973 Water influx to the bottom leak detection sump continued at a very low rate.

The evaporator feed pump was replaced due to a leaking seal.

Feb 1974 The evaporator feed pump was replaced due to packing failure.

Mar 1974 The evaporator feed pump was replaced on March 6, 14, and 20 due to motor failures.

May 1974 The evaporator feed pump was replaced due to motor failure.

A sonic probe was installed in the feed-pump pillbox to serve as a high-level leak detection alarm.

Jun 1974 The evaporator feed pump was replaced due to a motor failure.

Jul 1974 A Food Instrument Co. reel tape was installed and tank levels are now recorded in the 242-H control room.

Aug 1974 The evaporator feed pump was replaced due to a motor failure.

Sep 1974 The evaporator feed pump was replaced due to packing failure.

Oct 1974 The evaporator feed pump was replaced due to a packing failure.

A temperature profile was taken (figure 20); the supernate was 98°C.

Dec 1974 The evaporator feed pump was replaced twice due to packing and motor failures.

Periscopic inspection and photography of the tank interior below the southwest riser showed the tank was in good condition.

A temperature profile was taken (figure 21).

CONTAMINATED WATER IN THE BOTTOM SUMP

The first influx of water to the bottom leak detection sump was on February 7 and 8, 1966, when the liquid level increased to about 9 and 21 inches, respectively. The sump liquid level had previously not exceeded a few inches. Samples from the sump revealed beta-gamma activity was 20-35% above background. The water analyzed 1.9×10^{-7} Ci/ml of tritum and 2×10^{-11} Ci/ml of ^{137}Cesium. An earlier sample from the side wall sump of tank 21 also showed tritium. The tritium and cesium activity apparently migrated from the vicinity of tank 23, where tritiated water was introduced into the side wall sump (under TA 2-550) to study the hydrology around the elevated, uncooled tanks 21-24. On March 10, 1966, about 30 gallons of muddy water was pumped from the bottom sump, dropping the level to zero. The level then remained relatively low until November 1970.

The liquid level in the bottom leak detection sump rose from 42 inches November 30, 1970, to 122 inches on January 13, 1971. Radioactivity in the water removed from the sump ranged from 120 to 230 c/m/ml gross beta-gamma, and 1000 to 1500 d/m/ml ^{137}Cesium with about 200 d/m/ml ^{134}Cesium. Samples of the perched water taken from the side wall sumps of all four uncooled tanks (21-24) showed no radioactivity. Extensive investigations conducted during this report period failed to identify the source of the radioactivity contaminated water. However, D_2O tracer tests performed in 1976 established that condensate from the tank vapor space was the source of low level contamination in the bottom leak detection sump.

Chronology of Events Related to Contaminated Water in the Bottom Sump

Mar 1966 — Routine measurements of the liquid level in the bottom leak detection sump showed rises on February 7 and 28.

Samples from the sump showed traces of tritium and ^{137}Cesium.

Jan 1971 — The liquid level in the bottom leak detection sump rose from 42 inches on November 30 to 122 inches on January 13. Samples taken from the bottom sump showed low levels of ^{134,137}Cs activity. The source of the water and radioactivity was undetermined.

Feb 1971 The liquid collecting in the bottom leak detection sump was accumulated until it approached an equilibrium level which was compared with the liquid level in the tank and side wall sump to check for communication with these liquid sources. The liquid stabilized at 138 inches which was 154 inches below the liquid level inside the tank and 70 inches above the side wall sump liquid level. Radioactivity in the bottom sump water remained nearly constant at about 1200-1500 d/m/ml ^{137}Cs.

Mar 1971 Water accumulated in the bottom leak detection sump at a rate of 36 gallons per day. On March 25 the ^{137}Cs concentration was 1600 d/m/ml and the pH was 11.8.

Apr 1971 Efforts to determine the source of water to the bottom leak detection sump were unsuccessful. Evidence generally supports the premise that condensate from the underside of the tank roof is reaching the sump.

May 1971 Chemical analyses, attempted correlation of sump water collection rate and activity history with operation, and a heavy water tracer test failed to identify the source of contaminated water collecting in the bottom leak detection sump.

Jun 1971 Contaminated water was being pumped from the bottom leak detection sump daily. The influx rate decreased.

Sep 1971 Daily pumpout of the bottom leak detection sump continued. Cumulative radioactivity removed totals about 0.008 Ci.

Jan 1972 Contaminated water was pumped from the bottom leak detection sump at irregular intervals.

Mar 1972 Pumpout of the bottom leak detection sump was stopped on March 5 to observe the sump level change.

Apr 1972 Water was not pumped from the bottom leak detection sump to allow the sump liquid level to stabilize; it fluctuated between 35 and 41 inches.

May 1972 The liquid level in the bottom leak detection sump varied between 26 and 36 inches. The sump was sampled; the pH and radioactivity level remain essentially unchanged.

Jun 1972 The influx rate of contaminated water into the bottom leak detection sump, in test conducted from June through December 1971, was found to correlate best with the volume of water discharged to seepage basins from Building 242-H condensate hold tanks (figure 14). A test program, bypassing (in the vicinity of tank 21) that portion of the sewer line through which the condensate is discharged to the seepage basins, was planned to establish if water could be reaching tank 21 bottom leak detection sump from leaks in the sewer line.

Sep 1972 Installation was started of a plastic line to bypass the suspected leaking section of the seepage basin sewer from Building 242-H.

Oct 1972 Daily pumpout of the bottom leak detection sump was resumed to establish a base period influx rate before bypassing the seepage basin sewer from Building 242-H.

Nov 1972 The seepage basin sewer from Building 242-H suspected of leaking was bypassed on November 7. The rate of water influx and the ^{137}Cs concentration remain essentially unchanged.

Jan 1973 Test failed to confirm that leakage from the seepage basin sewer was the source of contaminated water entering tank 21 bottom leak detection sump. Figure 18 shows sump pumpout rates during the test.

Mar 1973 A second test was initiated to show correspondence between water released to the seepage basin sewer and the water influx to tank 21 bottom leak detection sump.

Samples of CRC effluent and the bottom leak detection sump water both showed 0.10 μCi ^{3}H/ml but the fission products present did not correspond.

Apr 1973 The second test confirmed that the seepage basin sewer was not a likely source of water to the tank 21 bottom leak detection sump (figure 19).

May 1973 Spectrochemical analyses of samples taken April 13 of the sump water, the evaporator overheads, the CRC effluent, and the perched and regional ground water were reported (Tables 7 & 8). No conclusions as to the source of contaminated water in the sump could be drawn from these data.

Drilling was begun for twelve additional piezometer wells and core holes around the uncooled tanks (21-24) for hydrology studies.

Jun 1973 The twelve new wells around the uncooled tanks (21-24) were completed.

Pumpout of the bottom leak detection sump was resumed on a semi-weekly basis.

Aug 1973 Water influx to the bottom leak detection sump continues at a rate of up to 2 gallons per week.

Sep 1973 The water influx to the bottom leak detection sump continued at a rate of less than a gallon per week. Based on available data, condensate from the tank roof was believed to be the source of the contaminated water.

Oct 1973 Water influx to the bottom leak detection sump continued at a very low rate.

Nov 1973 Water influx to the bottom leak detection sump continued at a very low rate. Weekly determinations of ^{3}H, ^{134}Cs, and ^{137}Cs concentration were initiated for evaporator overheads and water from the bottom leak detection sump to gain a better knowledge of tank waste, tank vapor, and sump relationship.

Dec 1973 Water influx to the bottom leak detection sump continued at a very low rate.

INSPECTION OF TANK INTERIOR

The interior of tank 21 was inspected by direct observation and photography using a 40-ft-long periscope through access risers in the roof. Periscopic inspections were made in 1971, 1972, and 1974 and showed the tank interior to be in good condition. All inspections are shown in figure 2. Color transparencies available are listed in table 9.

Chronology of Events Related to Inspection

Dec 1971 Periscopic inspection and photography of the tank interior below the northeast riser revealed no significant rusting of steel (figure 12) and no degradation of the concrete roof (figure 13).

Jan 1972 Periscopic inspection and photography of the tank interior below the southwest riser showed the tank was in good condition.

Dec 1974 Periscopic inspections and photography of the tank interior below the southwest riser showed the tank was in good condition.

SAMPLES

Tank contents were sampled several times between January 1963 and June 1972 to characterize the wastes. In 1970, samples of solids from the evaporator feed jumper and the feed jet pillbox that detonated upon impact were analyzed. After radioactively contaminated water began accumulating in the bottom leak detection sump in January 1971, numerous samples were taken and analyzed from the bottom leak detection sump, side wall sump, tank vapor space, other process points, and regional ground water in an effort to identify the source of water collecting in the bottom sump. All samplings are indicated on figure 2 and analytical results are summarized in table 10 or as noted below.

Chronology of Events Related to Sampling

Jan 1963	A supernate sample was taken (table 10).
May 1963	A supernate sample was taken (table 10).
Sep 1964	Hydrogen concentration increased to 10% LEL. Installation of a purge blower reduced the concentration to below the detectable limit.
Oct 1964	With operation of the purge blower discontinued, hydrogen concentration increased to 5% LEL.
Nov 1964	Water pumped from the side wall sump showed no radioactivity.
Jan 1965	A supernate sample was taken (table 10).
Jun 1965	During transfer of HW supernate without tank purge, the hydrogen concentration increased to 15% LEL.
Mar 1966	Samples from the bottom leak detection sump showed traces of tritium and ^{137}Cesium.
Jan 1970	Supernate samples were taken (table 10).

Jun 1970 Samples of solids associated with detonations in the evaporator feed jumper were taken (table 3).

Jul 1970 Samples of solids associated with detonations in the tank 21 feed jet pillbox were taken (table 4).

Aug 1970 Analyses of additional samples taken from the feed jet pillbox are shown in table 5.

Sep 1970 Samples of tank 21 supernate and Building 242-H evaporator overheads were analyzed for Hg, Ag, and Pb (table 6).

Jan 1971 Samples taken from the bottom leak detection sump showed low levels of $^{134,137}Cs$.

Feb 1971 Samples taken from the bottom leak detection sump showed 1200-1500 d/m/ml ^{137}Cs.

Mar 1971 Samples taken from the bottom leak detection sump showed the pH was 11.8 and the ^{137}Cs concentration was 1600 d/m/ml.

Apr 1971 Supernate samples were taken (table 10).

May 1971 Chemical analyses were made of bottom leak detection sump water but failed to identify possible source of the water.

May 1972 Samples taken from the bottom leak detection sump showed the pH and radioactivity level remained unchanged.

Two 10 ml supernate samples were taken for SRL.

Jun 1972 Three 12 ml supernate samples were taken for SRL.

Nov 1972 Samples taken from the bottom leak detection sump show the ^{137}Cs concentration remained unchanged.

Mar 1973 Samples of CRC effluent and the bottom leak detection sump water both showed 0.10 μCi ^3H/ml but the fission products present did not correspond.

May 1973 Samples were taken April 13 of the sump water, the evaporator overheads, the CRC effluent, and the perched and regional ground water for spectrochemical analyses (tables 7 & 8) in an attempt to identify the source of contaminated water to the bottom leak detection sump.

Nov 1973 Weekly determination of ^3H, ^{134}Cs, and ^{137}Cs concentrations in evaporator overheads and water from the bottom leak detection sump were made to gain better knowledge of tank waste, tank vapor, and bottom sump relationship.

PHYSICAL MEASUREMENTS

Numerous vertical temperature profiles were obtained by lowering a thermocouple incrementally into existing thermowells. Elevation measurements detected that the tank settled about one inch in 1962. Several elevation measurements made during 1963 revealed that settlement of the tank had essentially stopped. Numerous specific gravity measurements were made of the supernate. The sludge level was measured in October 1972. Steel thickness measurements were made in 1973 with an ultrasonic transducer positioned on the tank bottom using a 45-ft-long probe through an access port. Five measurements obtained under the northeast riser averaged 0.392 inch (nominal thickness 0.375 inch). These and other entries are shown in figure 2.

Chronology of Events Related to Physical Measurements

Jul 1962 Elevation measurements indicated that the tank had settled about one inch.

Mar 1963 Settlement gage measurements were taken indicating about 0.1 inch settling per week.

Apr 1963 Settlement gage measurements were taken again. The gages recovered most of the drop measured during March, indicating that the apparent week-to-week change of about ± 0.1 inch resulted from measurement errors.

Mar	1966	A temperature profile was taken (figure 5).
Aug	1966	The specific gravity of the supernate measured 1.36.
		A temperature profile was taken (figure 6).
Jun	1967	Temperature profiles were taken (figure 7).
Jul	1967	Temperature and specific gravity profiles were taken (figure 8).
Nov	1969	A specific gravity profile was taken (figure 9).
Dec	1969	Temperature profiles were reported (figure 10).
Jan	1970	Temperature profiles were reported (figure 11).
Sep	1972	Temperature profiles were taken (figure 15).
Oct	1972	The sludge level measured 28 inches under the southwest riser.
		Temperature profiles were taken (figure 16).
Nov	1972	Temperature profiles were taken (figure 17).
Apr	1973	Steel thickness measurements were made under the northeast riser. Five measurements obtained from a small area averaged 0.392 inch.
Oct	1974	A temperature profile was taken (figure 20).
Dec	1974	A temperature profile was taken (figure 21).

Mar 1973 Samples of CRC effluent and the bottom leak detection sump water both showed 0.10 µCi ^{3}H/ml but the fission products present did not correspond.

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Nov 1972 Temperature profiles were taken (figure 17).

Apr 1973 Steel thickness measurements were made under the northeast riser. Five measurements obtained from a small area averaged 0.392 inch.

Oct 1974 A temperature profile was taken (figure 20).

Dec 1974 A temperature profile was taken (figure 21).

TESTS CONDUCTED

Studies were made of heat dissipation from uncooled tanks. The apparent rate from tank 21 in August 1964 was 3300 Btu/(hr)(^{o}C). In July 1963, steel specimens were placed in tank 21 to study stress corrosion. In April 1964 and May 1973 piezometer wells were drilled to study hydrology around tanks 21-24. In January 1973 and May 1973 tests were conducted that bypassed a portion of the seepage basin sewer from Building 242-H that was suspected of leaking. Sewer leaks were suspected to be the source of radioactively contaminated water collecting in the tank 21 bottom leak detection sump. The tests established that the sewer was not the source of inleakage to the tank 21 bottom sump. These entries are shown in figure 2.

Chronology of Events Related to Tests Conducted

May 1963 The results of a heat dissipation study for uncooled waste tanks, including tank 21, were reported.

Jul 1963 Corrosion coupons of mild steel were placed in tank 21 to study stress-corrosion cracking.

Apr 1964 Thirteen piezometer wells were drilled around tanks 21-24 by Health Physics Department to determine the flow patterns of ground water around the bases of these tanks.

Aug 1964 Heat dissipation data showed the apparent rate from tank 21 to be 3300 Btu/(hr)(^{o}C).

May 1969 A smoke test indicated inadequate airflow through the ventilation inlet filter.

Jun 1969 "Freon" tracer was used to verify that the uncooled tanks (21-24) were being adequately ventilated.

Jan 1973 A portion of the seepage basin sewer from Building 242-H suspected of leaking water that might be the source of radioactive water accumulating in the bottom leak detection sump of tank 21 was bypassed. The test failed to confirm that the sewer was the source of water entering the sump (figure 18).

Mar 1973 A second test was conducted bypassing that portion of the seepage basin line suspected of leaking and revealed that it had no effect on the influx of water to the bottom leak detection sump (figure 19).

May 1973 Twelve additional piezometer wells were drilled around the uncooled tanks (21-24) for hydrology studies.

EQUIPMENT MODIFICATION AND REPAIRS

The condensate return and concentrate lines to the evaporator were cut and blanked in June 1962 to prevent strain on tank 21 when it was discovered that the evaporator building, 242-H, had settled. The lines were reinstalled in January 1963 with a modification to facilitate backflushing the concentrate line. In June 1963, grout was injected into voids around the upper part of the tank created by settling of the vermiculite cushion layer. The voids were filled to prevent uneven loading around the tank. The reel tape was modified June 1964 then replaced with reel tapes of new designs in December 1969, November 1970, and July 1974. A Coppus blower provided temporary tank ventilation from September 1964 until June 1965 when a permanent ventilation blower and filters were installed. The failed evaporator feed jet was replaced with a new jet in February 1970, and that jet was replaced by a feed pump in January 1973. Numerous repairs and replacements of the feed pump were made. These and other equipment modifications and repairs are noted on figure 2.

Chronology of Events Related to Equipment Modification and Repairs

Jun 1962 The condensate return and concentrate lines to the evaporator were cut and blanked to prevent strain on tank 21 since the evaporator building settled.

Jan 1963 Lines from the evaporator were reinstalled with modification to facilitate backflushing the concentrate line.

Settlement gages were installed on the tank.

Jun 1963 To minimize uneven loading around the tank, a sand-clay-water grout was injected to fill the voids left primarily around the upper part of the tank by settling of the vermiculite cushion layer.

Jul 1963 A thermocouple was installed at the bottom of the center settlement gage.

Jun 1964 The reel tape electrical circuit was modified to reduce current and prevent spark energy that could theoretically be generated in the tank to ignite a hydrogen-air mixture.

Sep 1964 A Coppus blower was installed to purge hydrogen from the tank.

Jun 1965 An underground transfer line of carbon steel encased in carbon steel was installed between tanks 21 and 22.

A permanent ventilation blower was installed on tank 22. This blower purges by drawing air from 21 through 22. Filters were installed at the air inlet of tank 21 and the outlet of tank 22.

Aug 1966 The tank bottom thermocouple was relocated to about 100 inches above the tank bottom.

Aug 1969 A jumper change was made on the evaporator to permit concentrated supernate from the evaporator to be recycled directly to tank 21.

Dec 1969 A reel tape of a new design was installed.

Feb 1970 The evaporator feed jet was replaced by a new jet with a flexible suction hose.

Sep 1970 A valved jumper was installed in diversion box 3 to facilitate diverting high activity RBOF/RRF waste to tank 21 and waste suitable for direct CRC processing to tank 23.

Nov 1970 A reel tape of a new design was installed.

Aug 1971 The evaporator feed line was blanked at tank 21 pillbox to prevent siphoning during flushing of the failed evaporator.

Jan 1973 The evaporator feed jet was replaced with a pump.

Jul 1973 The evaporator feed pump was replaced due to a leaking seal.

Aug 1973 The evaporator feed pump was replaced due to a leaking seal.

Sep 1973 The evaporator feed pump was replaced due to a leaking seal.

Dec 1973 The evaporator feed pump was replaced due to a leaking seal.

Feb 1974 The evaporator feed pump was replaced due to a packing failure.

Mar 1974 The evaporator feed pump was replaced on March 6, 14, and 20 due to motor failures.

May 1974 The evaporator feed pump was replaced due to a motor failure.

A sonic probe was installed in the feed pump pillbox to serve as a high level leak detection alarm.

Jun 1974 The evaporator feed pump was replaced due to a motor failure.

Jul 1974 A Food Instrument Co. reel tape was installed and tank levels are now recorded in the 242-H control room.

Aug 1974 The evaporator feed pump was replaced due to a motor failure.

Sep 1974 The evaporator feed pump was replaced due to a packing failure.

Oct 1974 The evaporator feed pump was replaced due to a packing failure.

Dec 1974 The evaporator feed pump was replaced twice due to packing and motor failures.

TABLE 1

TANK 21 TRANSFERS

DATE	TANK FROM	TANK TO	GALLONS TRANSFERRED	TYPE WASTE
Oct 1961	13		490,000	LW supernate
Dec 1961	13		718,000	LW supernate
Aug 1963	13		371,000	Frame Waste (FW) and LW supernate
Jun 1964	13		550,000	HW supernate
	13		550,000	HW supernate
Sep 1964	13		112,000	HW, FW & LW supernate
Jun 1965	13		939,000	HW, FW & LW supernate
		22	1,099,000	HW, FW & LW supernate
Sep 1965	22		1,160,000	HW, FW & LW supernate
Nov 1965	22		97,000	HW supernate
Dec 1965	13		324,000	HW, FW & LW supernate
	13		733,000	HW, FW & LW supernate
Mar 1966	13		762,000	HW supernate
Jun 1966	13		630,000	HW supernate
Sep 1966	13		318,000	HW, FW & LW supernate
Oct 1966	24		805,000	Concentrated supernate
Jan 1967	13		709,000	HW, FW & LW supernate
Feb 1967	13		441,000	HW, FW & LW supernate, plus sludge slurry water
Jun 1967	24		288,000	Concentrated supernate
Jul 1967	13		642,000	HW, FW & LW supernate
Aug 1967	13		290,000	HW, FW & LW supernate
Nov 1967	13		265,000	HW, FW & LW supernate
	13		291,000	HW, FW & LW supernate
Dec 1967	13		43,000	HW supernate
	13		496,000	Concentrated supernate
Mar 1968	13		371,000	Concentrated supernate
Apr 1968	13		477,000	HW supernate
	13		354,000	HW supernate
May 1968	13		69,000	HW, FW & LW supernate
Jul 1968	13		368,000	Concentrated supernate
	24		152,000	Concentrated supernate
Aug 1968	13		660,000	HW & LW supernate
	13		320,000	Concentrated supernate
Sep 1968	13		234,000	HW & LW supernate
	13		173,000	HW & LW supernate
Oct 1968	13		266,000	HW & concentrated supernate
Nov 1968	13		435,000	Concentrated supernate
	13		167,000	Concentrated supernate
Dec 1968	13		220,000	Concentrated supernate
	13		190,000	Concentrated supernate
Jan 1969	13		362,000	Sludge slurry water
	13		340,000	Concentrated supernate, plus unknown quantity of sludge
Feb 1969	13		223,000	Concentrated supernate
Mar 1969	13		194,000	HW supernate
	13		238,000	HW supernate
Apr 1969	13		303,000	LW & concentrated supernate
May 1969	13		254,000	Concentrated supernate
	13		326,000	HW & concentrated supernate
Jun 1969	13		341,000	LW & concentrated supernate
Jul 1969	13		196,000	LW & concentrated supernate
Aug 1969	13		383,000	HW & LW supernate
	13		241,000	LW & concentrated supernate
Sep 1969	13		166,000	Concentrated supernate
	13		142,000	Concentrated supernate
	13		154,000	HW & concentrated supernate
	13		139,000	HW & concentrated supernate
Oct 1969	13		316,000	HW supernate
	13		101,000	HW supernate
Nov 1969	13		90,400	HW supernate
	13		161,000	Sludge slurry water
	13		102,000	HW supernate
Dec 1969	13		189,000	HW & LW supernate
	13		133,000	HW & LW supernate
Jan 1970	13		230,300	Diluted concentrate
Feb 1970	13		50,300	HW & LW supernate
	13		158,500	HW & LW supernate
Mar 1970	13		369,000	HW & LW supernate

TABLE 1 (continued)

DATE	TANK FROM	TANK TO	GALLONS TRANSFERRED	TYPE WASTE
Apr 1970	13		168,500	HW & LW supernate
May 1970	13		603,000	Mixed supernates
	13		176,000	Semi-concentrated supernate
Jul 1970	13		431,000	Semi-concentrated supernate
Sep 1970	13		22,200	Mixed supernates
	13		488,600	Mixed supernates
Oct 1970	13		167,000	Semi-concentrated supernate
	13		112,000	Semi-concentrated supernate
Dec 1970		10	69,000	RBOF-RRF waste
Apr 1971		10	64,000	RBOF-RRF waste
	13		608,000	LW & concentrated supernate
May 1971	13		348,000	Mixed supernates
	13		101,000	Mixed supernates
Jun 1971	13		86,000	Mixed supernates
	13		109,000	Mixed supernates
	13		100,000	Mixed supernates
Jul 1971	13		191,000	Mixed supernates
Aug 1971	13		247,000	Mixed supernates
Sep 1971	13		289,000	Mixed supernates
Oct 1971	13		202,000	LW supernate
Nov 1971	13		91,000	LW supernate
	22		85,000	Concentrated supernate
	22		85,000	Concentrated supernate
	22		85,000	Concentrated supernate
	22		30,000	Concentrated supernate
	22		78,000	Concentrated supernate
Dec 1971	22		87,000	Concentrated supernate
	22		83,000	Concentrated supernate
	22		85,000	Concentrated supernate
	22		163,000	Concentrated supernate
	22		74,000	Concentrated supernate
	22		96,000	Concentrated supernate
Jan 1972	29		20,000	Concentrated supernate
	29		57,000	Concentrated supernate
	29		625,000	Concentrated supernate
Feb 1972	13		309,000	Mixed supernates
Mar 1972	13		600,000	Mixed supernates
Apr 1972	13		120,000	Mixed supernates
	13		184,000	Mixed supernates
	29		80,000	Concentrated supernate
May 1972	13		261,000	Mixed supernates
Jun 1972	22		39,000	Semi-concentrated supernate
	13		125,000	Mixed supernates
	22		44,000	Semi-concentrated supernate
	13		132,000	Mixed supernates
Jul 1972	13		73,000	LW supernate
	29		635,000	Concentrated supernate
	29		329,000	Concentrated supernate
Aug 1972	22		98,000	Dissolved HW salt
	23		32,000	RBOF-RRF waste
	22		22,000	Dissolved HW salt
	22		34,000	Dissolved HW salt
	22		34,000	Dissolved HW salt
Sep 1972	13		172,000	Mixed supernates
	22		42,000	Dissolved HW salt
	13		48,000	Mixed supernates
Oct 1972	31		105,000	Concentrated supernate
	13		112,000	HW supernate
	31		133,000	Concentrated supernate
	13		105,000	HW supernate
	31		211,000	Concentrated supernate
Nov 1972	13		105,000	HW supernate
	31		222,000	Concentrated supernate
Dec 1972	13		261,000	HW supernate
	29		8,000	Concentrated supernate
Jan 1973	29		86,000	Concentrated supernate
	29		520,000	Concentrated supernate

TABLE 1 (continued)

DATE	TANK FROM	TANK TO	GALLONS TRANSFERRED	TYPE WASTE
Feb 1973	29		468,000	Concentrated supernate
Mar 1973	13		354,000	LW supernate
Apr 1973	13		307,000	Mixed supernates
	13		291,000	Mixed supernates
May 1973	31		88,000	Concentrated supernate
	31		214,000	Concentrated supernate
	31		196,000	Concentrated supernate
Jun 1973	24		42,000	Concentrated supernate
Jul 1973	31		524,000	Concentrated supernate
	29		131,000	Concentrated supernate
Aug 1973	29		84,000	Concentrated supernate
	29		319,000	Concentrated supernate
	29		161,000	Concentrated supernate
	22		321,000	Concentrated superate
Sep 1973	13		196,000	LW & concentrated supernate
	29		534,000	Concentrated supernate
Oct 1973	22		61,000	Dissolved HW salt
	29		400,000	Concentrated supernate
	31		20,000	Concentrated supernate
	31		279,000	Concentrated supernate
	31		330,000	Concentrated supernate
Nov 1973	13		88,000	LW supernate
	29		287,000	Concentrated supernate
Dec 1973	31		812,000	Concentrated supernate
	22		219,000	Dissolved HW salt
	13		114,000	LW supernate
Jan 1974	29		196,000	Concentrated supernate
	29		353,000	Concentrated supernate
	22		110,000	Semi-concentrated supernate
	22		25,000	Semi-concentrated supernate
Feb 1974	13		103,000	LW supernate
	31		512,000	Concentrated supernate
Mar 1974	13		71,000	LW supernate
	22		96,000	Dissolved HW salt
	29		406,000	Concentrated supernate
Apr 1974	29		333,000	Concentrated supernate
	13		136,000	LW supernate
May 1974	29		258,000	Concentrated supernate
	13		46,000	LW supernate
	22		113,000	Dissolved HW salt
	29		289,000	Concentrated supernate
Jun 1974	29		431,000	Concentrated supernate
	29		201,000	Concentrated supernate
Jul 1974	31		946,000	Concentrated supernate
Aug 1974	29		662,000	Concentrated supernate
	29		267,000	Concentrated supernate
Sep 1974	29		221,000	Concentrated supernate
	29		294,000	Concentrated supernate
	29		140,000	Concentrated supernate
Oct 1974	29		222,000	Concentrated supernate
	31		53,000	Concentrated supernate
	24		55,000	HW supernate + CRC flushes
Nov 1974	29		578,000	Concentrated supernate

TABLE 2

GROUND WATER ELEVATIONS AROUND H-AREA UNCOOLED TANKS

Elevation of tank bottoms, feet	282	-	-	-	-	-	-	-	-
Elevation tip of piezometer, feet	296.54	281.07	281.52	281.33	281.10	280.75	295.25	301.14	280.54
Casing head el, feet	322.04	322.46	322.71	322.83	322.69	322.60	324.43	311.69	322.30
Well No.	HPM32	HPM33	HPM34	HPM35	HPM36	HPM37	HPM38	HPM39	HPM40
Date Sampled									
3/11/64	-	-	-	-	-	-	-	-	-
4/3/64	302.8	282.1	Dry	283.0	Dry	Dry	Dry	Dry	Dry
4/6/64	303.1	281.8	282.4	285.2	Dry	Dry	Dry	Dry	Dry
4/8/64	303.3	281.9	282.9	286.1	282.0	Dry	Dry	Dry	Dry
4/10/64	304.1	281.9	283.3	286.6	282.1	Dry	Dry	301.7	281
4/12/64	304.2	281.8	284.3	287.2	282.5	Dry	Trace	Dry	Dry
4/24/64	303.9	281.9	285.3	287.3	282.9	Dry	Dry	Dry	280.8
4/29/64	304.1	282.0	285.5	287.5	283.1	Dry	Dry	Dry	281.1
5/6/64	304.5	282.2	285.6	287.4	283.2	Dry	Dry	301.7	281.2
5/12/64	304.3	282.3	285.8	287.5	283.2	281.0	Dry	Dry	281.1
5/27/64	303.3	282.4	285.5	287.4	283.2	281.1	Trace	Dry	281.2
6/2/64	302.9	282.5	285.4	287.3	283.2	281.1	Dry	Dry	281.2
6/9/64	302.7	282.5	285.1	287.2	283.2	Dry	Dry	Dry	281.2
7/2/64	301.4	282.6	284.6	286.8	283.1	Dry	Dry	Dry	281.3
2/1/64	303.2	283.9	283.5	286.3	283.7	283.5	Dry	Dry	283.1
5/3/65	-	-	-	-	-	-	-	-	-
Elevation of tank bottoms, feet	-	-	-	-	-	-	-	-	-
Elevation tip of piezometer, feet	281.15	281.24	280.94	296.17					
Casing head el, feet	322.63	322.76	322.44	311.74	324.00	324.03	322.89	322.90	324.3
Well No.	HPM41	HMP42	PHM43	HPM44	PN	PE	PW	PS	PC
Date Sampled									
3/11/64	-	-	-	-	278	278.9	278.7	279.6	278.3
4/3/64	Dry	283.7	281.9	302.4	-	-	-	-	-
4/6/64	282.0	284.7	282.0	302.3	-	-	-	-	-
4/8/64	281.9	285.4	282.4	302.7	-	-	-	-	-
4/10/64	282.1	285.8	282.5	303.9	-	-	-	-	-
4/12/64	282.6	285.8	282.5	303.9	-	-	-	-	-
4/24/64	283.9	286.5	282.9	301.7	278.9	279.3	279.6	279.0	279.4
4/29/64	283.1	286.5	283.0	302.6	278.9	279.2	279.5	279.8	279.5
5/6/64	283.2	286.2	282.6	303.3	279.0	279.4	279.7	280.3	279.6
5/12/64	283.4	286.3	282.7	302.2	279.4	279.9	280.2	280.6	279.9
5/27/64	283.5	285.7	282.7	300.1	279.0	279.2	279.4	279.6	279.7
6/2/64	283.7	283.9	282.6	299.7	278.7	278.8	279.0	279.2	279.2
6/9/64	283.8	285.5	282.6	299.4	278.2	278.3	278.5	278.7	278.7
7/2/64	283.9	284.6	282.4	297.0	277.3	277.4	277.5	277.7	277.8
2/1/64	284.0	283.6	282.7	302.3	278.6	278.9	279.1	279.3	279.1
5/3/65	-	-	-	-	280.4	280.5	280.8	280.9	-

TABLE 3

COMPOSITION OF SOLIDS ON 242-H EVAPORATOR FEED JUMPER

	Weight %			Weight %	
Element	Black Solids	Gray Mix	Element	Black Solids	Gray Mix
Mercury	92	91	Chlorine	0.007	0.03
Silver	6	1	Magnesium	.007	.10
Ruthenium	0.9	0.5	Bismuth	.006	.03
Iron	.3	.8	Sulphur	.006	.1
Palladium	.2	0.07	Phosphorus	.006	.04
Silicon	.2	1	Lead	.004	.05
Oxygen	.1	1	Barium	.003	.06
Aluminum	.05	0.4	Uranium	.002	.02
Zinc	.04	.7	Molybdenum	.002	.008
Nitrogen	.04	.2	Zirconium	.002	.01
Manganese	.03	0.05	Strontium	.002	.02
Calcium	.02	1	Rubidium	.001	.006
Carbon	.02	0.2	Bromine	.001	.004
Cadmium	.01	.05	Gallium	.001	.005
Chromium	.01	.07	Niobium	.0004	.008
Potassium	.01	.1	Boron	.0004	.004
Sodium	.008	.1	Arsenic	.0003	.003
Thorium	.007	.05	Cobalt	.0003	.005
Titanium	0.007	0.9	Fluorine	0.0003	0.009

TABLE 4

COMPOSITION OF SOLIDS FROM TANK 21 PILLBOX

Element	Weight % West Side	SW Corner	NE Corner	NE Corner	North Side
Pb	2	73	1	2	6
Hg	9	0.4	36	4	3
Ba	0.3	.06	0.2	0.4	0.3
Cs	.00	.00	.03	.1	.1
Sb	.04	.02	0.04	.1	.2
Ag	.5	.02	1	.3	.08
Mo	.3	.02	0.1	.05	.3
Zr	.01	.02	0.1	.06	.05
Sr	0.08	.04	0.2	0.3	.4
Zn	2	.3	1.0	1	.5
Cu	0.03	.03	0.09	0.1	.07
Ni	0.08	0.08	0.08	0.1	0.04
Fe	64	15	25	32	31
Mn	2	0.2	0.7	1	0.8
Cr	0.4	.08	.09	0.5	.6
V	.01	.02	0.01	0.02	.6
Ti	0.2	0.2	6	1	0.01
Ca	2.0	2	5	19	15
K	0.3	0.1	0.4	1	0.6
S	.1	.07	.2	0.3	.2
P	0.09	0.03	0.1	0.3	0.3
Si	4	3	9	13	10
Al	0.5	0.3	2	5	6
Mg	.2	.1	0.5	0.7	0.5
Na	0.1	0.02	1	3	5
O	12	4	5	11	12
N	0.2	0.2	0.6	1	2
C	0.1	0.1	1	0.6	2

TABLE 5

COMPOSITION OF SOLIDS FROM TANK 21 PILLBOX

Element	Weight % Dry Floor Solids NW Corner	Weight % Dry Floor Solids East Side	Weight % Steam Line Encrustation White Salt	Weight % Steam Line Encrustation Black Paste
Pb	3	24	0.06	0.1
Hg	40	0.3	0.09	28
Ag	0.4	0.02	0.03	0.01
Fe	14	6	1	2
Si	5	22	0.3	8
Al	1	10	13	11
Na	9	4	43	13
O	6	6	22	7
N	2	3	7	2

TABLE 6

COMPOSITION OF LIQUIDS FROM ACTUAL AND SUSPECTED DETONATION SITES, ppm

Element	Tank 21 Supernate	Building 242-H Evaporator Overheads Before CRC	Building 242-H Evaporator Overheads After CRC
Hg	17	0.04	≤0.03
Ag	≤1	≤0.001	<0.006
Pb	≤8	0.04	0.05

TABLE 7

SPECTROCHEMICAL ANALYSIS OF TANK 21 SUMP WATER, 242-H PROCESS SOLUTIONS, AND GROUND WATER

Source	Ag	Al	B	Ba	Be	Bi	Ca	Co	Cr	Cu	Fe	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Sb	Si	Sn	Ti	Zn
	Element, ppm																								
Bottom sumps	<2	<20	<2	<50	<0.5	<10	40	<20	<20	<5	<20	<5	<2	<5	<20	200	<20	<20	<100	<5	<20	10	<50	<10	<50
Regional wells																									
North	L1-	L10	L10-	L50-	L1-	L10-	L50-	L200-	L20	L2	L10		L1	L5	L10-		L10-	L20-		L20-	L20-	L1	L50-	L5	L20-
South	L1-	L10	L10-	L50-	L1-	L10-	L50-	L200-	L20	L2	L10		L1-	L5	L10-		L10-	L20-		L20-	L20-	L1	L50-	L5	L20-
East	L1-	L10	L10-	L50-	L1-	L10-	L50-	L200-	L20	L2	L10		L1	L5	L10-		L10-	L20-		L20-	L20-	L1	L50-	L5	L20-
West	L1-	L10	L10-	L50-	L1-	L10-	L50-	L200-	L20	L2	L10		L1	L5	L10-		L10-	L20-		L20-	L20-	L1	L50-	L5	L20-
Center	L1-	L10	L10-	L50-	L1-	L10-	L50-	L200-	L20	L2	L10		2	L5	L10-		L10-	L20-		L20-	L20-	L1	L50-	L5	L20-
Process streams																									
Evap overheads	<2	<20	<2	<50	<0.5	<10	<5	<20	<20	<5	<20	<5	<2	<5	<10	<20	<20	<20	<100	<5	<20	<5	<50	<10	<50
CRC effluent	<20	20	<2	<50	<0.5	<10	<5	<20	30	<5	<20	<5	<2	<5	<20	400	<20	<20	<100	<5	<20	30	<5	<10	<50

Blank Element not investigated.
- Element not detected.
L___- Element not detected, limit shown.
L___ Element detected, but less than limit shown.
<___ Element, if present, less than limit shown.

TABLE 8

SPECTROCHEMICAL ANALYSIS OF SOLIDS SUSPENDED IN TANK 21 SUMP WATER, 242-H PROCESS SOLUTIONS, AND GROUND WATER

Source	Ag	Al	B	Ba	Be	Bi	Ca	Co	Cr	Cu	Fe	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Sb	Si	Sn	Ti	Zn
	Element, ppm or Abundance																								
Bottom sumps	-	T	FT	-	-	-	Min	-	T	T	Maj	-	T	T	-	T	-	-	-	Min	-	Min	-	T	Maj
Regional wells																									
North	L125-	37,500	L1250	L6250-	L125-	L1250-	L6250	L25,000-	L2500	1250	50,000		1000	L625	L1250-		L1250-	L2500-		2500	L2500	62,500	L6250-	2500	L2500
South	L125-	12,500	L1250	L6250-	L125-	L1250-	L6250-	L25,000-	L2500	2500	25,000		1250	L625-	L1250-		L1250-	L2500-		L2500	L2500-	50,000	L6250-	1250	L2500
East	L125-	12,500	L1250	L6250-	L125-	L1250-	L6250-	L25,000	L2500	1250	37,500		1000	1250	L1250-		L1250-	L2500-		L2500-	L2500-	57,500	L6250-	1250	L2500
West	L10-	50,000	100	L500	L10-	L100-	2000	2000	L200	500	50,000		1500	1000	L100-		L100-	500		500	L200-	40,000	L500-	1000	1000
Center	L125-	12,500	L1250	L6250-	L125-	L1250-	18,750	L25,000-	L2500	1250	62,500		1250	2500	L1250-		L1250-	L2500-		L2500	L2500-	25,000	L6250-	12,500	12,500
Process streams																									
Evap overheads	-	-	Maj	-	-	-	Maj	-	Maj	Min	Maj	-	Min	Maj	-	-	-	Maj	-	Maj	-	Maj	-	-	-
CRC effluent	-	-	Min	-	-	-	Maj	-	-	-	Maj	-	Min	-	-	-	-	Maj	-	-	-	Maj	-	-	-

Blank Element not investigated.
- Element not detected.
L___- Element not detected, limit shown.
L___ Element detected, but less than limit shown.
<___ Element, if present, less than limit shown.
Maj Major, 10-100% of sample.
Min Minor, 1-10% of sample.
T Trace, 0.01-1% of sample.
FT Faint trace, 0.01-1% of sample.

TABLE 9

TANK 21 COLOR PHOTOGRAPHS

Date	Riser	Object of Photo	PRD Number	Sep.Tech File Location Box	Sep.Tech File Location Slot
12/16/71	NE	Interior	15431-(1-26)	15	C19-25, D1-19
12/30/71	SW	Interior	15503 (1-29)	15	D20-25, E1-23
12/18/74	SW	Interior	18765 (1-12)	57	3

TABLE 10

TANK 21 SAMPLE ANALYSES

Phase:	Supernate	Supernate	Supernate	Supernate	Supernate	Supernate	Supernate	Sludge Unwashed	Sludge Washed	Supernate	Supernate	Supernate	Supernate
Date:	1/23/63	5/13/63	1/14/65	1/7/70	1/7/70	1/7/70	1/7/70	1/7/70	1/7/70	3/30/71	3/30/71	3/30/71	3/30/71
Location, Height above tank bottom:	27'	12'	27'4"	28'4"	13'	3'4"	25-30"	25-30"	25-30"	3'	6'	11'8"	16'8"
Pu Alpha, d/m/ml	190	210	8.2×10^{4}	1.6×10^{5}	1.66×10^{5}	2.60×10^{5}	2.98×10^{5}	2.38×10^{4}	2.83×10^{4}				
Gross Alpha, d/m/ml			7.6×10^{4}	1.82×10^{5}	2.25×10^{5}	2.67×10^{5}	2.64×10^{5}	2.46×10^{4}	3.35×10^{4}				
Gross Beta, c/m/ml	2.19×10^{5}	3.08×10^{5}	7.0×10^{7}	1.32×10^{8}	1.40×10^{8}	1.84×10^{8}	2.41×10^{8}	4.35×10^{6}	8.6×10^{5}				
Gross Gamma, c/m/ml	1.2×10^{5}	1.69×10^{5}	4.1×10^{7}	6.6×10^{7}	6.42×10^{7}	8.36×10^{7}	1.04×10^{8}	1.71×10^{6}	3.89×10^{4}				
Sp. Gravity	1.214	1.273	1.251	1.257	1.255	1.356							
$NaHCO_3$, g/l				0.6	1.0	3.1							
NaOH, g/l				24.5	25.3	35.4							
Total Solids,wt.%		29.9	16.56										
^{95}Zr-^{95}Nb gamma, c/m/ml				ND	ND	ND	<20	<0.1	1.08×10^{6}		1.24×10^{8}		
Ru gamma, c/m/ml	6.0×10^{6}			ND	ND	ND	<40	<0.3	1.08×10^{6}				
pH		11	11.7-12.3	11	11	11				11+	11+	11+	11+
Cl^-, g/l				<0.05	<0.05	<0.05	.08	<.05	<0.05				
^{137}Cs, d/m/ml	6×10^{6}	9.1×10^{6}	2.0×10^{9}	2.66×10^{9}	2.50×10^{9}	3.56×10^{9}	4.17×10^{9}	7.40×10^{7}	2.27×10^{5}	2.12×10^{9}	2.5×10^{9}	9.07×10^{7}	8.88×10^{7}
^{134}Cs, d/m/ml			9.3×10^{7}	3.88×10^{8}	3.88×10^{8}	4.16×10^{8}	4.91×10^{8}	8.15×10^{6}	ND	2.13×10^{8}	1.98×10^{8}	8.69×10^{6}	8.69×10^{6}
$^{89,90}Sr$, d/m/ml	5.1×10^{3}		2.5×10^{6}	6.97×10^{5}	7.00×10^{5}	1.14×10^{6}							
$NaNO_3$, wt %	8.8	14.3	2.50										
NaOH, wt %	6.40	7.5	1.18										
$NaAlO_2$, wt %	3.58	4.7	1.71										
Na_2CO_3, wt %	0.19	0.3	1.66										
Na_2SO_4, wt %	0.10												
$NaNO_2$, wt %			0.72										
$^{141,144}Ce$, d/m/ml				ND	ND	ND	<300		2.58×10^{6}				
Cl^-, ppm			16										
PO_4^{---}, g/l			<0.02	0.56	0.55	0.74	0.76	0.10	<0.10				
Fe^{+++}, g/l			<0.005	38	33.1	46.7							
Reducing Normality				0.015	0.011	0.016							
NO_3^-, g/l				142	135	162							
SO_4^{--}, g/l				<3	<3	<3	3.6	<.2	<.2				
Al^{+++}, g/l				15.5	16.6	21.2	17.0	.34	<0.01				

ND = Not detectable in presence of other more abundant radionuclides.

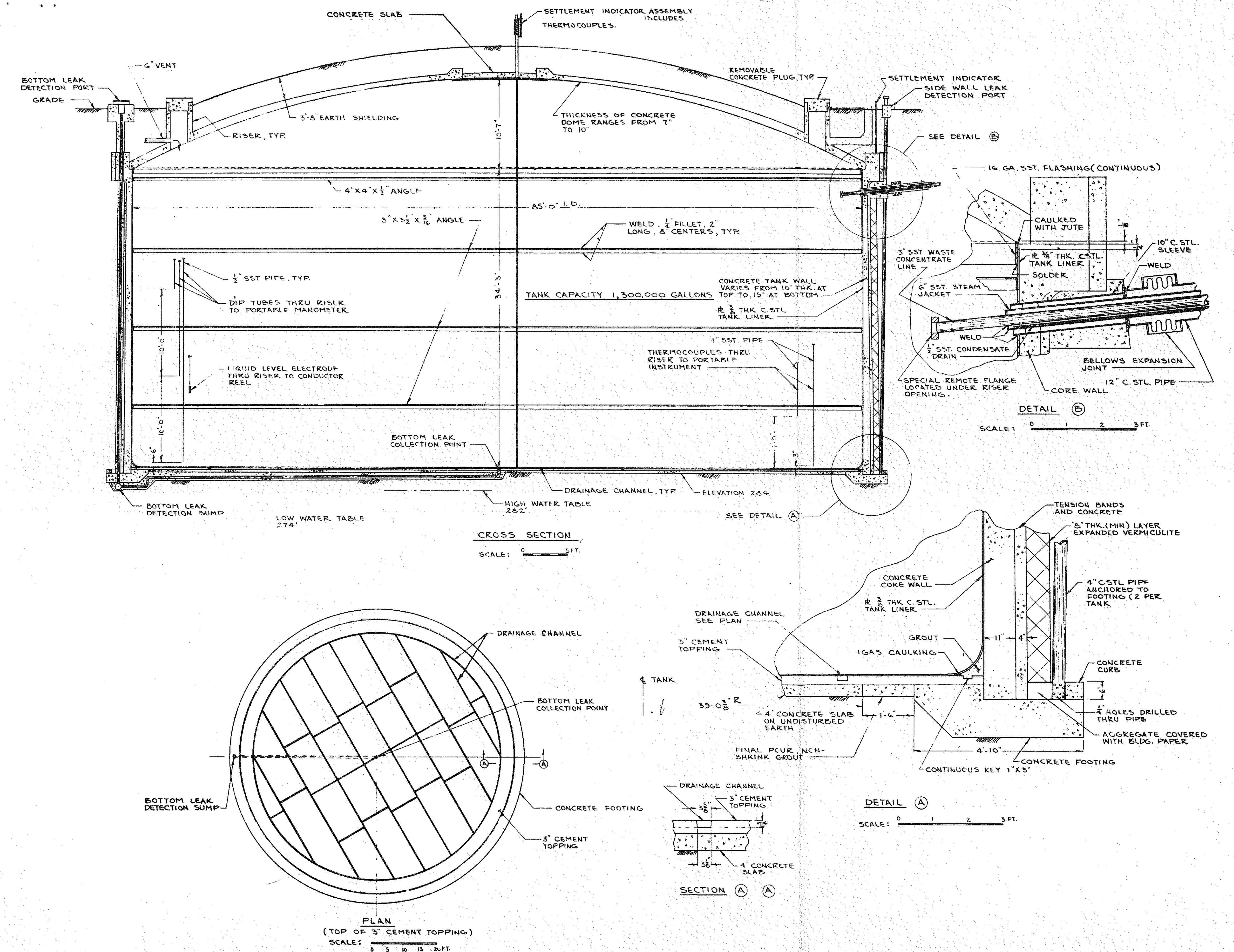


FIGURE 1. WASTE STORAGE TANK 21

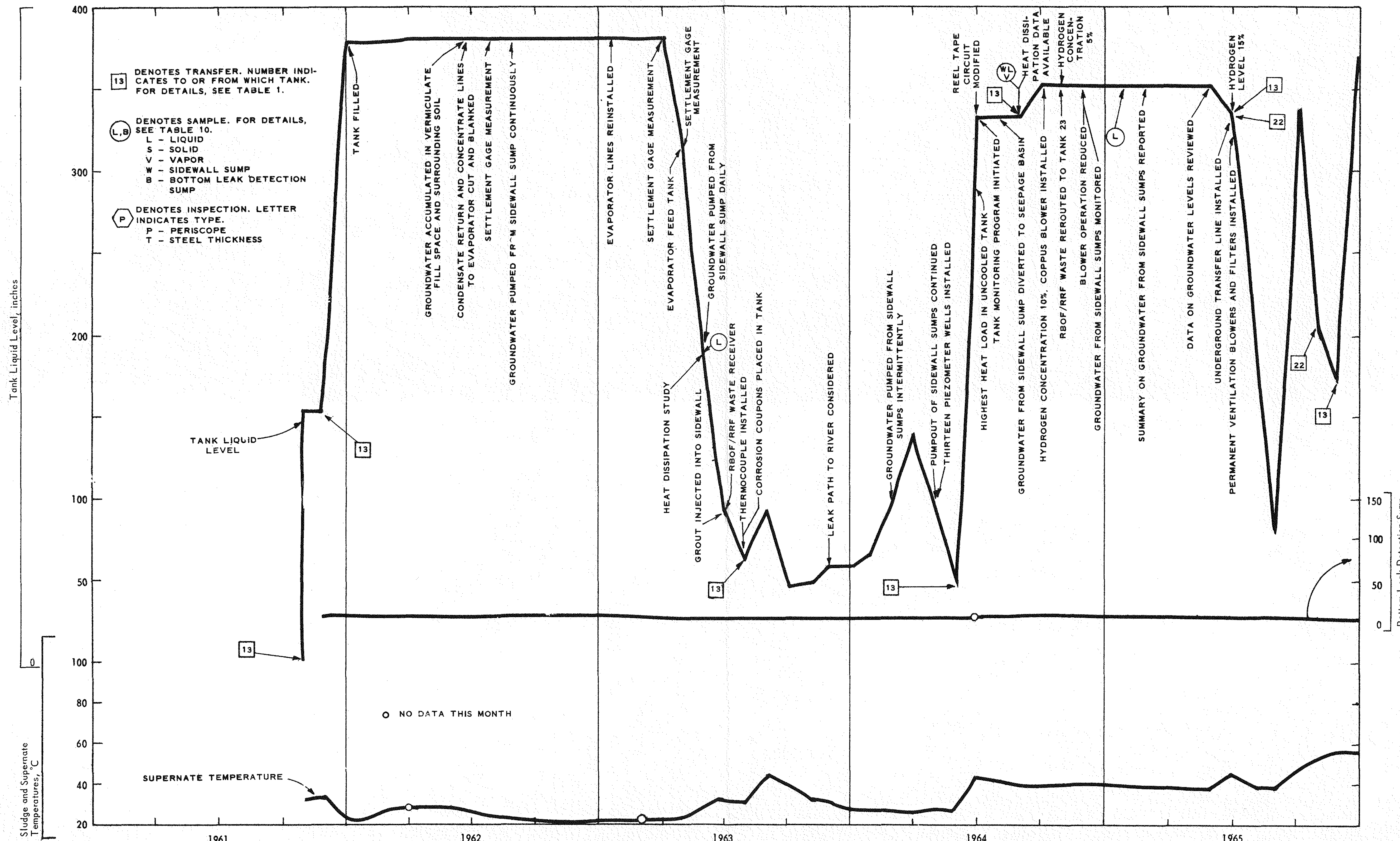


FIGURE 2. TANK 21 LIQUID LEVELS AND TEMPERATURES

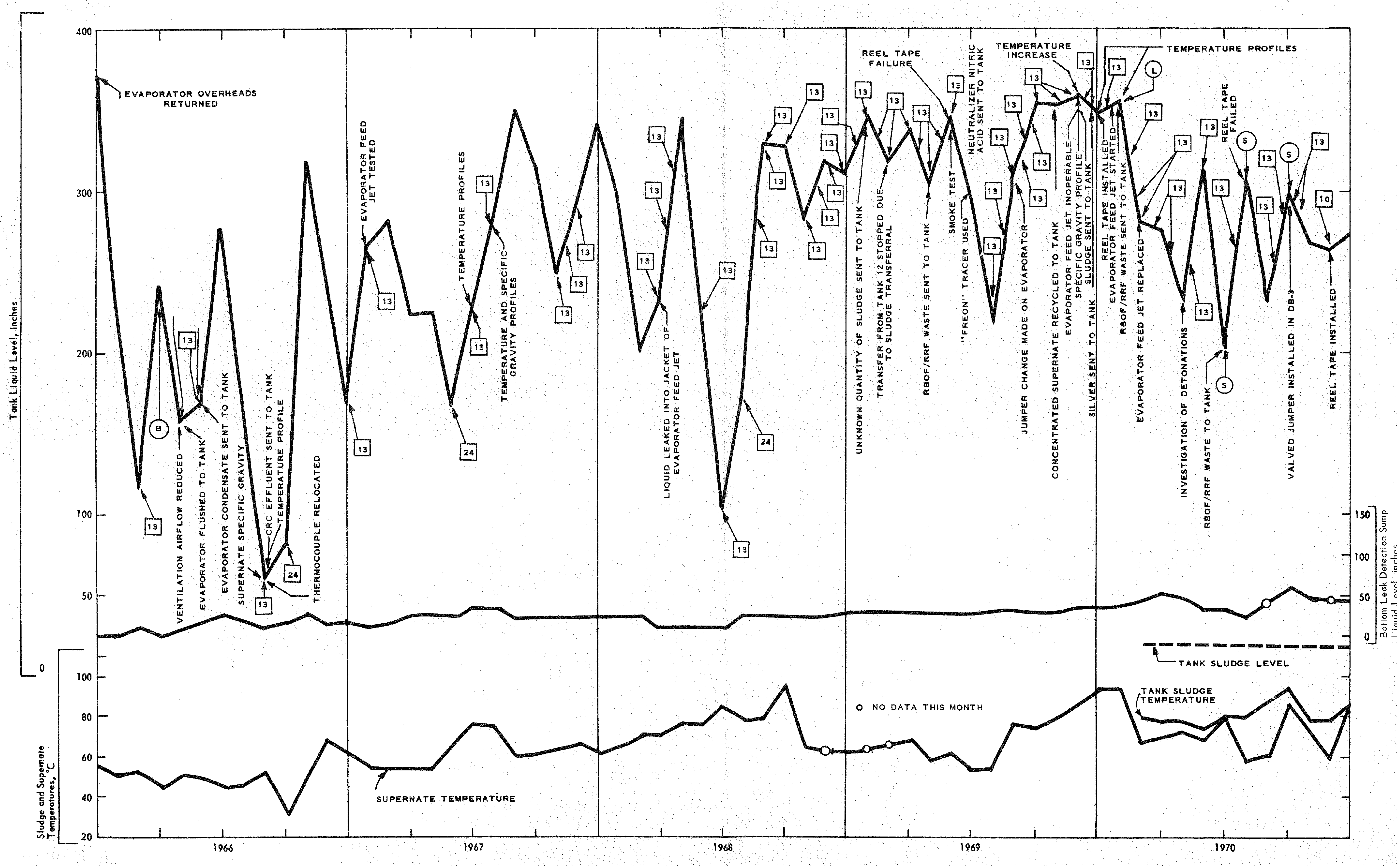


FIGURE 2 (contd)

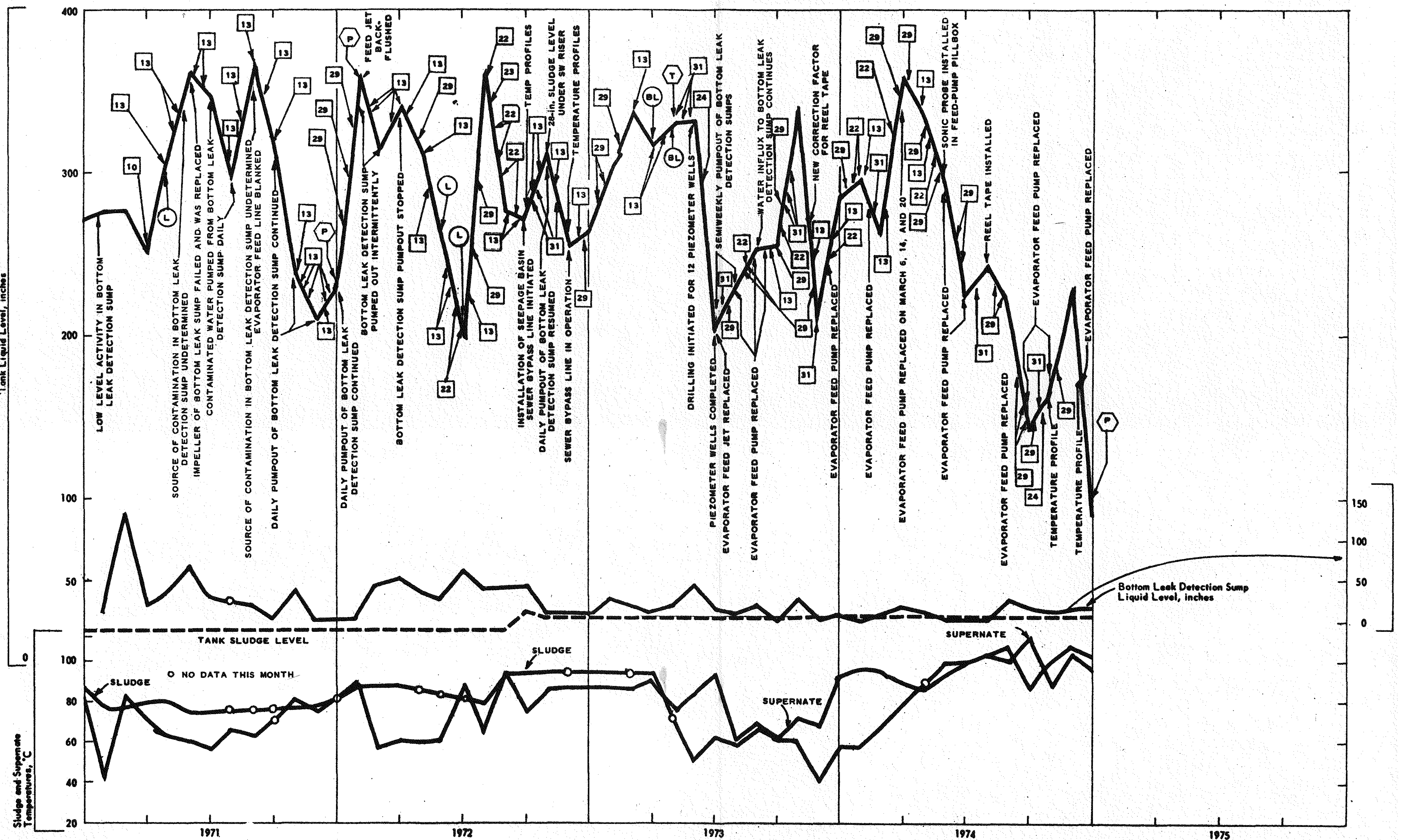


FIGURE 2 (contd)

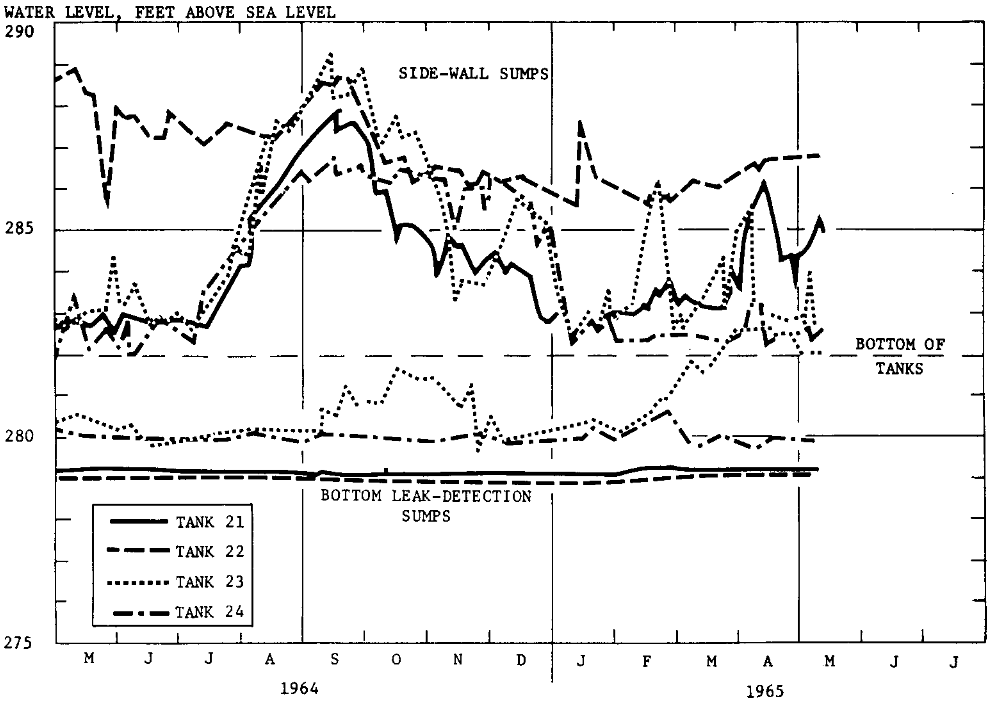


FIGURE 3. GROUND WATER LEVEL AROUND H-AREA UNCOOLED TANKS

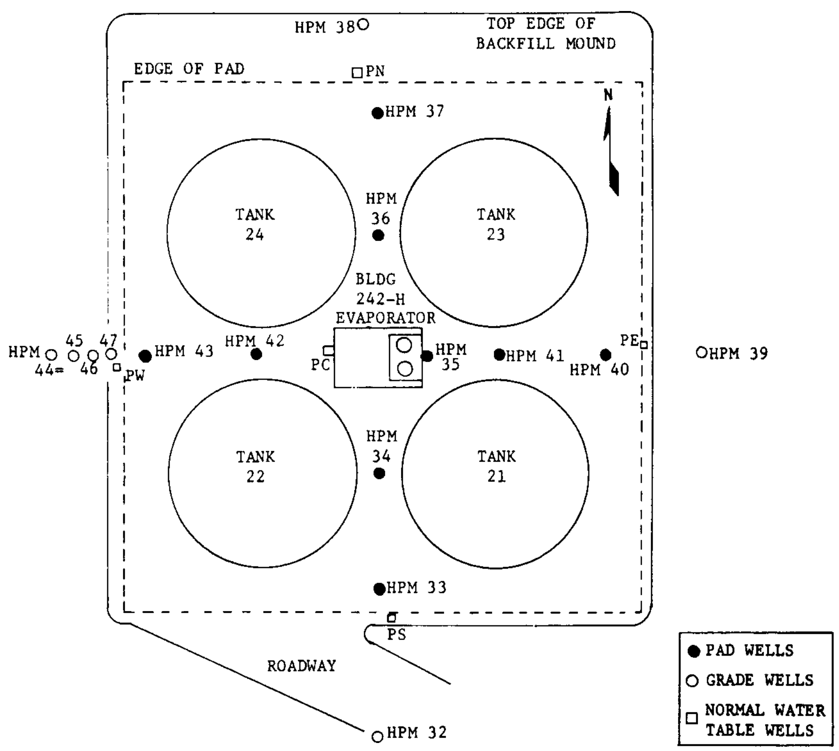


FIGURE 4. LOCATION OF OBSERVATION WELLS AT H-AREA UNCOOLED TANKS

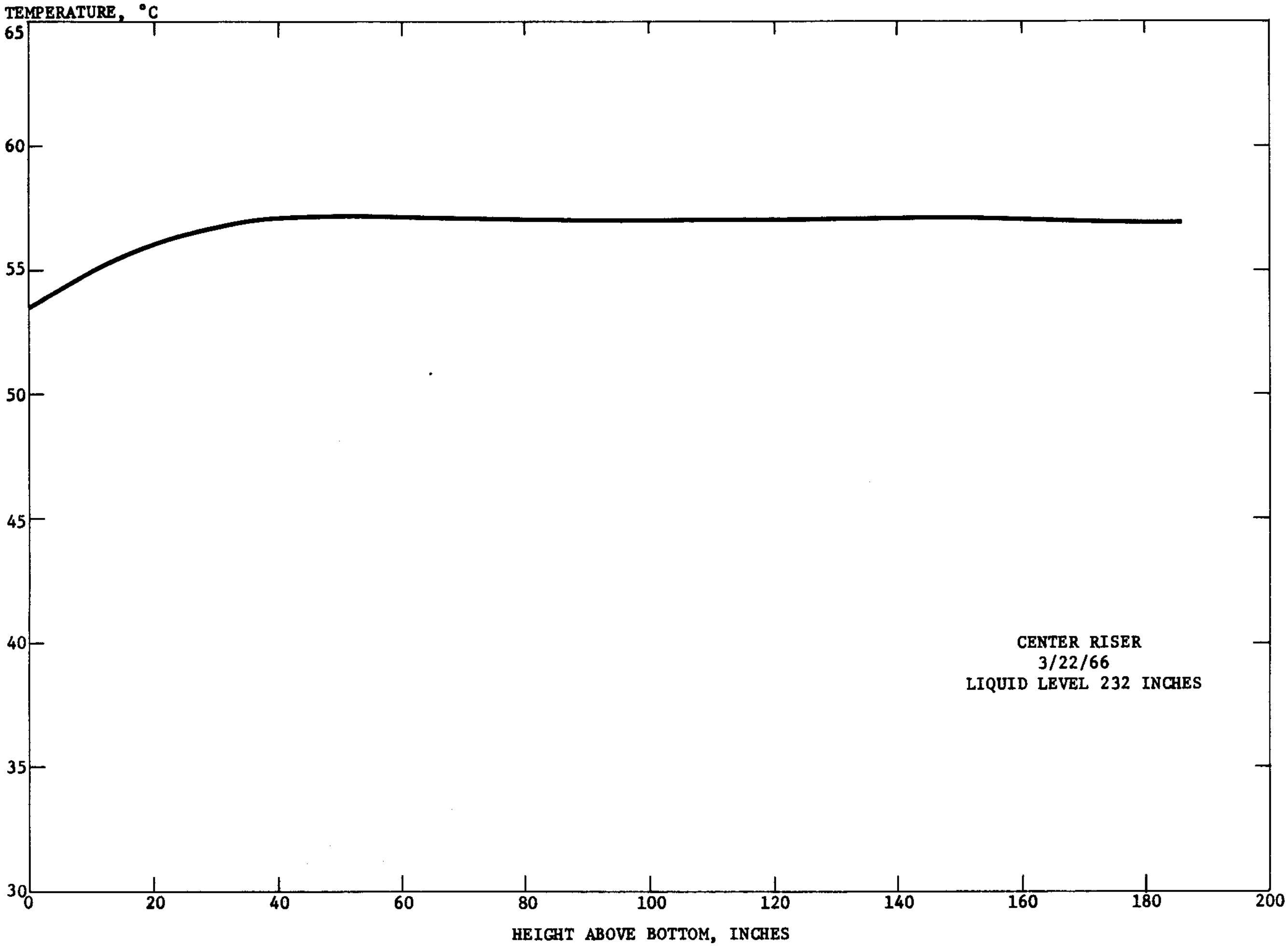


FIGURE 5. TEMPERATURE PROFILE, MARCH 1966

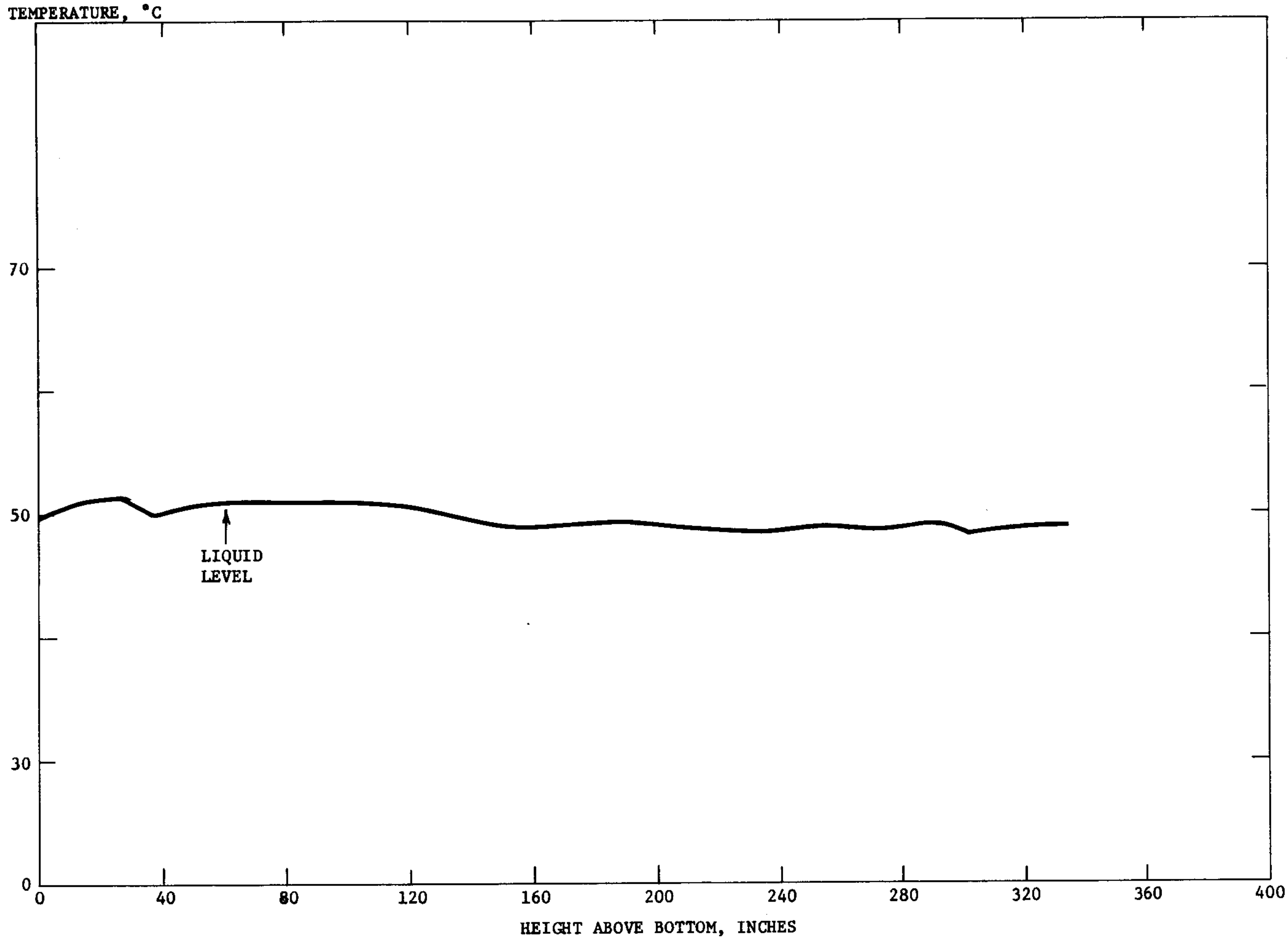


FIGURE 6. TEMPERATURE PROFILE, AUGUST 1966

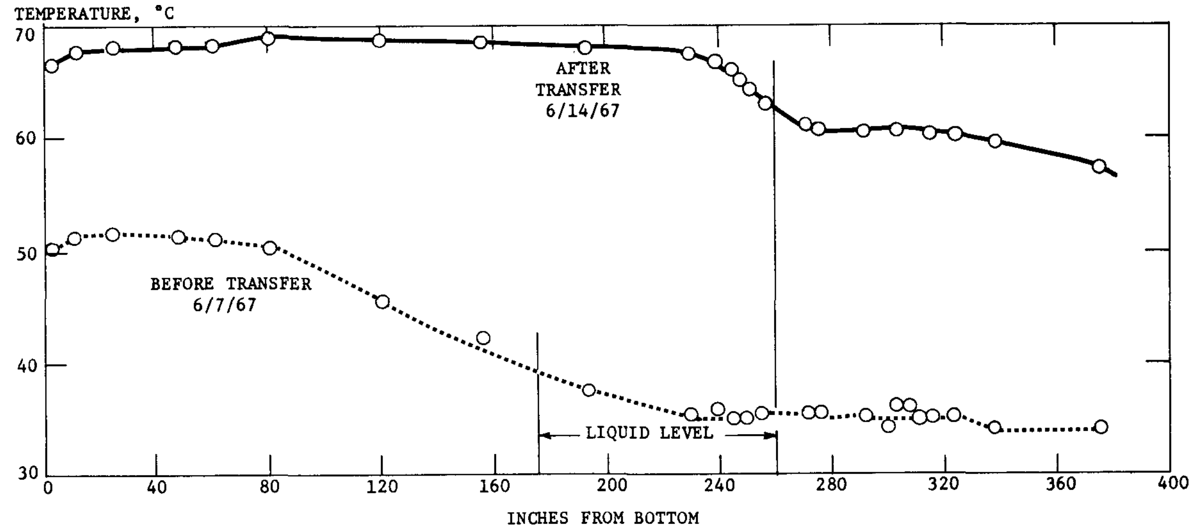


FIGURE 7. TEMPERATURE PROFILES, JUNE 1967

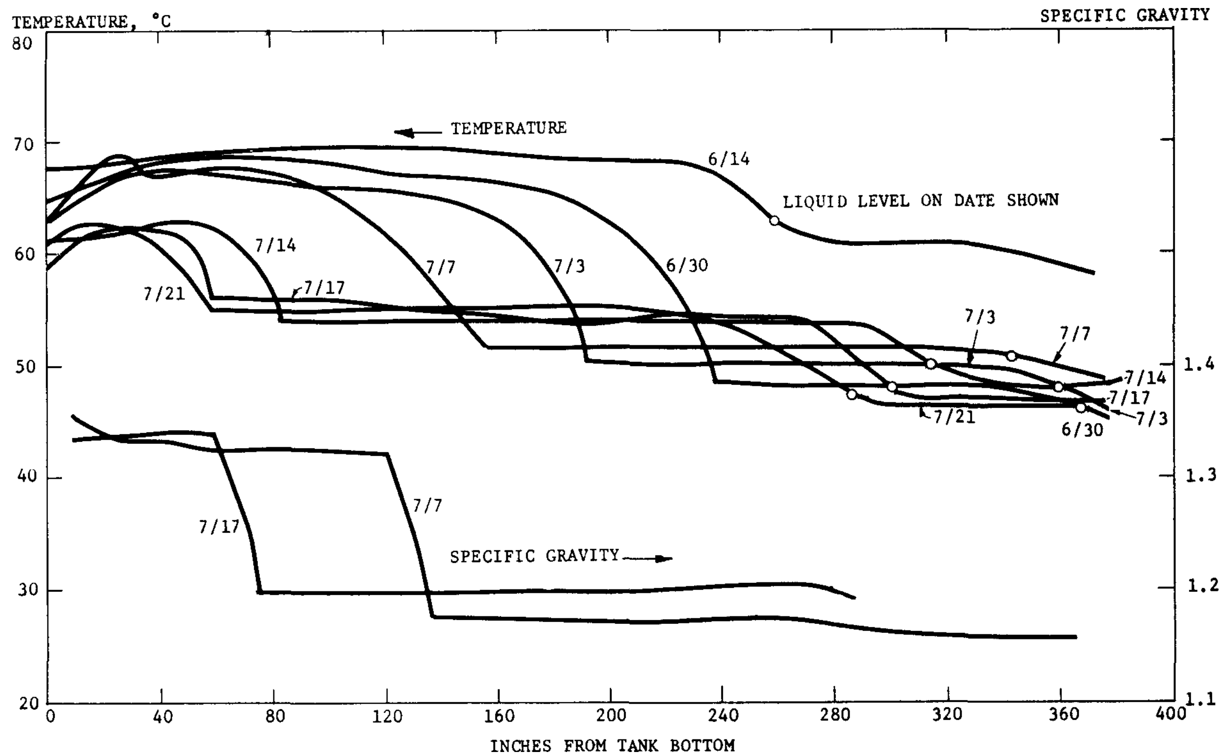


FIGURE 8. TEMPERATURE AND SPECIFIC GRAVITY PROFILES

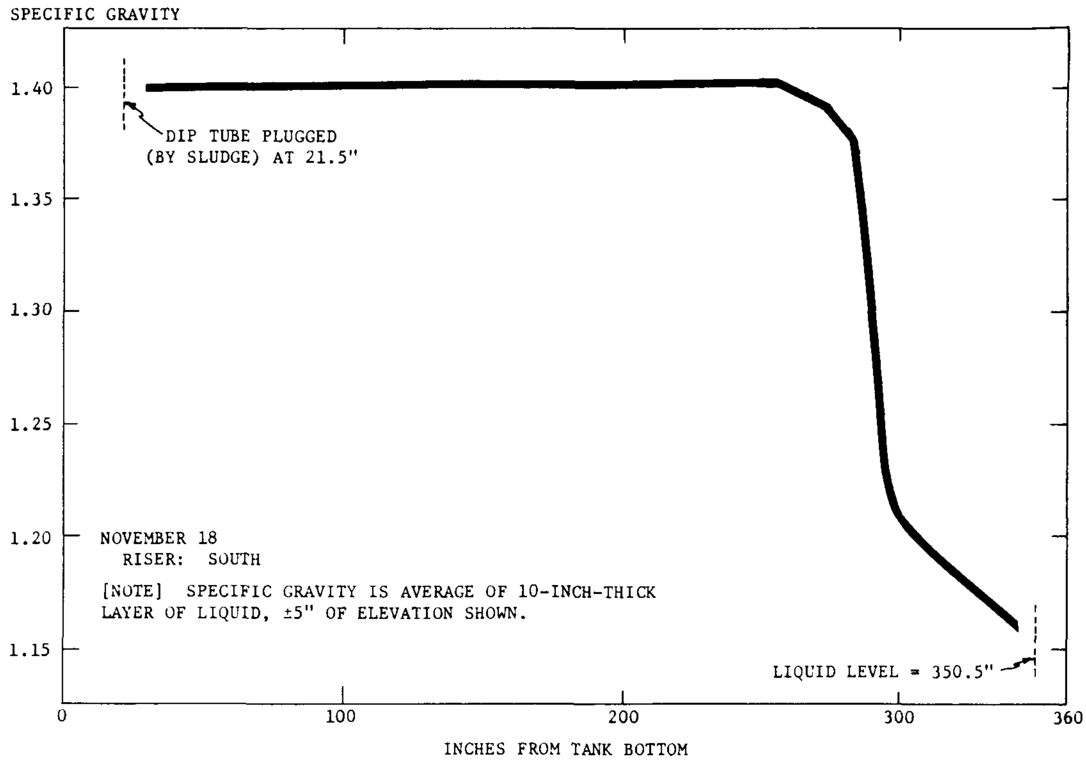


FIGURE 9. SPECIFIC GRAVITY PROFILE, NOVEMBER 1969

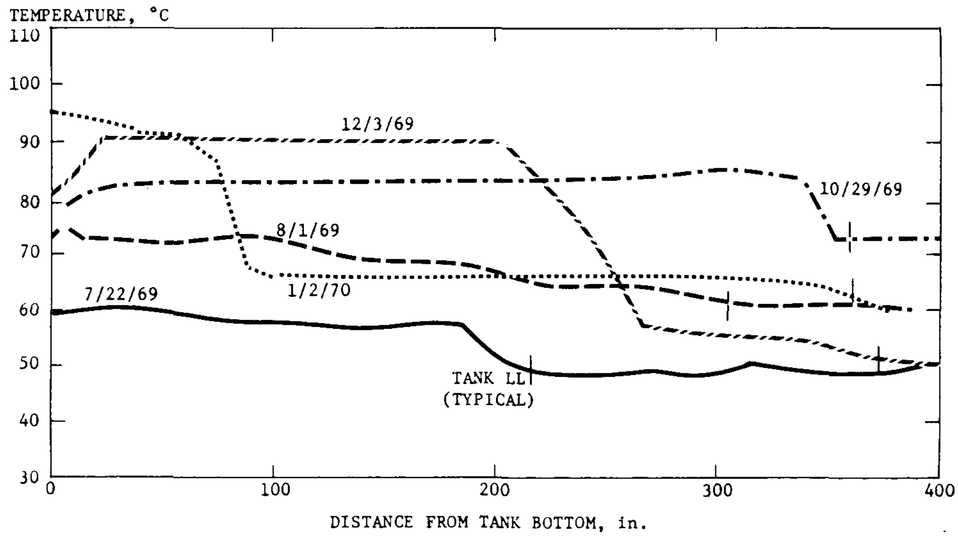


FIGURE 10. TEMPERATURE PROFILES

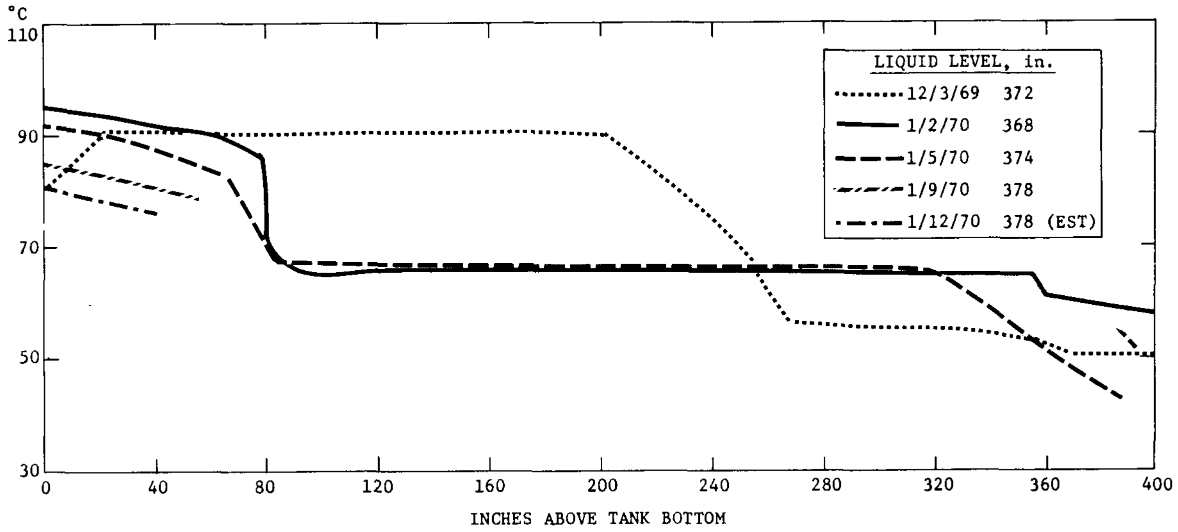


FIGURE 11. TEMPERATURE PROFILES (CENTER THERMOWELL)

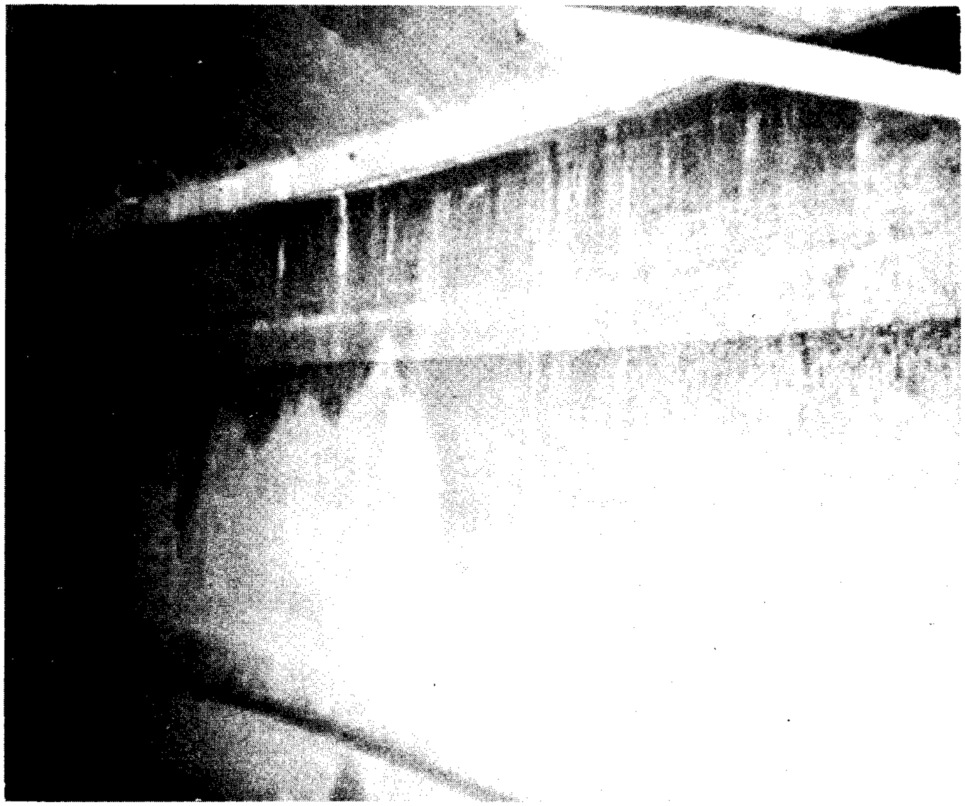


FIGURE 12. INTERIOR OF TANK 21 STEEL WALL ON DECEMBER 16, 1971 DPSPF 15431-18.

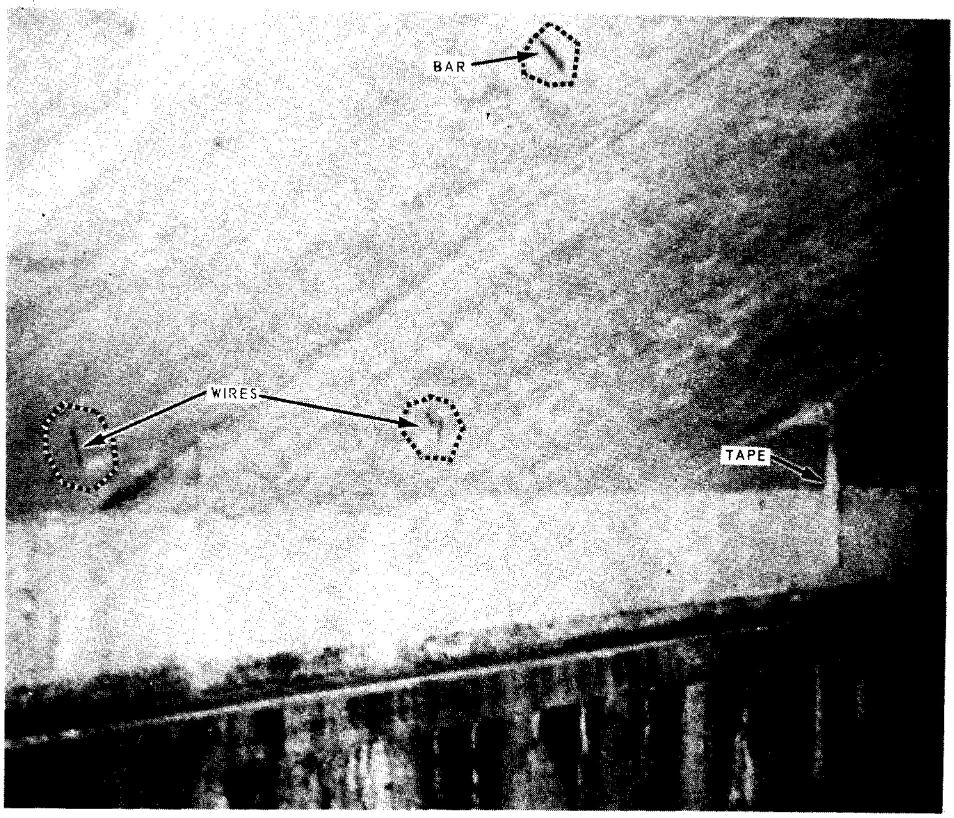


FIGURE 13. INTERIOR OF TANK 21 – CONCRETE ROOF ON DECEMBER 16 1971. DPSPF 15431-4.

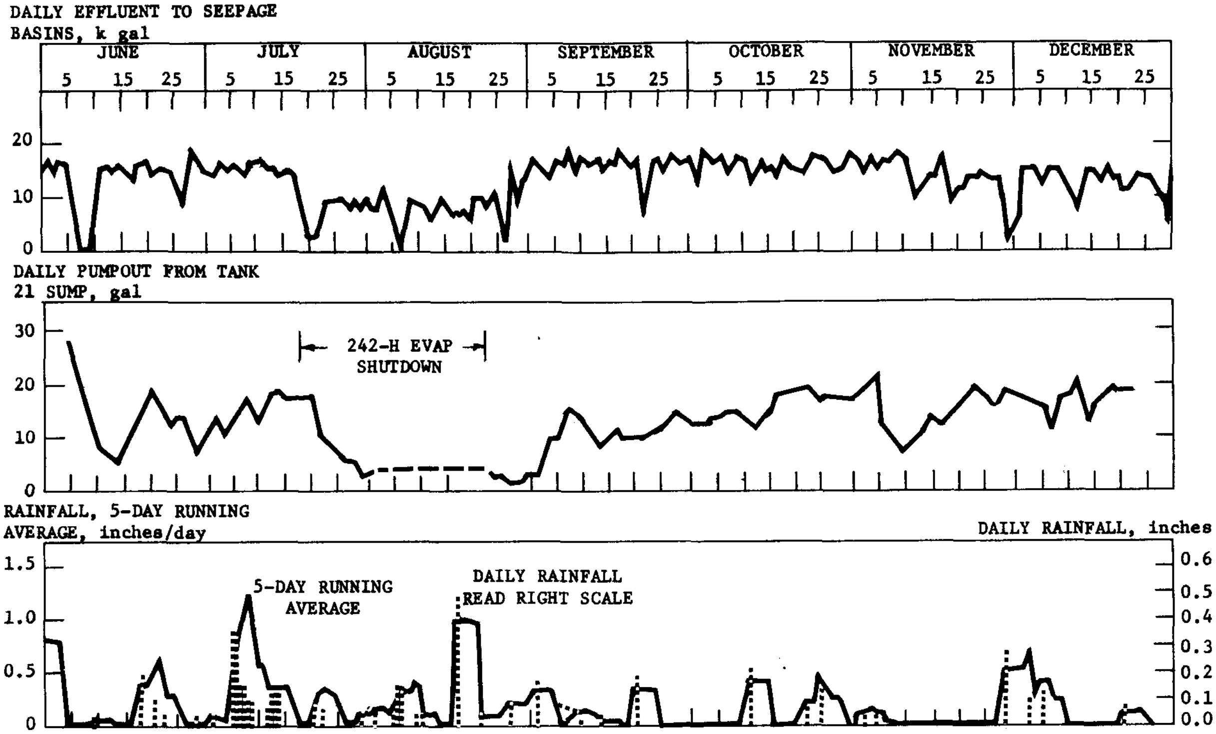


FIGURE 14. BUILDING 242-H EFFLUENT DISCHARGED, TANK 21 SUMP ACCUMULATION, AND RAINFALL, JUNE-DECEMBER 1971

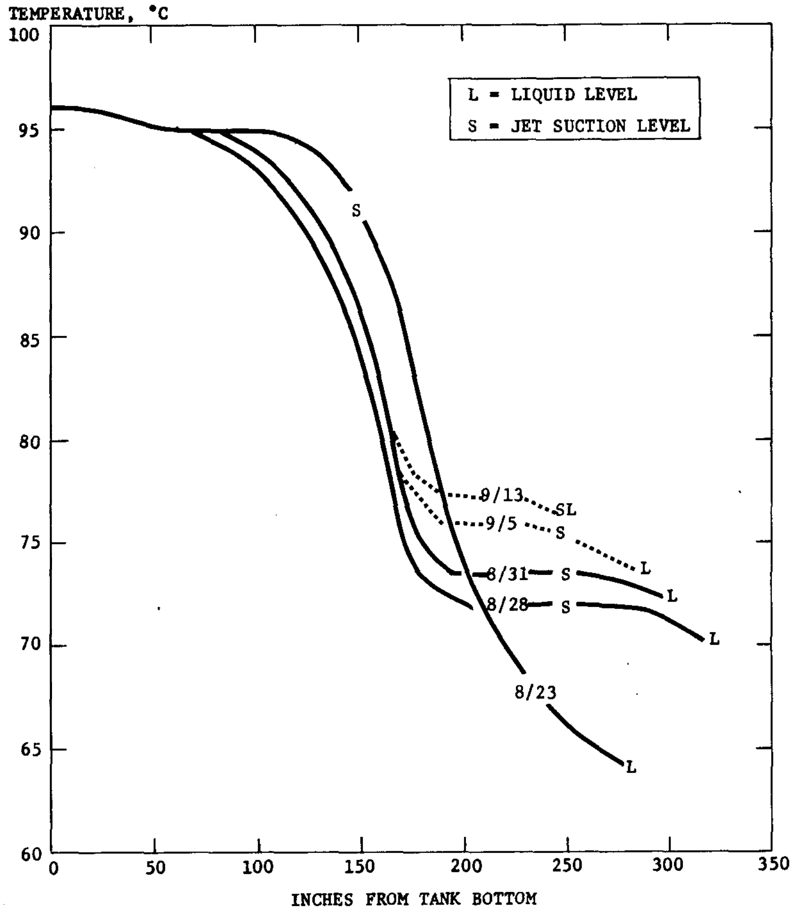
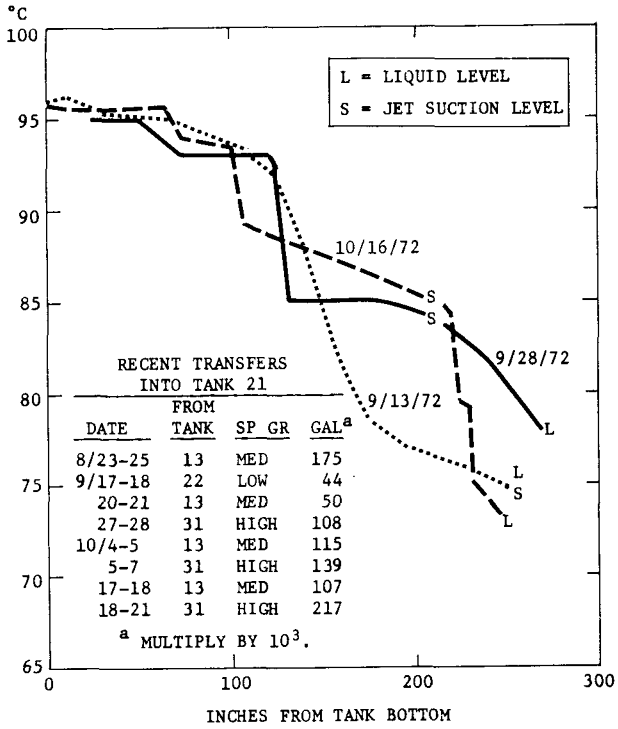


FIGURE 15. TEMPERATURE PROFILES, AUGUST-SEPTEMBER 1972



DATE	FROM TANK	SP GR	GAL[a]
8/23-25	13	MED	175
9/17-18	22	LOW	44
20-21	13	MED	50
27-28	31	HIGH	108
10/4-5	13	MED	115
5-7	31	HIGH	139
17-18	13	MED	107
18-21	31	HIGH	217

[a] MULTIPLY BY 10^3.

FIGURE 16. TEMPERATURE PROFILES, SEPTEMBER-OCTOBER 1972

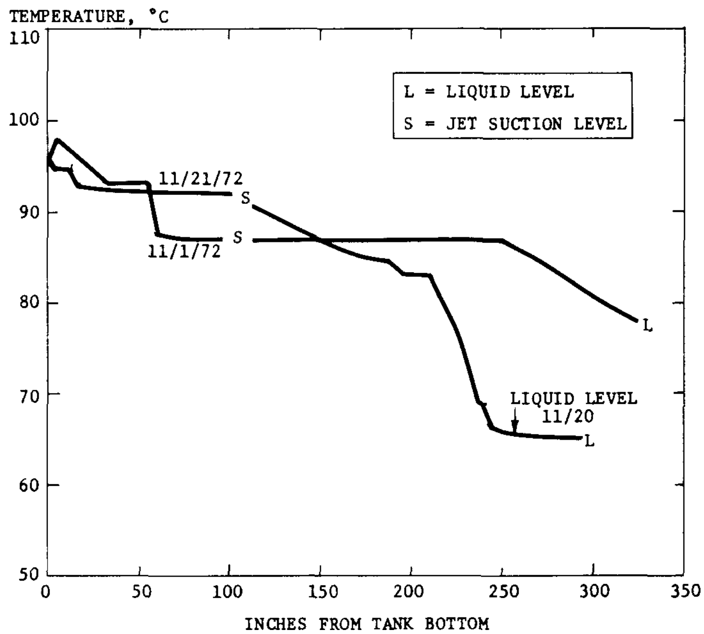


FIGURE 17. TEMPERATURE PROFILES, NOVEMBER 1972

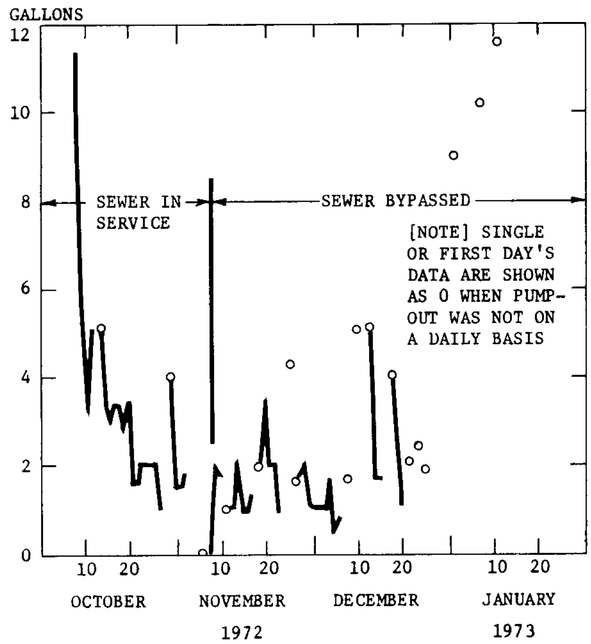


FIGURE 18. TANK 21 BOTTOM SUMP PUMPOUT

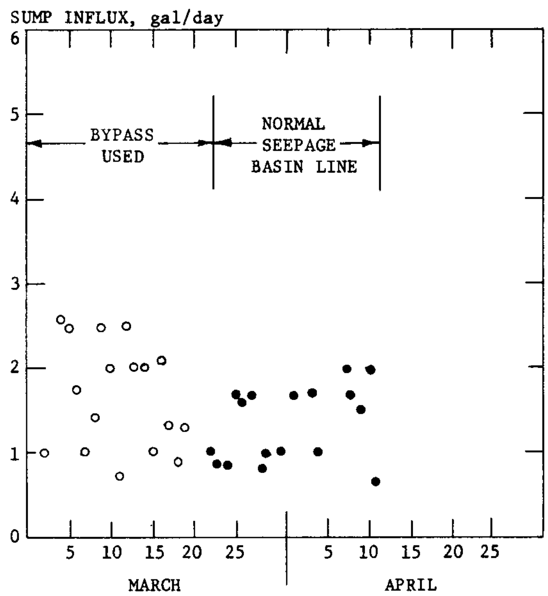


FIGURE 19. CONTAMINATED WATER INFLUX INTO THE BOTTOM LEAK DETECTION SUMP

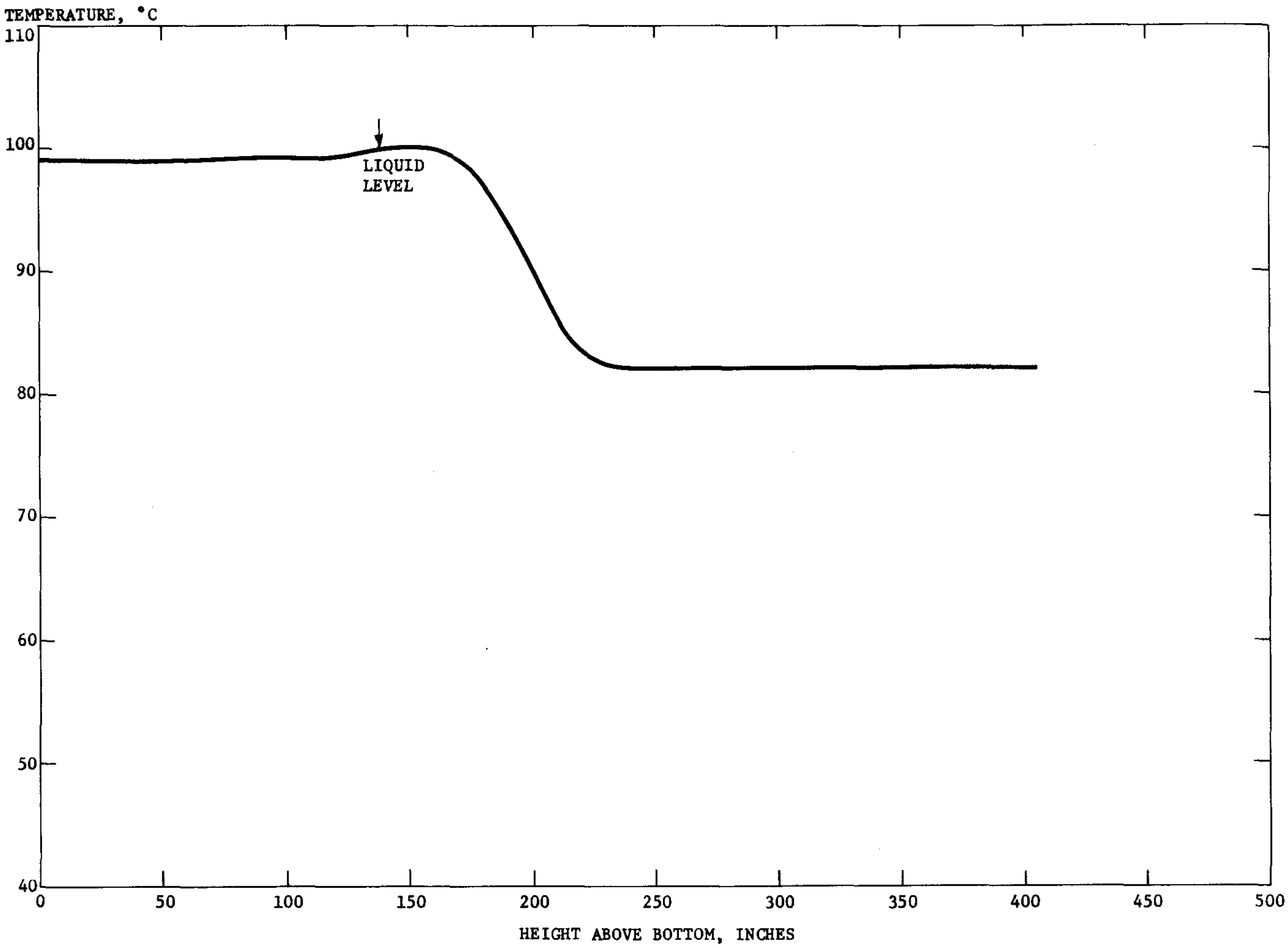


FIGURE 20. TEMPERATURE PROFILE, OCTOBER 1974

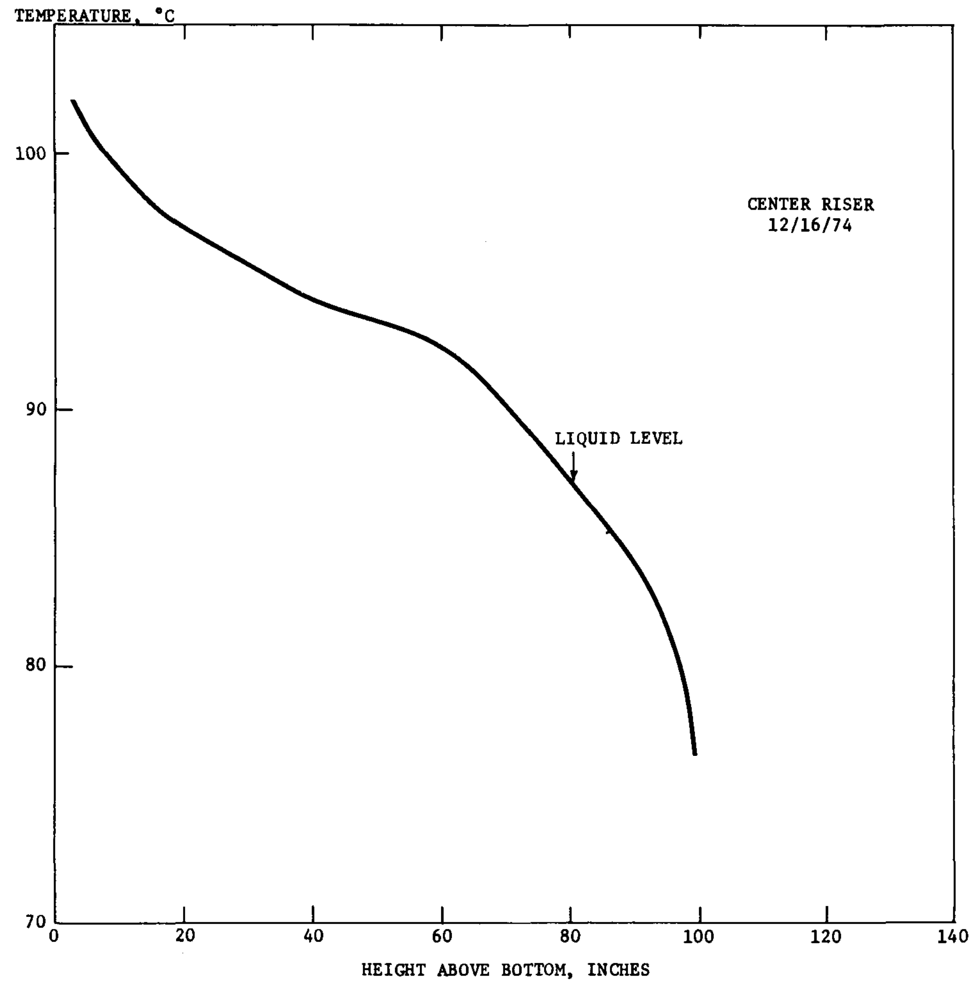


FIGURE 21. TEMPERATURE PROFILE, DECEMBER 1974