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7 Abstract

The radioactivity contents of Hot Semiworks Waste Tank 241-CX-72 were evaluated. The tank was used for terminal storage of process waste from pilot studies of the Plutonium Uranium Extraction (PUREX) process. The tank was also used to investigate self-concentration and bumping of stored waste. Nondestructive measurements and historical documentation were utilized to estimate the amount and chemical form of plutonium contained the bottom 11 feet dry layer.

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RADIOLOGICAL EVALUATION

OF

HOT SEMIWORKS WASTE TANK 241-CX-72

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June 27, 1989

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RADIOLOGICAL EVALUATION

OF

HOT SEMIWORKS WASTE TANK 241-CX-72

EXECUTIVE SUMMARY

Alpha activity was detected in smears from a 15 ft agitator rod section removed from the 241-CX-72 tank during decommissioning activities of Hot Semiworks Facility. The presence of alpha contamination required additional evaluation of tank contents for safe disposal. Available historical records were found to be either incomplete or inadequate to ascertain the nature and quantity of the contents. Results of radiological investigations by nondestructive methods, and personal discussions with individuals associated with the Semiworks facility during its operational period, were used to augment the available data.

Records indicated that tank 241-CX-72 was used exclusively for terminal storage of waste from pilot studies of plutonium and uranium recovery by extraction (PUREX) process. A record was found indicating the existence of 61.2 pounds of uranium and 48.49 grams of plutonium in the tank. Fluids, some containing fluorine compounds, from the decontamination of the operational areas of the Semiworks following the PUREX study (and even other later transuranic separation projects) may also have gone into this tank. Studies of waste self-concentration, as well as the investigations of bumping phenomenon in waste tanks, were conducted in the tank.

Tank 241-CX-72 is a cylinder approximately 36 ft long and 40-inch diameter, located vertically in a 6-foot diameter outer caisson. In addition to two 8-inch risers, a 3-inch diameter drywell is located at the periphery of the tank. All investigations reported here were conducted inside this drywell.

Radiation dose rate and neutron flux measurements strongly suggest the presence of a minimum 10-foot layer of radioactivity at the tank bottom. The temperature readings in the drywell also support the presence of an internal energy source.

A close examination of radiation dose rates at different depths revealed a step-wise increase (approximately ten fold) in 5-foot intervals. This may have resulted from the practice at that time of maintaining as high a liquid level as practical in the self-concentrating tanks.

Gamma spectroscopic investigation, with a shielded detector equipped with a window provided evidence of the presence of radioactive material in the tank. The gamma spectrum at the 19-foot depth contained only the gamma ray of 137-Cs. Higher activity levels, and possibly other gamma emitters, are present at deeper locations.

Irradiation of indium foils at a depth of 47 feet, confirmed the presence of essentially fast neutrons. Measurements at depths below 40 feet, with a thermal neutron detector (10BF3 tube) wrapped with 0.5-inch polyethylene, 0.5-inch lead, and 0.5-inch lead with 1/16-inch cadmium foil, showed that >90% of the neutrons are of epithermal energies. The absence of thermal moderation of neutrons can be attributed to the 2% liquid reported in waste when its volume was reduced by a factor of five.

The neutron flux, determined from indium foil irradiations combined with the geometry of irradiation, resulted in a calculated value of 7 neutrons per second per cubic centimeter of a cylindrical source with uniformly distributed neutron sources.

Concentrations of transuranium isotopes, consistent with the calculated bulk neutron production rate, depends on the relative isotopic composition and, more importantly, on their chemical form of existence. Three different isotopic compositions (weapons-grade plutonium, dissolved fuel irradiated to 9% of 240-Pu, and the composition based on smear samples obtained from a deep bed fiberglass filter) and two chemical forms (oxides and fluorides) were considered.

Calculated values of plutonium present as oxide in a 11-foot activity layer for the three isotopic compositions were respectively 149, 51, and 0.65 kg. The corresponding values for fluoride forms were 1.8, 0.80, and 0.16 kg.

The estimates of 51 or 0.8 kg of dissolved fuel in the tank is unrealistic since only the unrecovered plutonium and other transplutonium isotopes of the processed fuel are most likely to be left in the waste sent to the tank. Again, assuming 2% of the plutonium content of the processed 9% burnup fuel as being present in the tank waste, the calculated fissile content values were 8070 and 290 grams as oxide and fluoride forms,respectively.

Based on an objective assessment and evaluation of all pertinent data it was concluded that the 11-foot activity layer at the bottom of tank 241-CX-72, at the Hot Semiworks, contains fission products mixed with a conservatively estimated 150 to 200 grams of plutonium.

1.0 INTRODUCTION

The Hot Semiworks was a chemical processing facility constructed to test existing and proposed separation processes, as well as to evaluate full scale equipment under actual conditions. This facility located in the "C" site of the 200 East area at Hanford. It consists of a canyon-type, 3-cell, concrete, partially below-grade, "hot" process building, and other auxiliary structures [1]. Process improvement and flow sheet refinement studies, for the reduction and oxidation (REDOX) process, were conducted when the facility was brought into operation in 1951. Pilot plant investigations of plutonium/uranium recovery by extraction (PUREX) process [2], lasted for about one year following the completion of REDOX process studies and decontamination of the operational areas. The facility, subsequent to decontamination following PUREX process development, was placed on a stand-by status in July 1957, until its reactivation for a short period in 1961, for strontium recovery [3]. The same facility is believed to have been used for the recovery of americium and curium isotopes [4] prior to declaring the plant as a surplus facility in 1967. The final decontamination and decommissioning (D&D) of Hot Semiworks started in 1983.

In October 1988, a mixer agitator rod was pulled approximately 15 feet out of a tank, identified as 241-CX-72, by heavy equipment used for D&D work. A radiological survey [5] of the component revealed significant levels of alpha activity and the equipment was buried as low level waste (LLW) based on design calculations [6]. Neutron flux measurements [7] indicated the presence of a >10-foot thick, dry, transuranic (TRU) activity layer at the bottom of the tank. Beta/gamma dose rate readings [8], taken subsequent to neutron measurements, were consistent with this conclusion.

This report presents the results of investigations conducted and nondestructive assays performed for a radiological evaluation of tank 241-CX-72 contents. A search for the complete history and documentation of the facility [9], and an engineering study [10] for decommissioning the tank, were initiated to proceed in parallel that will result in separate reports.

2.0 BACKGROUND HISTORY OF TANK 241-CX-72

Tank 241-CX-72, shown in Figure 1, was installed at the Hot Semiworks in 1956. The only inlet to the tank is from the "A" cell of 201-C building, and there is no exit from the tank [11,12].

The cylindrical tank approximately 36-feet long, 40-inch diameter was set vertically in a 6-foot diameter outer caisson. The top of the tank was 13.7 ft below-grade [13], and was equipped with two 8-inch risers, and a 3-inch diameter drywell at the periphery of the tank.

Historical records indicate that tank 241-CX-72 received process waste [14], with additional information in the records to suggest that 8723.9 L of waste, exclusively from pilot studies of PUREX process, and containing 61.2 pounds of uranium, and 48.49 grams of plutonium entered this tank for terminal storage. This tank was also used in experimental studies of self-concentrating wastes [12,15]. The presence of 74.5 inches of sludge, including 1 inch of liquid, was reported [12] in 1974. Attempted sludge measurements and visual inspection, in November 1976, indicated the absence of any material in the tank. Finally, based on a 1978 "record" of the tank as being empty, it was filled with grout in 1986.

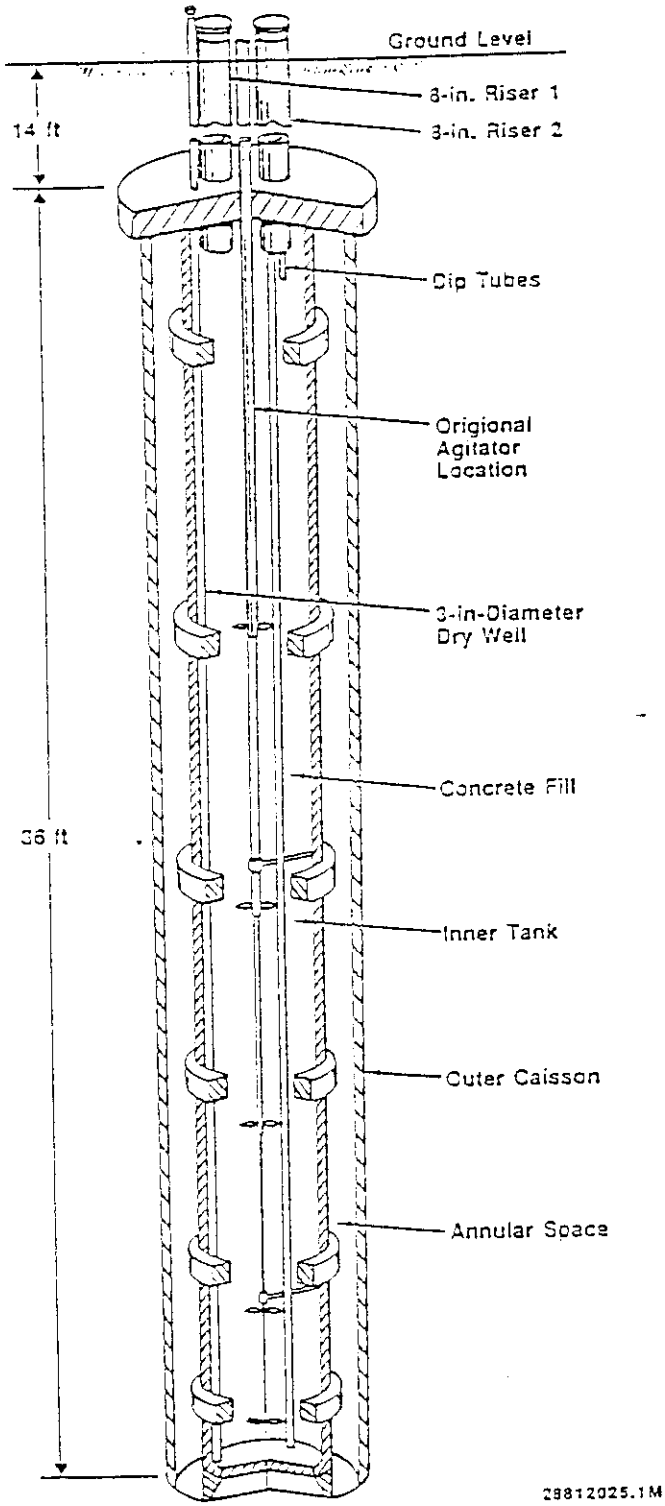

Figure 1

Schematic of Hot Semiworks Waste Tank 241-CX-72

3.0 RADIOLOGICAL CHARACTERIZATION METHODS

The expected radioactivity content of tank 241-CX-72, apart from the inert grout poured in 1986, prompted the undertaking of nondestructive measurements in order to identify qualitatively the contents, and to quantify their amount whenever possible. All the measurements described here were made by introducing the appropriate equipment into the 3-inch diameter drywell located at the periphery of the tank. The above-grade flange of the drywell was used as the reference plane for depth identification. Record drawings indicate that the bottom of the tank should be 51 ft below the drywell flange. However, during measurements in January 1989, the bottom of the drywell was at 48 foot. A depth of only 46 foot could be reached during investigations in May 1989. Details of the various measurements are described below.

3.1 Gamma Spectroscopic Survey

Measurements were initiated to identify specific gamma emitters present in the tank contents, by using a 1-inch diameter, 1-inch long NaI(Tl) detector. The cylindrical detector was wrapped in a 0.5-inch lead shield with a 5/8-inch circular aperture at the middle of the detector. Gamma spectra could not be accumulated at or below the 20-foot depth because of high levels of activity. Gamma spectra were collected at the 19-foot depth and analyzed. Four spectra were recorded, starting with the collimator directed towards the center axis of the tank, and by rotating the window in 90 degree increments. This approach was intended to determine whether the detected gamma activity is indeed located in the tank.

3.2 Relative Axial Neutron Flux Profile

The neutron flux profile along the length of the drywell was determined in January 1989 using a 1.5-inch diameter, 8-inch long detector, filled with 10BF3 gas. The active region of the detector was surrounded by 0.25-inch lead in order to reduce the potential interference from gamma flux. This measurement was undertaken to establish the distribution with depth of neutron sources that are present in the formation surrounding the drywell. The observed count rate, at discrete positions along the axis of the drywell, is proportional to the neutron flux experienced by the detector.

Similar measurements were also made in May 1989, but using a different 10BF3 detector, and surrounded by 0.5-inch polyethylene, 0.5-inch lead, or 0.5-inch lead with an additional layer of 1/16-inch cadmium.

3.3 Neutron Flux Measurements

The methodology of American Society for Testing and Materials (ASTM) method E-262-77 [16] was used to determine the neutron flux at the 47-foot depth in the drywell. Indium metal foils were selected for irradiation because of the potential to detect simultaneously products of two different nuclear

reactions: 115-In (n,gamma) 116m-In and 115-In (n,n') 115m-In. The gamma activities from the two products provide a means of calculating the respective fluxes of thermal neutrons, and of neutrons with energies between 1.2 and 5.9 MeV.

Neutron activation of indium foils was initiated primarily to confirm the presence of neutrons and quantify their flux. A 2-inch diameter indium foil enclosed in a thin polyethylene bag, was irradiated overnight and the activities of the product(s) determined by gamma energy analysis using a precalibrated hyperpure intrinsic germanium (HPIGe) detector.

3.4 Axial Temperature Profile

The temperature, at different positions along the axis of the drywell, was measured using a standard K-20 thermocouple. The 12-inch long probe, with its sensing position pointed downward, was suspended by a 2-lead wire provided with the unit, and attached to the read out unit at the surface. The wire was kept taut by a weight attached to the thermocouple. The calibrated condition of the thermocouple was confirmed by surrounding the junction with compacted atmospheric precipitation in the form of snow.

Temperature readings were taken with the thermocouple junction at various positions allowing the reading to reach a stable value. Readings were taken at 1-foot intervals.

3.5 Axial Dose Rate Profile

The beta/gamma dose rate readings were taken at various depths using a high range (500 R/hr) direct reading instrument. These measurements were made by D&D personnel and are included here for completeness.

4.0 ADDITIONAL INVESTIGATIONS

The details of the tank history can be found in the Standby Status Report of Hot Semiworks [14]. Information recorded in later documents was found to be inconsistent and even contradictory at times. This difficulty constantly encountered made it difficult to assess the composition and nature of the material present in the tank.

Attempts were made to contact individuals who are familiar and/or associated with Semiworks operations. This effort was intended to clarify some of the inconsistencies found, as well as to obtain details that were not otherwise easily available. The search started with persons presently in the Hanford work force and was extended by following the references provided. The information was gathered in conversations with Messrs L.E. Kusler, A.M. Platt, B.J. Saueressig, R.E. (Roy) Tomlinson, and F.W. Woodfield. Two other individuals, who could not be contacted but may have relevant information in their possession, were Max Kreiter and John Springer.

5.0 RESULTS

The results of relative axial profiles of neutron flux and dose rate measurements are given in Table I and shown in Figure 2. The temperature readings, measured at different positions along the 3-inch diameter drywell, are also given in Table I.

Three smears from the "hot" end of the agitator rod pulled out of the 241-CX-72 tank were reported [6] to contain, respectively, alpha activities of 2000, 7000, and 8000 disintegrations per minute (dpm). Gamma activities of 2.64E3, 4.46E3, and 5.81E3 pCi in each of the three smears were also reported with a beta/gamma ratio of 25:1.

The gamma spectrum, at the 19-foot depth in the drywell, showed the presence of only 137-Cs. Maximum activity of this isotope was observed with the collimator window directed towards the center axis of the tank. A 40% lower value was detected when the window was rotated 180 degrees.

The gamma spectrum of indium foil exposed overnight to neutrons, at the 47-foot depth, contained only the 341 keV gamma ray attributable to the (n,n′) reaction with a 174 mb cross-section. Intense gamma rays expected from the thermal neutron capture product with 157 b formation cross-section [17] were not observed. Epithermal energies of the neutrons at this location were confirmed by count rates of a thermal neutron detector wrapped with different shielding materials as shown in Table II.

A neutron flux value of 141 neutrons per sq. cm per second was calculated from the measured activity of the (n,n′) reaction product and the irradiation parameters. Taking into consideration the irradiation geometry [18], verified by numerical integration [19], the measured flux corresponds to a bulk neutron generation rate of 7 neutrons per second per cubic centimeter.

The following information was obtained in telephone conversations with individuals familiar with Semiworks and its operational history.

The waste discharged to tank 241-CX-72 for terminal storage came exclusively from pilot studies of PUREX process development. The wastes discharged to tanks 70 and 71 came only from REDOX process flow sheet improvement studies [12] at the Semiworks facility.

It was learned from B.J. Saueressig that the tanks 70, 71, and 72 did not receive any waste from the strontium recovery campaign that was also conducted in the facility.

TABLE I

RELATIVE AXIAL PROFILES
OF
NEUTRON FLUX, DOSE RATE AND TEMPERATURE
IN
SEMIWORKS TANK 241-CX-72

Depth (ft)	Neutron Flux (cpm)	Dose Rate (mrem/hr)	(°F) Temp
30	1.06E3	3.80E3	
31		6.34E3	
32	1.36E3	6.45E3	59.4
33		8.75E3	60.2
34	1.42E3	1.52E4	60.8
35	5.72E3	1.88E4	61.5
36	1.35E4	4.11E4	61.9
37	7.05E4	7.75E4	62.4
38	2.18E5	1.68E5	63.0
39	9.34E5	2.72E5	63.4
40		2.65E5	64.0
41	1.50E6	2.58E5	64.8
42	1.52E6	2.93E5	65.5
43	1.33E6	2.88E5	66.0
44	1.26E6	3.01E5	66.5
45	1.29E6	3.04E5	66.7
46	1.31E6	4.91E5	67.4
47	1.65E6	4.76E5	72.0
48	2.16E6		72.2

TABLE II

ENERGY MODERATION
AND
RELATIVE AXIAL NEUTRON FLUX
IN
SEMIWORKS TANK 241-CX-72

Depth (ft)	Neutron Count Rate (cpm) Poly[1]	Lead[2]	Lead + Cd[3]
40	92160	12316	5266
42	116350	14080	5716
44	107700	13590	5704
46	141760	26454	10214

[1]Polyehylene 0.5 in

[2]Lead 0.5 in

[3]Lead, 0.5 inch + 1/16 Cd

It was learned from R.E. Tomlinson, one of the engineers engaged in development work at the Hot Semiworks, that the contents of tank 241-CX-72 consist of liquid high level waste (HLW) from the pilot scale studies of PUREX process. This tank was also reported to have been used to investigate self-concentration of wastes and the "bumping" associated with wastes with internal energy source or when the energy is provided from an external source such as a heater.

It was also learned, from conversations with Mr. Tomlinson, that tank 241-CX-72 received liquid waste from "heel" recovery studies, as well as from zirconium cladding dissolution investigations processes, that most likely utilized fluorides and/or fluorinated solvents. Also mentioned was a plan to discharge into tank 241-CX-72, solutions containing fluoride ion used for decontaminating the operational areas [20,21].

The information gathered in conversations with R.E. Tomlinson, was for the most part corroborated by F.W. Woodfield, who was a Manager at the Hot Semiworks during the pilot studies.

6.0 DISCUSSION OF RESULTS

The measured 40% higher activity of 137-Cs, with the collimator window directed towards the center axis of tank 241-CX 72, at a depth of 19 feet, provides strong support for the presence of fission product activity in the tank. Because of the 75% attenuation of 137-Cs photons by the 1/2-inch lead shielding, and a fairly wide field of view through the collimator window (103 degrees of arc), it was not possible to detrermine the likely existence of 137 Cs activity as a thin layer on the walls of the tank and/or outer surface of the drywell. Measurements of a similar nature with a narrower view cone are required to confirm or refute this possibility. Sudden increase of activity with possible presence of other gamma emitters, at about the 20-foot depth, precluded the accumulation of gamma spectra below the 19-foot depth.

The relative neutron flux and radiation dose profiles (see Table I and Figure 2) clearly indicate the distinct boundary of an activity layer at a depth of about 40 feet. The constant levels of these two profiles suggest the uniform distribution of activity in the contents of the tank at depths below 40 feet, with likely higher concentrations in the bottom 2 to 3 feet. This activity region can be determined to be approximately 11 feet based on the record drawings of tank 241-CX-72 that establish the bottom of the tank at a depth of 51 feet.

A close examination of the radiation dose readings of Table I revealed that the dose rates can be approximated by a constant value in 5-foot length segments. This step-wise (approximately tenfold) increase in dose rate every 5 feet is most likely a consequence of the then practice of maintaining as high a liquid level as possible in self-concentrating tanks.

The investigation of neutron flux measurement with indium foil irradiation, at the 47 foot depth, resulted in the observation of only the 341 keV gamma ray of the product formed by (n,n') nuclear reaction. The detection of the product, with a formation cross-section of only 174 mb, and the absence of expected intense gamma rays from the thermal neutron capture product 116m-In, with a formation cross-section of 157 b, clearly suggests that the thermal neutrons constitute only a negligible fraction of the neutrons at that depth.

The epithermal energies of neutrons at the 47 foot depth, in the 3-inch diameter drywell, was further supported by the investigations with a thermal neutron (10 BF3) detector. The ratio of neutron count rates of approximately 3 at depths below 40 feet (See Table II) with a 0.5-inch lead shielding, and with the additional 1/16-inch layer of cadmium confirm that the energies of neutrons are above the cadmium cut-off energy of 0.5 eV. A significant increase in neutron count rate observed by replacing the lead shield by an equal thickness of polyethylene is further evidence of the epithermal energies of the neutrons. These neutron count data can be shown to be consistent with a system in which epithermal neutron represent greater than 90% of the total neutron present.

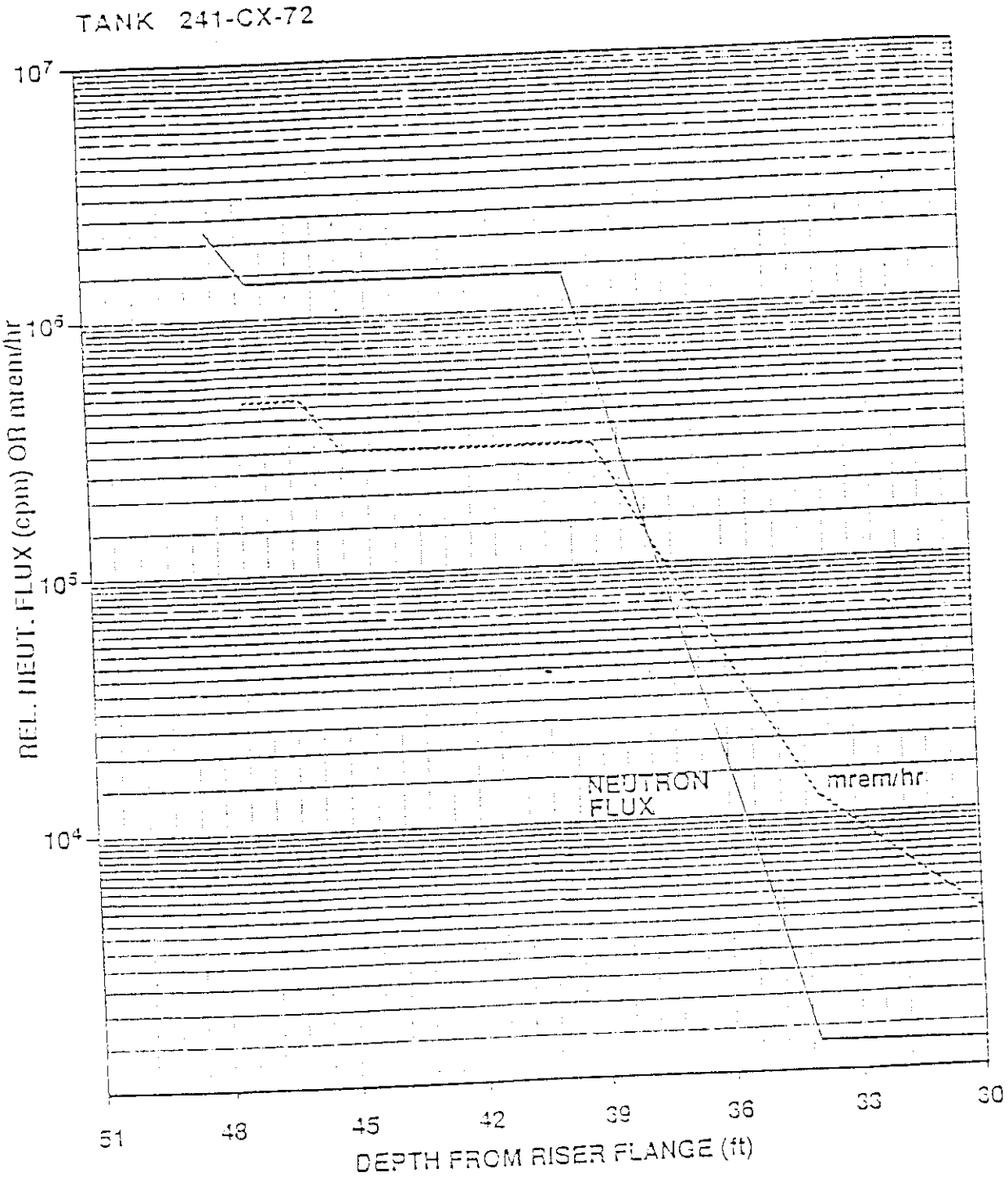

Figure 2

Profiles of Relative Axial Neutron Flux

and

Radiation Dose

The observation of high energy neutrons generated in the contents of tank 241-CX-72, and the apparent absence of any moderating constituents can be reconciled on the basis of the information from historical records and the reported results [21] of self-concentration of waste stored in tanks. The addition of 8724 liters of liquid waste to tank 241-CX-72, prior to 1957, reported containing 61.2 pounds of uranium and 48.49 g of plutonium [14], was reported in 1974 to occupy 74.5 inches of the 40-inch diameter tank with only 1 inch of liquid [12]. This is equivalent to a reduction in volume in excess of a factor of 5. This observation, coupled with the experimental data from waste concentration studies [21] that reported less than 2% liquid content when the waste volume was reduced by a factor of 5, and the lapse of time since 1974, leads to the conclusion that the sediment layer at the bottom of tank 241-CX-72 is essentially free of any liquid; hence, the absence of any neutron energy moderating constituents.

The recorded absence of any material in this tank in 1978, attempts at sampling and waste inspection, could possibly be due to a compact, dry layer at the bottom of the tank, with the remainder of the tank volume being void space. Also, this interpretation led to the filling of the assumed "empty" tank with grout in 1986. The poor structural integrity of the grout was indicated by the examination of a 2-foot core specimen retrieved recently from one of the 8-inch risers of the tank. Measurements performed with an Acme penetrometer indicated penetrability of 500 to 945 psi in the confined core.

The indium foil irradiation data allowed for the evaluation of an epithermal neutron flux of 141 neutrons per second per square centimeter. Based on the geometry of irradiation, and utilizing a reasonable relaxation length of 25 cm, this flux was shown to be 20 times the specific bulk neutron production rate (neutrons per second per cubic centimeter). This conversion factor was also confirmed by a numerical integration method [19]. It was therefore concluded that 7 neutrons per second per cubic centimeter are being generated in the 40-inch diameter cylindrical source with uniformly distributed neutron sources.

The neutrons generated in the 11-foot activity layer arise from spontaneous fissions and by (alpha,neutron) reactions. Therefore, any attempt to calculate the bulk concentration of transuranium isotopes requires not only a knowledge of the TRU isotope composition but also the chemical form of these isotopes. The latter chemical form of the isotopes is of great significance because of the two orders of magnitude higher cross section for the (alpha, neutron) reaction with F atoms compared to oxygen atoms that are chemically bound to the alpha decaying nucleus.

Three different isotopic compositions, (See Table III), weapons-grade plutonium, dissolved fuel irradiated to 9% buildup of 240-Pu and the isotopic composition of smears from a deep bed fiberglass filter (DBFF) [4] in addition to the oxide and fluoride chemical forms of TRU isotopes were used to estimate the TRU quantity in the tank contents. The TRU content

TABLE III

ISOTOPIC COMPOSITIONS (WT %) USED
FOR
CALCULATING TRU CONTENT

Isotope	WG[1]	9% BU Fuel[2]	DBFF[3]
Pu-238	0.012	7.07E-2	1.70E-2
Pu-239	93.8	87.8	88.1
Pu-240	5.8	10.0	5.3
Pu-241	0	0.49	5.0E-2
Pu-242	0.002	0.11	---
Am-241	0.3	1.56	6.3
Cm-244	1E-6	2.69E-4	0.21

[1]Weapons-Grade material from Reference 22.

[2]Fuel Burnup to 9% Pu-240 from Reference 23.

[3]Deep Bed Fiberglass Filter Smears from Reference 4.

based on different fractions of the plutonium content of the processed 9%Pu-240 burnup fuel being present in the waste,in addition to the fission products and transplutonium isotopes, was also calculated as shown in Table IV.

The calculated plutonium values, with all TRU isotopes present as oxides and fluorides, present in an 11-foot layer of activity in tank 241-CX-72, consistent with the measured bulk neutron production rate are given in Table IV. Based on these values, it can be concluded that the only chemical condition of the TRU isotope that is reasonable is the fluroide form. The presence of an estimated 51 and 0.80 kg of dissolved 9% Pu-240 burnup fuel was also considered unrealistic because the waste discharged to the tank for terminal storage contained only the unrecovered plutonium that was originally present in the processed fuel. For this reason, the plutonium content of the activity layer corresponding to the plutonium losses to waste of 1 to 10% are also given in Table IV. It can be seen that the estimated 157 grams of plutonium in the tank, based on DBFF isotopic composition in fluoride form, corresponds to about 1% of unrecovered product to be present in the waste discharged to the tank. This conclusion is not unreasonable because of the pilot nature of the studies conducted in the initial stages of PUREX process development.

Additional support for the estimated plutonium content of tank 241-CX-72 is provided by actual analyses of sludge specimens from tank 241-CX-70 [24]. The reported 239/240-Pu activity was 253 uCi/L of centrifuged sludge that constituted 42 vol% of the specimen. This tank received waste exclusively from REDOX process flow sheet refinement investigations, with <0.1% plutonium losses. Based on this result. plutonium content of tank 241-CX-72 can be calculated as 12 grams. Incorporation of 1% plutonium losses (in the developmental stages of PUREX process as compared to <0.1% in REDOX process), results in a plutonium content of 120 grams in tank 241-CX-72.

An objective assessment of pertinent information found in historical records and its technical evaluation, the plutonium content of the 11-foot activity layer at the bottom of tank 241-CX-72 can be concluded to range between 150 and 200 grams. This estimate can only be confirmed by actual analysis of a sample obtained from this region of the tank. A sampling of tank CX-72 contents, when implemented, can be augmented by analyzing the specimen for hazardous components. The expected reports based on a search of historical records [9] and the outcome of an engineering study for decommissioning of the tank [10] when combined with the conclusions reached in this report, are expected to help in the selection of an appropriate, prudent, and cost effective approach for an eventual disposal of the tank.

TABLE IV

ESTIMATES OF PLUTONIUM IN TANK 241-CX-72

Isotope Comp*		Plutonium Content (g) Oxide	Fluoride
WG		1.49E-5	1751
% Pu in Waste**;	100	5.11E-4	800
	10	2.76E-4	489
	5	1.72E-4	473
	2	8.07E-3	290
	1	3.62E-3	151
DBFF		645	157

* See Table III.

** Percent Pu of 9% Pu-240 fuel in waste in addition to transplutonium isotopes of fuel.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions can be reached based on an evaluation of the information presented in this report.

A layer of radioactivity, approximately 11 feet in thickness, exists at the bottom of tank 241-CX-72. The activity is comprised of fission products and transuranium isotopes.

The tank received process waste for terminal storage, exclusively from pilot studies of PUREX process. Fluoride ion containing effluents from decontamination of operational areas of the Semiworks facility and/or other investigations may have also been discharged into this tank.

The activity layer is dry and does not contain any hydrogenous materials to thermalize the neutrons generated within the contents of the tank.

The TRU content of the activity layer was estimated using the measured neutron flux and assumed isotopic composition and chemical forms of the elements. Such estimates, using three possible isotopic compositions, and two chemical forms (oxides and fluorides), suggest very strongly that the TRUs are present as fluorides.

Calculations of plutonium content in the activity layer, using realistic and reasonable isotopic compositions, resulted in a conservative estimate of 150 to 200 grams. This estimate is also consistent with recent analyses of sludge from tank 241-CX-70, that is known to contain REDOX process waste with <0.1% plutonium losses to waste, provided the 241-CX-72 tank waste (from pilot studies of PUREX process) contains 1 to 2% of plutonium originally present in the processed fuel.

Estimates of plutonium can only be confirmed or refuted by direct analysis of representative specimens retrieved from the tank. Sampling of the bottom layer of tank 241-CX-72 is recommended. Radiochemical characterizations should be augmented by analyses for hazardous waste designation. This approach requires adhering to mandated sampling and documentation protocol.

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