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Characterization of Nuclear Decontamination Solutions at the Idaho Chemical Processing Plant from 1982 to 1990

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ABSTRACT

This report represents possibly the single largest collection of operational decontamination data from a nuclear reprocessing facility at the Idaho National Engineering Laboratory and perhaps anywhere in the world. The uniqueness of this data is due to the Idaho Chemical Processing Plant's (ICPP's) ability to process different types of highly enriched nuclear fuel. The report covers an 8-year period, during which six campaigns were conducted to dissolve nuclear fuel clad in stainless steel, aluminum, graphite, and zirconium. Each fuel type had a separate head-end process with unique dissolution chemistry, but shared the same extraction process equipment. This report presents data about decontamination activities of the ICPP's First Cycle extraction vessels, columns, piping, and aluminum dissolution vessels. Operating data from 1982 through 1990 has been collected, analyzed, and characterized. Chemicals used in the decontamination processes are documented along with quantities used. The chemical solutions are analyzed to compare effectiveness. Radioisotopic analysis is recorded, showing and quantifying what nuclides were removed by the various solutions. The original data is also provided to make it possible for researchers to address questions and test other hypotheses not discussed in this report.

SUMMARY

Decontamination activities from 1982 through 1990 at the ICPP First Cycle operation have generated nearly 270,000 gal of unprocessed liquid waste. Approximately 13,000 curies have been removed, which accounts for over 32,000 Roentgens/hour (R/h) cleaned from First Cycle equipment.

From 1982 through 1990, five types of nuclear fuel were dissolved and processed through the ICPP. Each fuel type presented unique problems. Different fuel cladding, burnup, and cooling times contributed to the radionuclide distribution that remained in the process equipment, which had to be removed before maintenance activities could be done.

The major fuel types were:

- Electrolytic, Stainless Steel Cladding (Fuel Campaign #37)
- Aluminum Cladding (Fuel Campaign #38)
- ROVER, Graphite (Fuel Campaign #39)
- Aluminum Cladding (Fuel Campaign #40)
- FDP, Zirconium Cladding (Fuel Campaigns #41 and 42).

Fuel campaign #37 was the last Electrolytic dissolution of stainless-steel-clad fuel. Decontamination activities occurred in 1982. The fuel had cooled for a short time, resulting in large quantities of Ru-106 in the process equipment. The decontamination solution that proved most effective in removing the Ru-106 was potassium permanganate in nitric acid. Nearly 60% of the Ru-106 was removed with this acidic permanganate solution. This decontamination generated 52,000 gal of unprocessed waste, and 1,950 kg of sodium and potassium went to the waste tanks. It required 171 flushes to remove 1,140 curies, which accounted for the removal of 1,070 R/h. Ru-106 accounted for 60% of the activity removed.

Fuel campaign #38 dissolved an aluminum-clad fuel in the G cell. Decontamination activities during 1983 removed large quantities of Zr-95 and its daughter Nb-95. Ru-106 only accounted for 4% of the activity, while Zr/Nb-95 made up 70%. The acidic permanganate solution did poorly in removing contamination. However, a solution of sodium hydroxide and tartaric acid proved extremely effective. This caustic tartaric solution removed 54% of the activity in curies. Solids removed from the floor were soluble in sodium hydroxide but not in nitric acid. Nearly 59,000 gal of unprocessed waste was generated, containing approximately 2,300 kg of sodium and potassium. It took 174 flushes to remove 5,730 curies, which accounted for about 21,500 R/h.

The ROVER fuel campaign #39 burned graphite-clad fuel and recovered the uranium. The fuel was not radioactively very hot. Decontamination of the First Cycle took place in 1984. Only 9 curies were removed during the cleaning activities. This decontamination generated approximately 10,000 gal of unprocessed waste, containing about 300 kg of sodium and potassium. The distinctive feature of this decontamination was the presence of large quantities of ROVER bed material spread throughout First Cycle equipment. Many vessels had to have a bottom process line cut so solids could be flushed out onto the floor. Fortunately, the solids contained few fission products.

Fuel campaign #40 dissolved another aluminum-clad fuel in the G cell. Decontamination occurred in 1986. For the first time, a decontamination solution developed by WINCO was used. This oxalic acid in

nitric acid solution proved to be the most effective solution for removing fission products. Decontamination consisted of 145 equipment flushes generating 58,500 gal of unprocessed waste. Approximately 1,500 kg of sodium and potassium was sent to waste. Total activity removed was 1,060 curies, accounting for approximately 2,510 R/h. The major fission products removed, in curies, were Sb-125 at 40% and Zr/Nb-95 at 27%. From a dose perspective, the major contributors removed were Zr/Nb-95 at 51% and Cs-134/137 at 33% of the R/h removed. The second-most effective solution was caustic tartaric.

The last major First Cycle decontamination occurred following the Fluorinel Dissolution Process (FDP) zirconium-clad fuel in campaign #41 and 42. This was the first zirconium-clad fuel dissolution at FDP. Fission products removed were significantly different from any previous decontamination. There were no curies of Zr/Nb-95 removed. Ru-106 accounted for 45%, and Cs-134/137 made up 36% of the curies removed. The major contributors to dose were Cs-134/137, which accounted for 77% of the R/h removed, and Ru-106, which accounted for 16%. For the first time, Turco 4502 removed the most activity as measured in curies. This is a caustic permanganate solution. The INEL-developed, HNO_3/oxalic acid was the next-best solution in removing curies. Hydrofluoric acid was used in two separate situations and proved to be a very poor decontamination solution for this type of fuel. The decontamination removed 4,650 curies that accounted for about 7,400 R/h. The decontamination took 132 flushes and generated 91,000 gal of unprocessed waste. Approximately 4,600 kg of sodium and potassium were sent to waste.

The 8 years covered by this report represent a unique period in the history of nuclear fuel reprocessing. It became obvious early in this project that each major decontamination was different from any other. It should never be assumed that if a solution was effective for one type of fuel that it will be useful for another. The importance of sampling spent solutions cannot be over-emphasized. Without this type of process data, it is impossible to select appropriate solutions to address specific problems.

The major fission products removed varied dramatically with the type of fuel dissolved. Historically, Zr/Nb-95 have been the major isotopes removed, in curies, yet after dissolving the zirconium-clad fuel, no Zr/Nb-95 was detected. Once the absence of Zr/Nb-95 was discovered, decontamination solutions effective for the remaining fission products were selected. The major isotope was Ru-106. The Electrolytic decontamination following the stainless steel dissolution also had large quantities of Ru-106, which was removed effectively by acidic permanganate. However, the acidic permanganate proved of little use following the zirconium-clad fuel. Instead, a solution of caustic permanganate adequately removed the Ru-106 from the zirconium fuel. This information was detected by examining sampling results and helps to illustrate the importance of adequate analysis during decontamination activities.

As each flush was completed, it was sampled. These flushes were analyzed and the activity removed per flush was plotted. Generally, these plots showed a logarithmic type curve. The first few flushes removed relative large amounts of activity and then the removal dropped off sharply. However, caustic solutions would often cause a spike in the graph, illustrating that these solutions can remove contamination left behind by acidic flushes. Control of the decontamination involved the use of these graphs. Once the decontamination had progressed to the flat portion of the graph and caustics no longer produced spikes, then it was time to stop the decontamination or find out if any lines or other equipment had been missed.

Missed equipment did pose special problems. Sometimes bellow valves would develop internal leaks and during processing could accumulate hundreds of R/h. Decontamination solutions could not adequately penetrate these ruptured valves, so continued flushing would not reduce the radiation field around the valves. However, by knowing the valves were hot and that decontamination solutions had not removed the contaminations, the valves could easily be shielded, cut out and replaced without generating large volumes of waste. This issue was always a trade off between reducing waste volumes and maintaining workers radiation exposure to ALARA practices. Cells required personnel entry to repair, replace or modify equipment. This work was not designed for remote access and the usefulness of robotics was very limited due to the cell's design.

ACKNOWLEDGMENTS

This report was made possible by the efforts of many dedicated individuals working at the ICPP. Operations personnel spent thousands of hours preparing decontamination solutions, performing valve line ups, transferring solutions through every vessel, column, and process line in each cell. These individuals pulled nearly 500 radioactive samples for needed analyses. Sampling was usually complicated by plugged or restricted lines and many samples were obtained due solely to the dedication and ingenuity of the operators. These individuals were exposed to additional radiation whenever a sample was pulled. Without their diligence, persistence, and patience, valuable information would never have been obtained.

The analytical personnel provided state of the art radioisotope identification. Sample turnaround times were short enough to enable operations identification of less effective solutions and replace them with more effective chemicals. Their professional attitude and attention to details helped to ensure that the samples were analyzed correctly and improved our knowledge concerning what was happening during decontamination activities. Their aggressive analysis schedule made it possible to take control and maximize the usefulness of decontamination chemicals.

Spanning the years from 1982 through 1990, two managers provided guidance, technical advice, operational experience, and interpersonal skills. Jack G. Scott and Dennis A. Schmidt created a work environment of cooperation between a divergent group of individuals. Often acting as intermediaries, they forged a network of departmental relationships based on trust and professionalism. They empowered individuals and provided the tools necessary to accomplish the work. In addition, they allowed original ideas and sometimes authorized unorthodox approaches to problems. Under their guidance, many 30-year-old assumptions were challenged, often leading to new understanding of basic processes.

To all these individuals and to the many that have contributed in unnamed ways, deep appreciation is extended for all their efforts. The scope of this project would not have been possible without their contributions.

CONTENTS

FIGURES

TABLES

ACRONYMS

ALARA	As Low As Reasonably Achievable
ARR	Alkaline Rust Remover made by Turco
atm	atoms
Ci	curie
Citrox	a solution made of Citric and Oxalic Acids
d	day
decon	decontamination
DOE	Department of Energy
dps	decays per second
dpm	decays per minute
1.0E-4	represents scientific notation, 1.0E-4 = 1.0×10^{-4}
E	Energy
EDTA	Ethylenediaminetetra-acetic acid
FDP	Fluorinel Dissolution Process
gal	gallon
h	hour
HP	health physicist
ICPP	Idaho Chemical Processing Plant
INEL	Idaho National Engineering Laboratory
kg	kilogram
$<$	less than
L	Liter
λ	Lambda, constant representing the probability of a dps
ln	natural log
M	Molar, moles per Liter
m	minutes
mCi	millicurie, 1×10^{-3} Ci
MeV	million electron volts, $1 \times 10^{+6}$ eV
mg	milligram, 1×10^{-3} g
mR/h*L	milliRoentgen per hour per Liter, also written (mR/h)/L
MW	Molecular Weight
N	Number of Atoms
NRTS	National Reactor Testing Station
NWCF	New Waste Calcining Facility
PEW	Process Equipment Waste
POD	Plan of the Day

QB	Energy of Beta Decays
R	Roentgen
R/h	Roentgen per hour
R/h*dps	Roentgen per hour per dps, also written (R/h)/dps
TBP	TriButyl Phosphate
$t_{1/2}$	half life
μg	micrograms, 1×10^{-6} g
vol	volume
WCF	Waste Calcining Facility
WINCO	Westinghouse Idaho Nuclear Company
wt%	weight percent or percent based on weight
y	year

Characterization of Nuclear Decontamination Solutions at the Idaho Chemical Processing Plant From 1982 to 1990

INTRODUCTION

The Idaho Chemical Processing Plant (ICPP) is one of the principal facilities at the United States Department of Energy's Idaho National Engineering Laboratory (INEL). The ICPP facilities are designed for the reprocessing of spent nuclear fuel from test and research reactors in the United States and foreign countries, and from the U. S. Navy's ship propulsion reactors.

In 1949, the U.S. Atomic Energy Commission established the National Reactor Testing Station in southeastern Idaho, near the western edge of the Upper Snake River Plain, for testing various types of nuclear reactors, equipment, and materials. This site is now known as the INEL and covers 890 mi^2 (see Figure 1). The ICPP is located in the south-central portion of the INEL and occupies 147 acres. The ICPP began reprocessing nuclear fuel in 1953 as a demonstration project.

The ICPP processes highly enriched fuels, those in which the concentration of U-235 has been artificially increased from the 0.7% present in natural uranium to 20–90% by blending the natural uranium with U-235 concentrate. Expended fuels of this type are shipped to the ICPP from test and research reactors at the INEL, from other reactors in various parts of the world, and from the U. S. Navy's ship reactors.

The First Cycle extraction process preferentially separates uranium from fission products, whereas subsequent extraction cycles separate the transuranics. In the First Cycle process, uranyl nitrate, in an aqueous solution, is brought in contact with tributyl phosphate (TBP) in an organic diluent (dodecane), and the uranium transfers to the TBP. The fission products are left in the aqueous solution that is sent to waste storage tanks.

In the First Cycle extraction process, the uranium containing stream is processed through a series of four perforated-plate columns and then through a product evaporator. The aqueous dissolver product is fed into the first column, where the uranium enters the organic phase and the fission products remain in the aqueous. The organic uranium phase flows to the second column where more fission products are scrubbed out of the organic phase into the aqueous. The organic containing uranium enters the third column where the uranium is extracted into an aqueous solution. This aqueous solution is transferred to the next column where any remaining organics are removed. The aqueous uranium is then concentrated in an evaporator and is sent to interim storage until enough solution is collected for processing in second and third cycle extraction.

Because highly radioactive solutions are processed at the ICPP, concrete walls up to 5 ft thick are required for shielding. The quantity of radioactive materials within some processing cells of the plant may be as high as 500,000 curies.

Decontamination of a process cell's equipment is accomplished by flushing all vessels and piping within that cell. The decontamination solutions are heated and maintained at about 50 °C. The solutions are often recycled through equipment in the cell to increase chemical contact time. Individual process vessels often have an upper and lower spray ring that may be used to cycle solutions within that tank. The temperature during in-vessel recycle may increase to boiling but would have to be cooled to around 50 °C for transferring.

The sampling of decontamination solutions occurs just before the solutions are sent to waste. Originally, in Electrolytic decontamination, solutions were transferred to individual vessels where they were heated, sparged, and recycled through the vessel's spray rings. Then each vessel was sampled, and the solution from that vessel was sent to waste. This required sampling each vessel for each solution. After the Electrolytic decontamination, a solution was recycled from vessel to vessel throughout the cell. Once all the vessels and process lines had been cleaned, the solutions would be sampled in the last vessel before being sent to waste. This reduced the number of samples to one per solution rather than one per vessel.

First Cycle decontamination has been a major part of fuel reprocessing since the 1950s. As the plant aged, increased cell entries to repair or replace equipment has resulted in a First Cycle decontamination effort following each fuel campaign since 1981. The purpose of this report is to summarize much of the information gained from these experiences, present the data, look at trends, and discuss lessons learned.

OVERVIEW

Decontamination of First Cycle is not a simple task. Considerable time and labor are required to get cells and equipment to ALARA standards before workers can enter. Internal flushing of vessels and piping may be as short as one month or as long as half a year with the average time being around four months. The amount of time, labor, and chemical usage for external cell decontamination (cell floors, walls, etc.,) is not included in this report. Instead, emphasis has been placed on the heavily contaminated and difficult-to-reach interiors of vessels, piping, and equipment.

Internal decontamination is usually accomplished by making up a chemical solution and then passing or recycling this solution through a cell's equipment and piping. Before the solution goes to waste it is sampled and various analyses are performed to obtain information on the chemical's effectiveness and what radionuclides have been removed. There have been nearly 650 flushes of First Cycle piping and equipment from 1982 to 1990. Seventy-five percent of these were sampled.

Decontamination sample results are given in Appendices C through H. The log number shows the month and the day the sample was taken while the remaining numbers are the unique sample number for that day. Because one-fourth of the flushes were not sampled, an attempt was made to estimate the missing data. This was done by using the average values for each solution or by using the average value of all solutions. For example, if solution A was used 5 times and sampled 3 times then the average of the 3 sampled solutions would be used to "fill in" the two missing flushes for solution A. However, if solution A had been used but had not been sampled, then the average of all solutions, (B, C...etc.), used in that decontamination unit would be used to "fill in" the missing data. This approach helps maintain the average calculated by actual data, while providing a reasonable estimate for what may have been removed in unsampled solutions. Any averaged solution has a log number of 1 to provide easy identification and may be left out of the computer analysis if desired.

Averaging was done based on logical sampling units to help provide better estimates for missing samples. For example, if vessel G-106 was flushed and sampled, then the averages used for estimating missed data would be based on sampled flushes from this vessel. The averages would not be based on samples taken from another vessel. However, if flushes from the E cell were being sampled, then E cell becomes the unit. Missing data from E cell would come from averages calculated from E-cell data rather than from another cell. Appendices C through G contain decontamination data listed by the logical unit.

Each First Cycle decontamination will be discussed separately. Care needs to be exercised when comparing one turnaround with another. Comparisons of solutions should be done on a curie-per-liter or R/h-per-liter basis. This provides a common denominator, rather than allowing the total volume of each solution to distort the solution's effectiveness. For example, water and nitric acid are used to flush gross contamination from the system before other solutions are used. Over 50% of the flushes were either water or nitric acid. These flushes removed large quantities of radioactivity because of the many times they were used. However, on a per liter basis, other solutions removed more activity per liter of solution used than did nitric acid or water.

At this point, a brief discussion on radionuclide activity is necessary. The most common and easiest activity measurement is simply the number of nuclear transformations per second. One curie equals $3.7 \times 10^{+10}$ nuclear transformations per second and includes all types of decay. To give the reader a better general feel for the actual radiation fields produced by these transformations, a second measurement is used, the roentgen (R). This is a unit of exposure and refers only to gamma rays and X-rays (electromagnetic radiation). The roentgen is defined in terms of the number of ions, or the resulting electric charge, produced by radiation in a specified mass of air. Equation 1 gives the mathematical relationship.

$$1\ R = 2.58 \times 10^{-4}\ \text{coulombs/kg of air} \qquad (1)$$

Because exposure is dependent on the distance from the source, all exposure calculations in this report were calculated assuming a distance of 1 ft from a point source. Appendix A contains radiochemical information for the various isotopes normally found at the ICPP.

Decontamination of First Cycle occurs after a fuel campaign. The decontaminations are also grouped by each fuel campaign. The year the decontamination occurred is also used, but it may be confusing. Often a decontamination will begin in one year and end in the next, or, there may be two decons in the same year. For these reasons, the fuel type or campaign number is used to help identify the various First Cycle decontaminations.

Beta activity is referenced several times in this report. Plant operating personnel use beta activity as a quick reference to how well the solutions are doing, because these results come back first. Also, there is a $1.0 \times 10^{+7}$ β/min/mL limit for solutions going to the process equipment waste liquid evaporators (PEW). Decontamination solutions go to the deep tanks, and after enough solution is collected, it is sampled. If the gross beta were greater than $1 \times 10^{+7}$ dpm/mL, then the solution would be sent directly to the tank farm. If the beta were lower, it would go to the PEW where it would be concentrated and sent to the tank farm. The actual quantities sent to PEW were not tracked. However, it is estimated that 80% went through the PEW.

Sodium and potassium in waste solutions create problems during calcination of the waste. It is therefore advantageous to keep sodium and potassium concentrations as low as possible. For these reasons, sodium and potassium generation is tracked and reported here.

Figure 2 (figures will be found at the end of each section in which they are referenced) summarizes the various First Cycle decontamination results following each fuel campaign from the Electrolytic campaign #37 to the FDP campaign #42 in 1990. Over 268,000 gal of unprocessed liquid has been generated along with 10,600 kg of sodium and potassium waste. One-third of the flush solutions contained sodium or potassium. Over 12,600 curies have been removed from First Cycle that amounts to 32,500 R/h. The flush solutions averaged 12.4 mCi/L (see Figure 3) and about 32 (mR/h)/L. The radioisotopes removed are shown in Table 1.

Figure 4 illustrates this distribution of radionuclides. The radioisotope's mass is not included because almost all of the mass is from the cesium isotopes (92%). An interesting observation from Table 1 is that 1 mg is almost exactly equivalent to 1 R/h. Gross beta activity from 1982 to 1990 averaged $5.9 \times 10^{+7}$ β/min/mL.

Table 1. Radioactivity removed during decontaminations from 1982 to 1990.

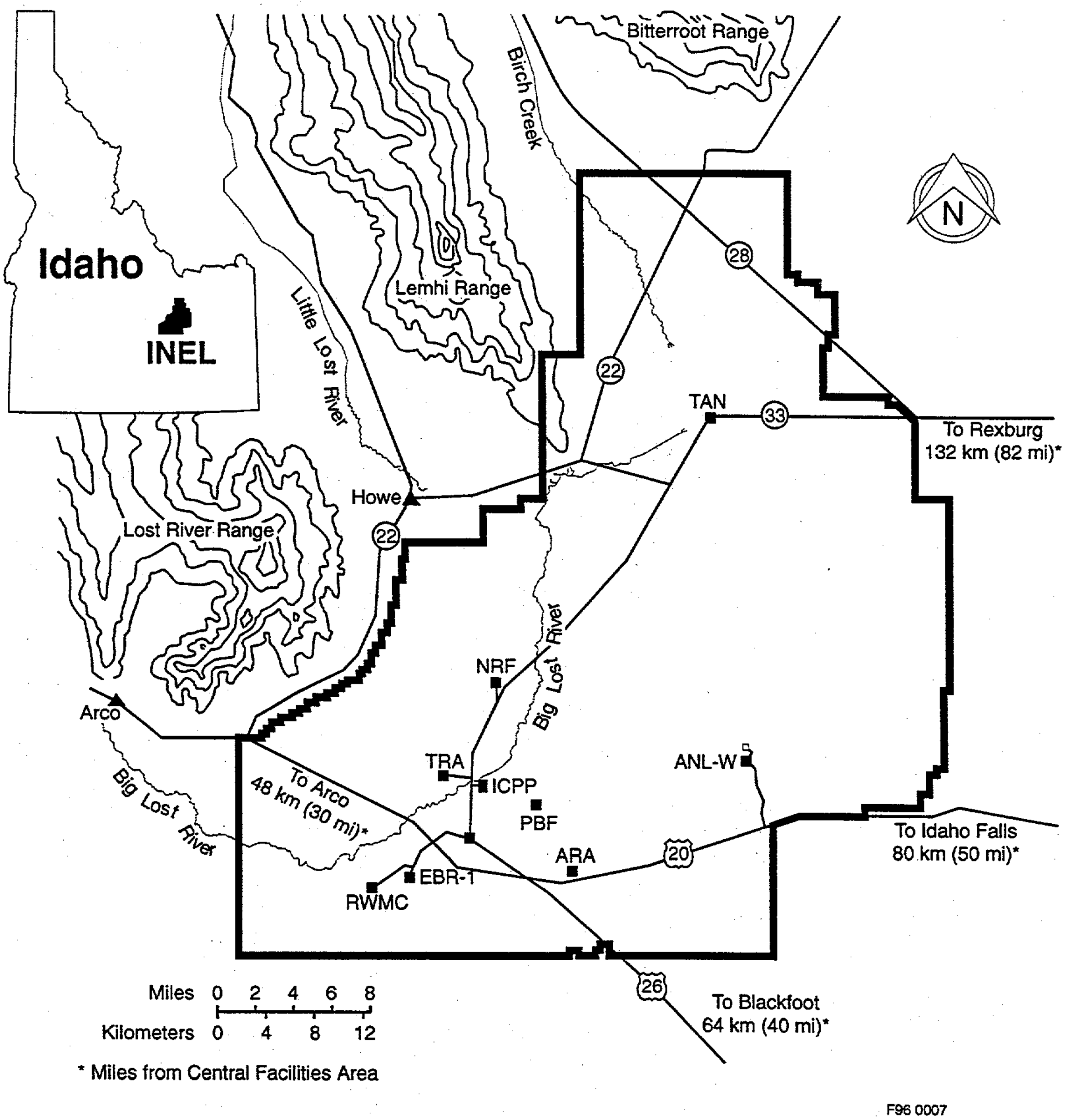
Isotope	% Ci	% R/h	% mg
Zr/Nb-95	34.6	59.8	0.3
Ru-106	24.7	5.6	2.8
Sb-125	12.9	3.9	4.7
Cs-134/137	23.4	30.7	91.6
Ce-144	4.4	0.2	0.5
Total	12,600 Ci	32,500 R/h	32,700 mg

Decontamination volumes are given before being processed through the PEW. This evaporator significantly reduces the volumes. However, for this report, the volumes represent the amount of solution made up and sent into the cells for decontamination. Table 2 shows the activity removed by decontamination solutions from 1982 to 1990.

Throughout this report, the Zr-95 parent and Nb-95 daughter will be combined. However, it is possible to separate these nuclides to determine if solutions preferentially remove them. Cs-134 and Cs-137 have also been combined because they react chemically the same. Ru-106 has been combined with Ru-103 again because chemically they react the same. Also, Ru-103 only accounted for very small amounts of the total ruthenium removed. Actual quantities of these specific nuclides removed are provided in the appendix.

Table 2. Total activity removed by decontamination solutions from 1982 to 1990.

Solution	Activity % Ci	Removed % R/h	Volume % gal	Number of flushes
H_2O	11.6	9.8	24.7	169
HNO_3	17.1	17.3	23.9	164
Tartaric/NaOH	30.2	42.5	10.1	71
Turco 4502	14.7	11.4	11.3	55
Turco 4521	2.7	3.1	4.9	39
$KMnO_4/HNO_3$	5.5	2.3	5.3	35
Oxalic/HNO_3	9.9	6.1	7.0	31
EDTA/NaOH	0.4	0.3	1.9	20
Citrox	2.7	3.0	2.2	15
Oxalic	1.6	1.8	3.5	12
Turco 4324	2.5	1.7	2.2	10
Turco ARR	0.8	0.7	1.0	5
HF/HNO_3	0.1	0.06	1.5	4
Citric	0.02	0.01	0.3	3
NH_4OH	0.1	0.09	0.28	1
Total	12,600 Ci	32,500 R/h	26,800 gal	634



Legend:

ARA	Auxiliary Reactor Area
ANL-W	Argonne National Laboratory-West
CFA	Central Facilities Area
EBR-1	Experimental Breeder Reactor - 1
ICPP	Idaho Chemical Processing Plant
NRF	Naval Reactors Facility
PBF	Power Burst Facility
RWMC	Radioactive Waste Management Complex
TAN	Test Area North
TRA	Test Reactor Area

Figure 1. Major facility areas located at the Idaho National Engineering Laboratory site.

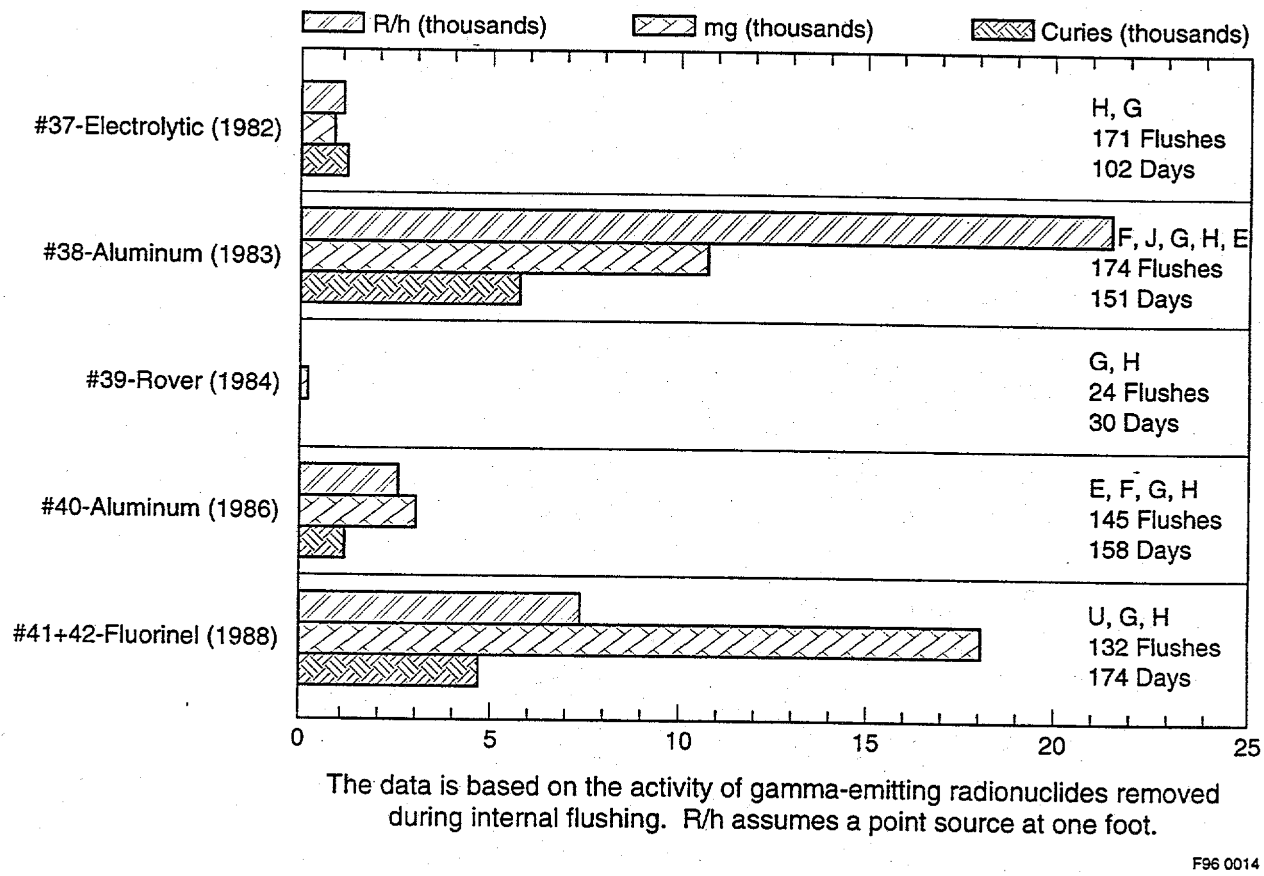


Figure 2. 1982–1989 decontamination of first cycle activity removed following each fuel campaign.

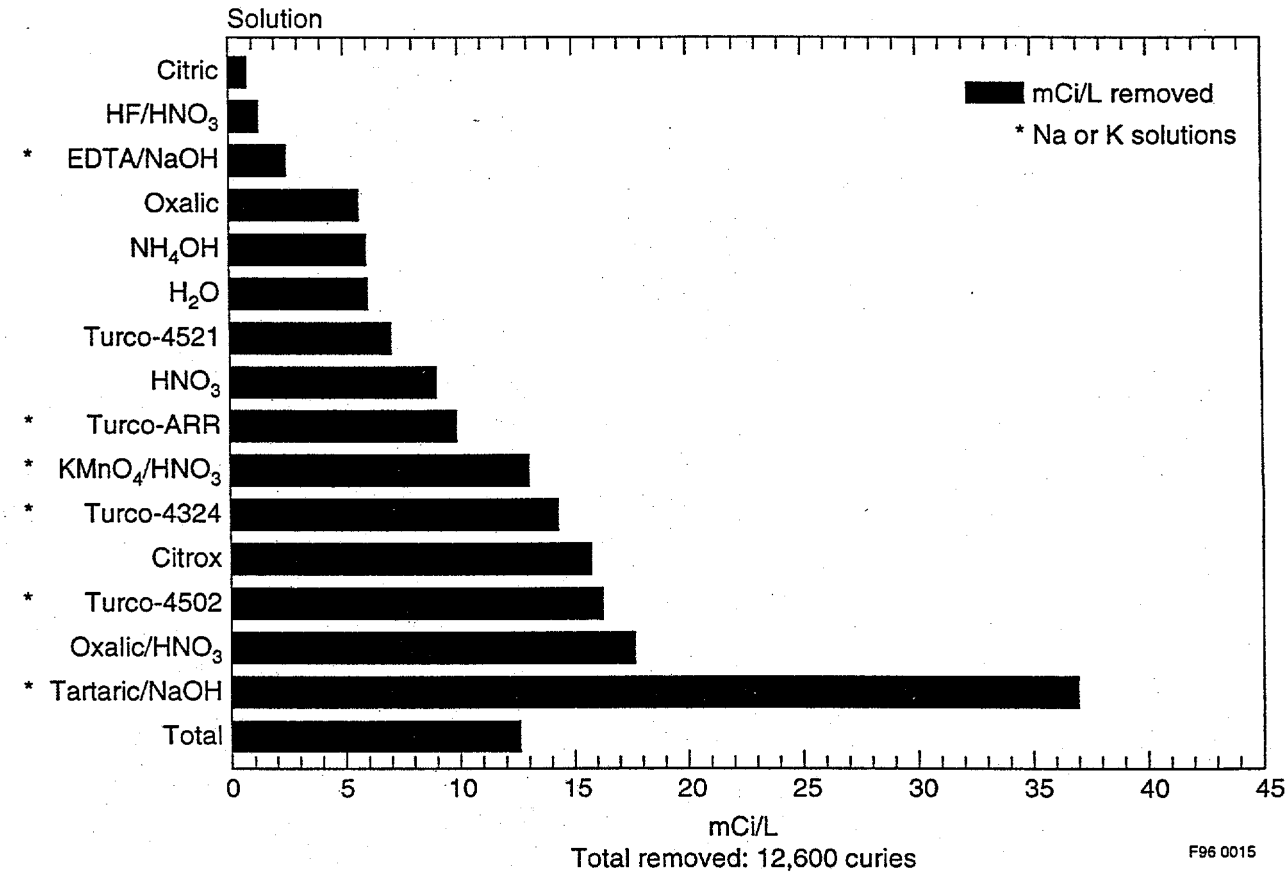


Figure 3. 1982–1989 first cycle decontaminations.

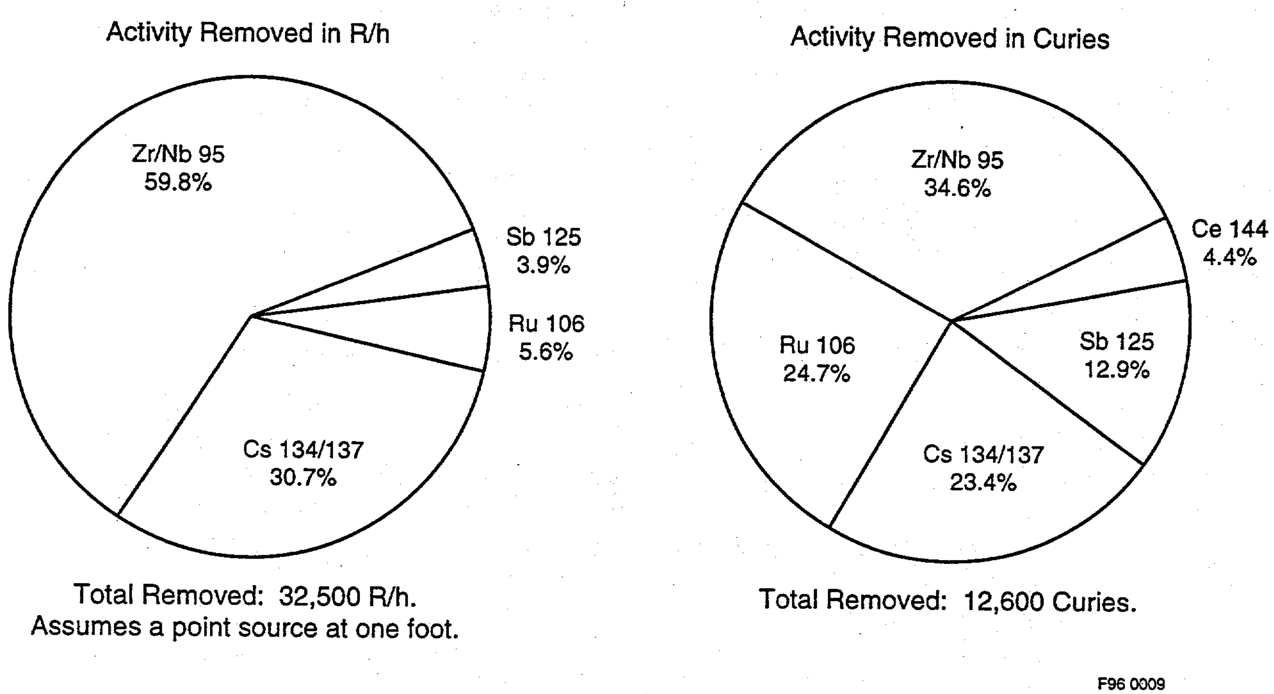


Figure 4. 1982 decontamination of H-100 following electrolytic #37.

1982 ELECTROLYTIC DECONTAMINATION (FUEL CAMPAIGN #37)

The 1982 decontamination of G and H cells was the first time individual flush solutions were analyzed for effectiveness. A total of 171 internal flushes were used, of which 65% were sampled.

During this period individual vessels were flushed and the solution sampled before transferring it to the deep tanks for waste treatment. These samples were analyzed for activity and the results are illustrated in Figures 5 through 10 and Appendix C documents the data. These figures show each flush solution, the sequence it was used and the amount of activity removed.

Radionuclide analysis was done on each flush solution to help learn what isotopes were present and which solutions were removing specific radionuclides. Table 3 gives the isotopic distribution from the total decontamination.

Figure 11 illustrates the above data. It is easily observed that Ru-106 was a major source of activity measured in curies (60%). Further analysis of each individual solution showed exactly what radionuclides were removed by which solution. Table 4 shows the isotopic activity removed per solution.

Appendix B provides information about each flush solution used in the decontamination of First Cycle. Besides showing typical concentrations, the appendix also provides information concerning the composition of commercial products used.

Figures 12 and 13 compare each solution's effectiveness using a Pareto type analysis. The solutions are compared on a per-liter basis to remove volume biases. Acidic permanganate stands out by being about three times as effective as any other solution.

This information is useful in that it easily shows which solution was most effective in removing individual isotopes. For example, nitric acid removed 41% of all Sb-125 while acidic permanganate removed nearly 60% of all the Ru-106. The following general summaries may be made from the data.

- Nitric acid removed most of the Sb-125
- Acidic permanganate was effective on Ru-106 and Ce-144.

Table 3. Radioactivity removed during the 1982 Electrolytic decontamination.

Isotope	% Ci	% R/h	% mg
Zr/Nb-95	6.8	27.6	0.3
Ru-106	59.8	38.1	23.4
Sb-125	29.4	24.1	36.9
Cs-134/137	2.8	10.1	38.9
Ce-144	1.2	0.1	0.5
Total	1,140 Ci	1,070 R/h	860 mg

Table 4. Isotopic activity removed by 1982 Electrolytic decontamination solutions.

	% Ci, mg, R/h shown down columns[a]				
Ce-144	Cs-134/137	Zr/Nb-95	Ru-106	Sb-125	Solution
4.9	6.5	9.1	6.0	2.0	H_2O
27.6	16.1	27.3	14.2	40.9	HNO_3
45.3	22.6	31.2	59.1	24.2	$KMnO_4/HNO_3$
7.6	0.0	26.0	10.5	3.6	Turco 4521
5.1	22.6	0.0	2.1	0.2	Turco 4502
6.1	25.8	1.3	1.6	0.1	Citrox
3.4	6.5	5.2	6.5	29.0	Tartaric/NaOH

a. Since each column contains just one isotope, the percentage values down the column will not change when referring to curies, milligrams or R/h. The reason for this is that when converting curies into mg or R/h, the same conversion factor will be used for all the values in the same column. Therefore, the percent will not change since all the values were multiplied by the same conversion factor.

Data from each individual flush solution was compiled so that a comparison could be made between solutions. A Pareto analysis is shown in Figure 12 for mCi/L and Figure 13 for (mR/h)/L. The result of this analysis is clear, the acidic permanganate solution was about four times more effective in removing contamination than the next best solution. The solutions are compared by activity removed on a per liter basis.

The total activity removed by each solution along with the number of times the solution was used is given in Table 5. Again, activity is shown in both curies and R/h. Nearly half of the curies removed was in the acidic permanganate solution. Nitric acid removed about 25% of the curies. From a dose perspective, the acidic permanganate removed 39% of the R/h while nitric acid removed 25%.

Figure 14 is a Pareto analysis comparing the total amount of activity removed by each solution. The activity is measured in both curies and R/h. Historically, decontamination solutions have removed more activity measured as R/h than curies. This was not true here, where 1,140 curies were removed which

Table 5. Total activity removed by chemical solutions during the 1982 Electrolytic decontamination.

Solution	% Ci	% R/h	Number of flushes
H_2O	5.0	6.1	57
HNO_3	23.2	24.7	38
$KMnO_4/HNO_3$	45.7	38.8	17
Turco 4521	9.2	2.2	19
Turco 4502	2.1	3.3	10
Citrox	1.8	3.5	8
Tartaric/NaOH	13.0	11.4	22
Total	1,140 Ci	1,070 R/h	171

amounted to only 1,070 R/h. The main reason for this was the high Ru-106, which does not emit gamma radiation and its daughter, Rh-106, only gives off a weak gamma. Therefore, it contributes heavily to the activity as curies due to its one year half life but its contribution to radiation fields as measured in R/h is significantly less.

Decontamination activities generated 52,000 gal of unprocessed waste. There were approximately 1,950 kg of sodium and potassium sent to waste. The average beta activity of the decontamination solutions was $1.5 \times 10^{+8}$ β/min/mL.

Lessons Learned

The fuel dissolved in Electrolytic was "green". Due to its short cooling period, the time it was removed from the reactor until it was dissolved, there was a larger than normal ratio of short-lived isotopes, specifically Ru-106, to long lived isotopes. This was unusual by itself. It was further learned that acidic permanganate worked well in removing ruthenium. [Ruthenium found in the Waste Calcining Facility (WCF) had previously been removed with an acidic permanganate solution.]

During the decontamination activities a large number of samples were requested. Sixty-five percent of the samples were taken which means one third were not taken. To reduce the number of samples it was decided to sample the solutions as they left the cell rather than after each vessel.

Evaluation of the individual flushes showed that repeating flushes with the same solution is not necessarily effective. In fact, we learned that a caustic solution had very little effect after the second consecutive flush, Figures 5, 9, 10. In other words, a caustic solution should not be used more than twice in a row. If it did not remove the contamination, then there was probably a reason, such as the solution was not getting to the contamination. Sometimes a line was missed or a bellows valve had internal leaks that prevented decontamination solutions from reaching the contamination.

Table 6 summarizes the removal efficiency of the decontamination solutions used during the 1982 Electrolytic decontamination. The table is provided in contamination removed per L of solution used. This will give a better picture of which solutions were the most efficient in removing contamination.

Table 6. Solution's effectiveness during the 1982 Electrolytic decontamination.

Solution	mCi/L	(mR/h)/L	µg/L
H_2O	1.0	1.1	0.7
HNO_3	6.2	6.2	5.1
$KMnO_4/HNO_3$	25.8	20.6	13.6
Turco 4521	4.6	5.7	1.6
Turco 4502	2.0	3.0	6.5
Citrox	2.1	3.9	8.4
Tartaric/NaOH	5.2	4.3	4.4
Total	5.8	5.5	4.4

The acidic permanganate solution proved to be the most effective in removing contamination. The major radionuclide removed by this solution was Ru-106 (77% of the curies removed by this solution were ruthenium).

Appendix C provides a detailed analysis of each decontamination solution. The analysis covers cost, waste generation, and a comprehensive analysis of sample results.

Figures 5 through 10 graphically illustrates activity removed by each flush solution in the sequence used. An (*) means the flush had no sample analysis. Averaged flushes were not included in these graphs—only actual data has been plotted. The numbers at the bottom of their graphs represent the chemical flush. The key to the numbers is located below the numbers themselves.

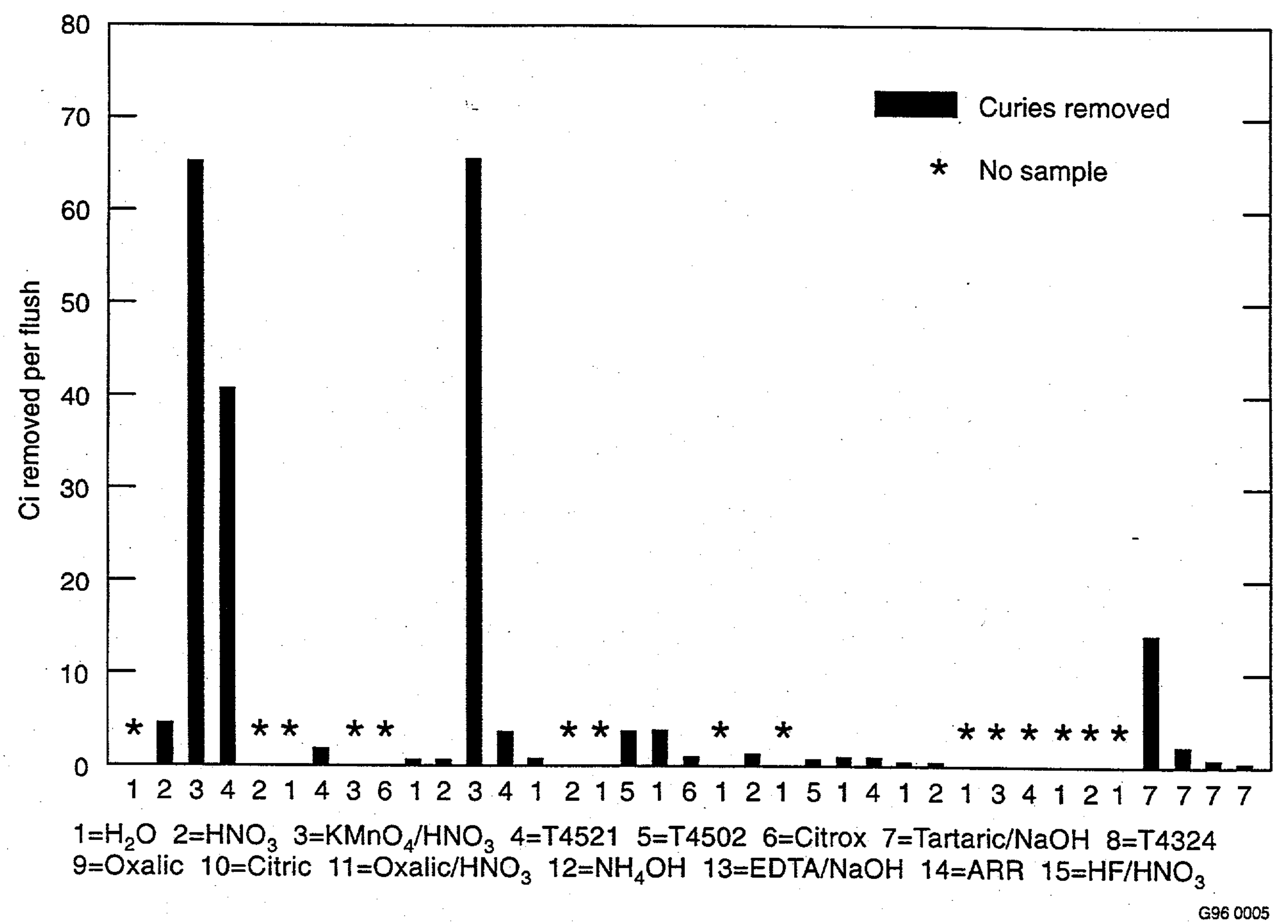


Figure 5. 1982 decontamination of H-100 following Electrolytic #37.

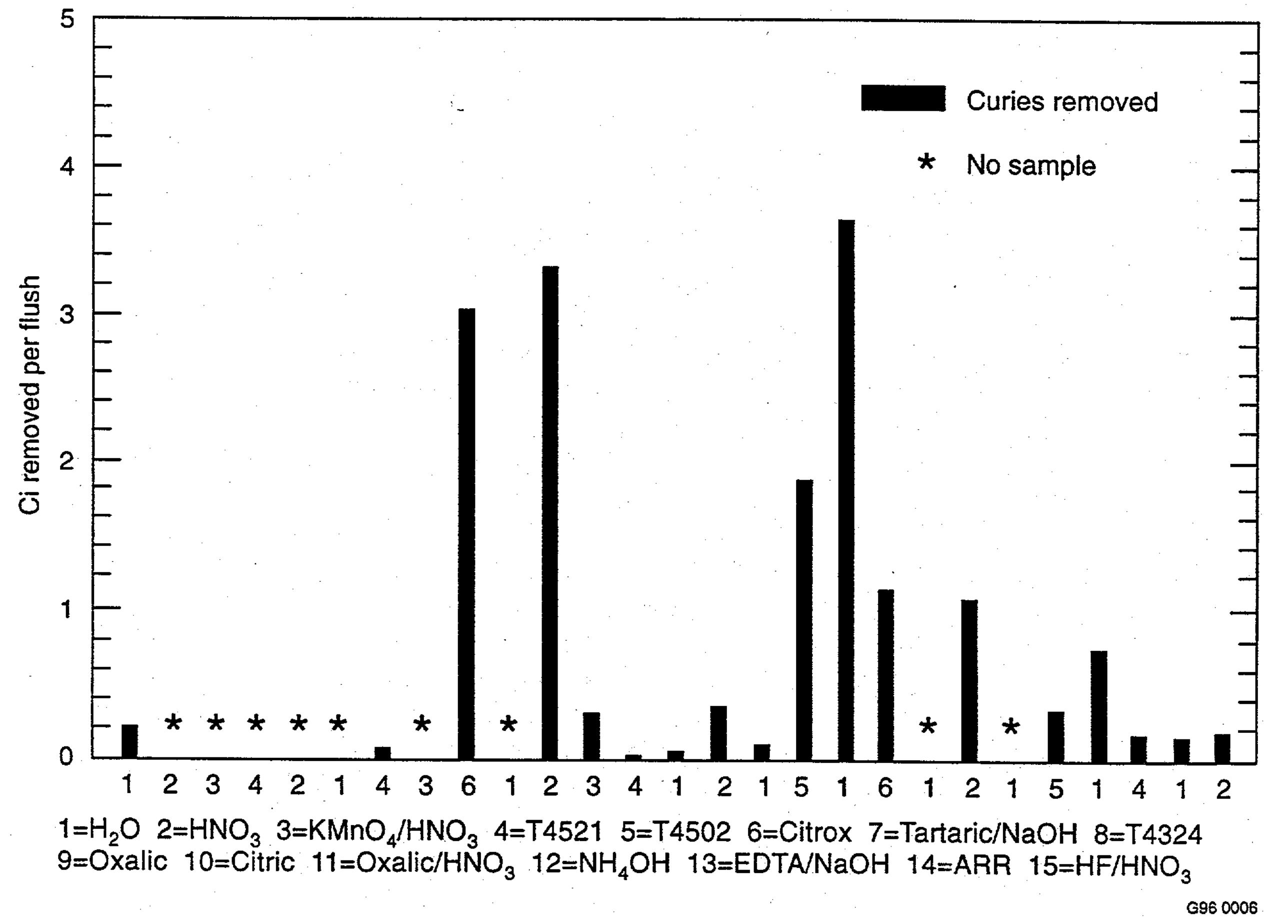


Figure 6. 1982 decontamination of H-103 following Electrolytic #37.

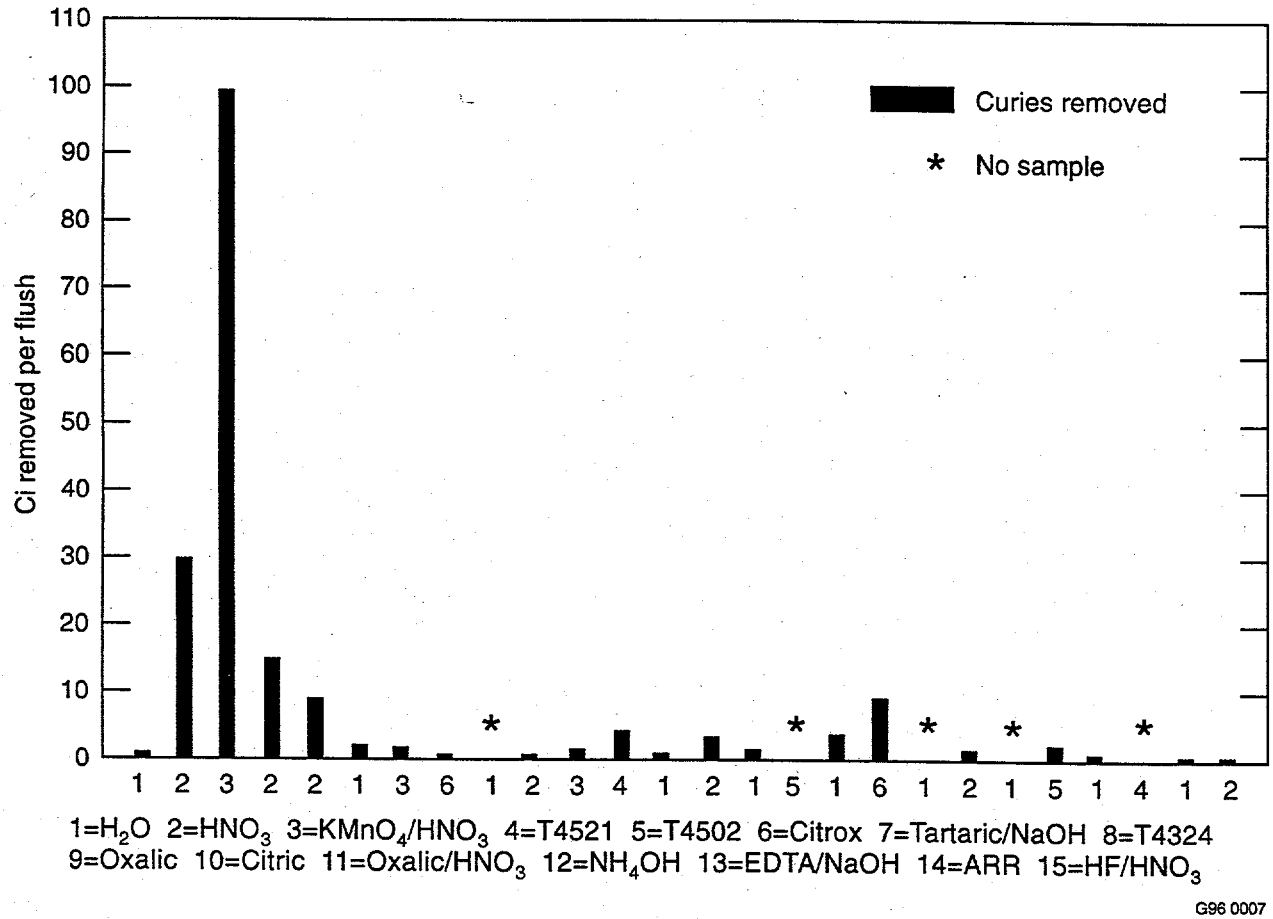


Figure 7. 1982 decontamination of H-134 following Electrolytic #37.

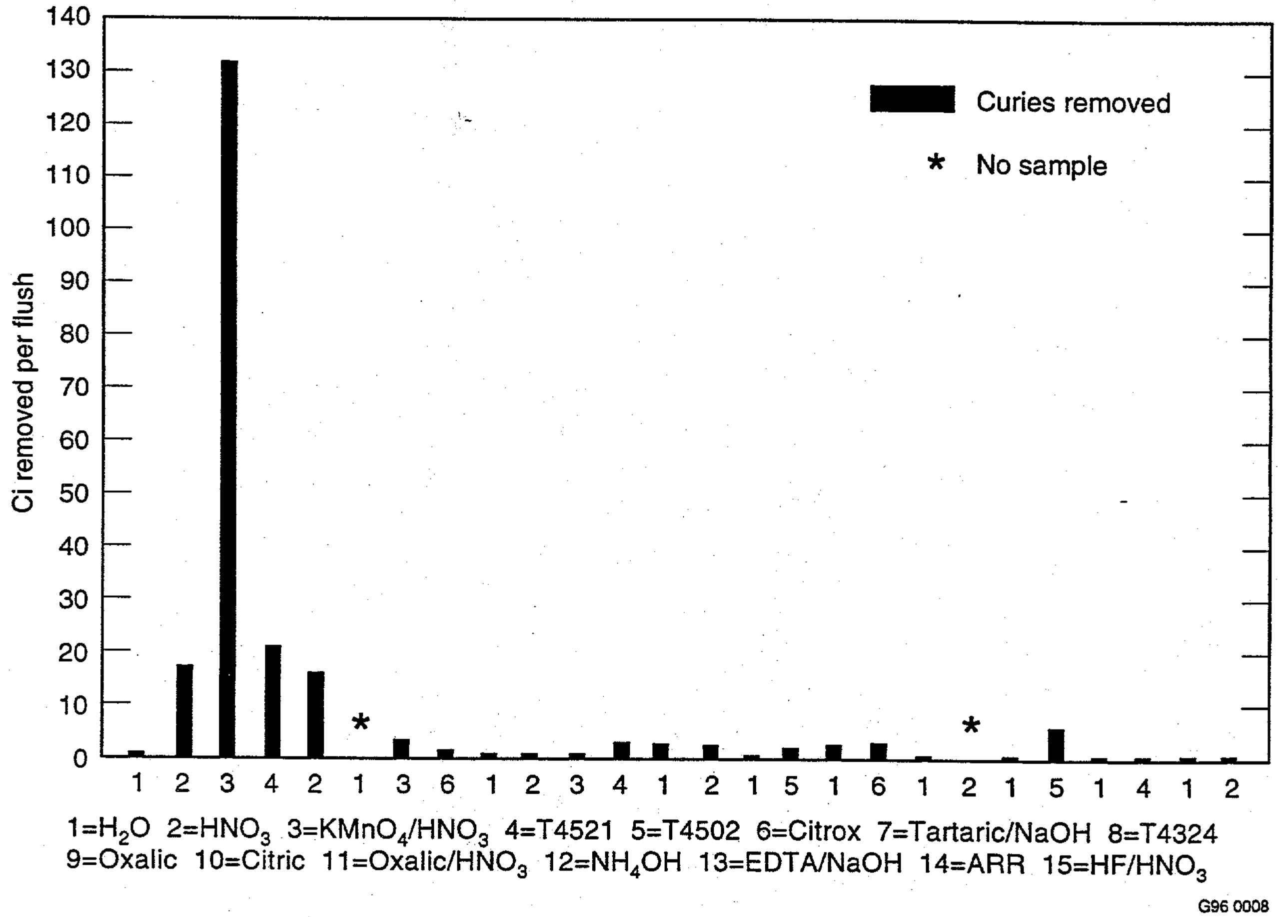


Figure 8. 1982 decontamination of H mixers following Electrolytic #37.

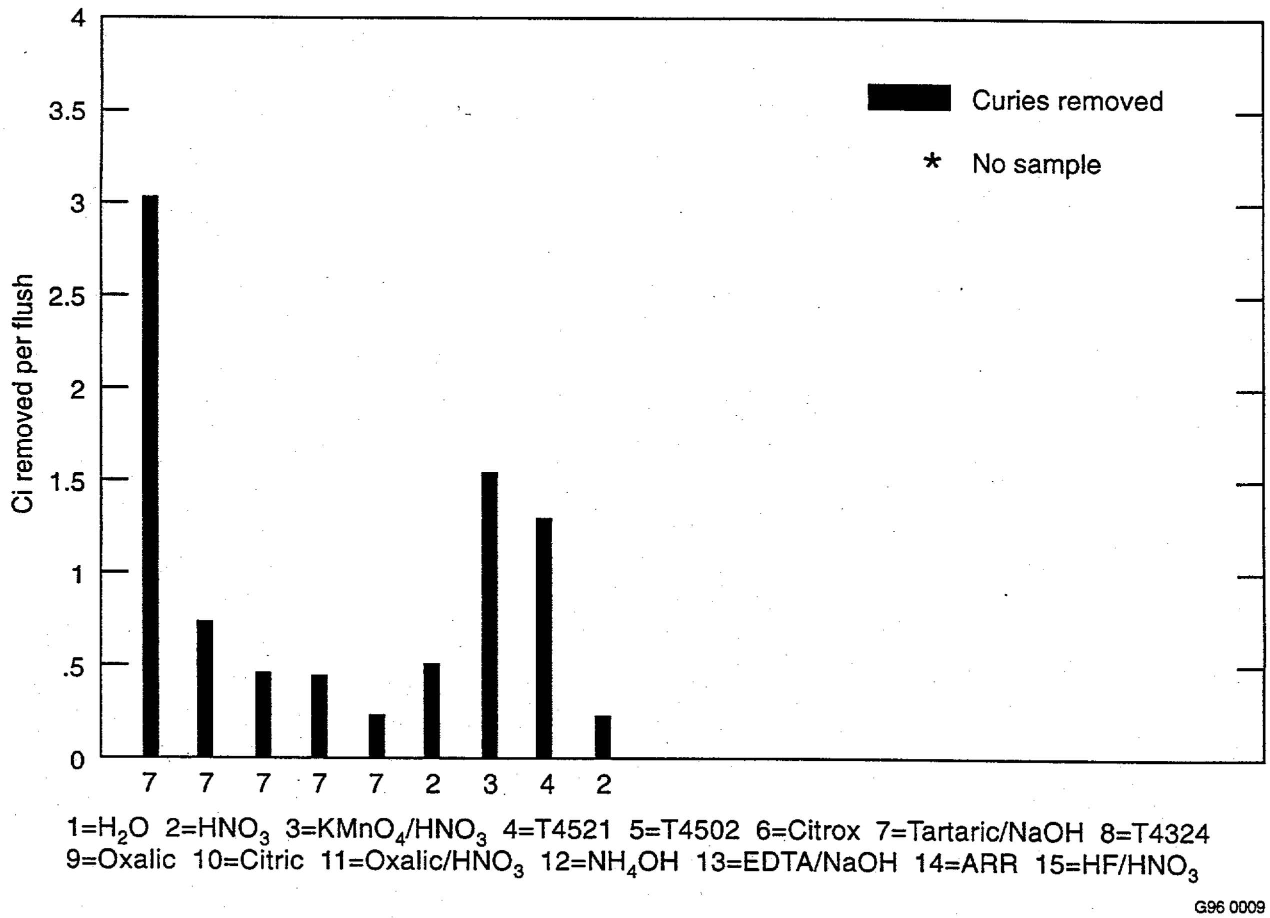


Figure 9. 1982 decontamination of G-106 following Electrolytic #37.

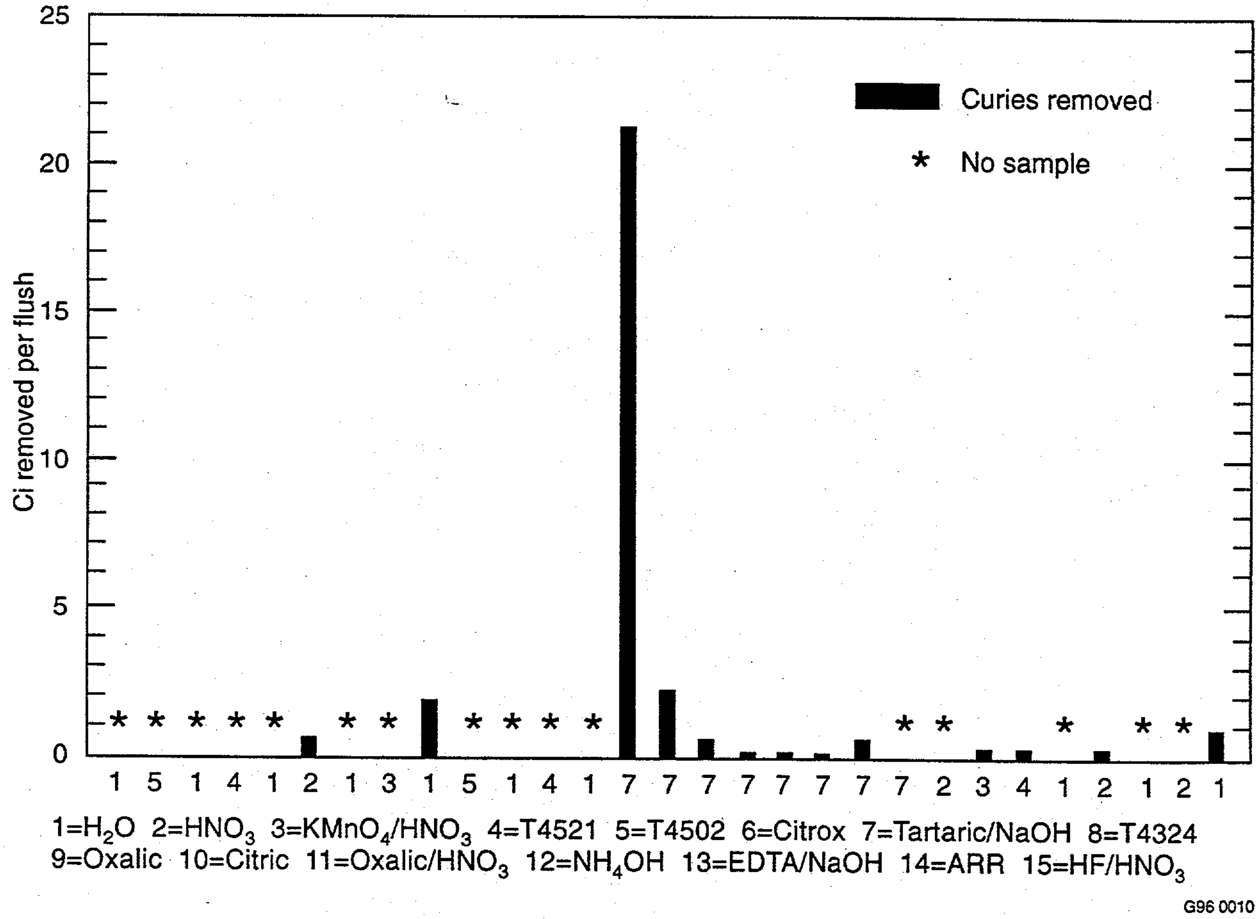


Figure 10. 1982 decontamination of G-111 following Electrolytic #37.

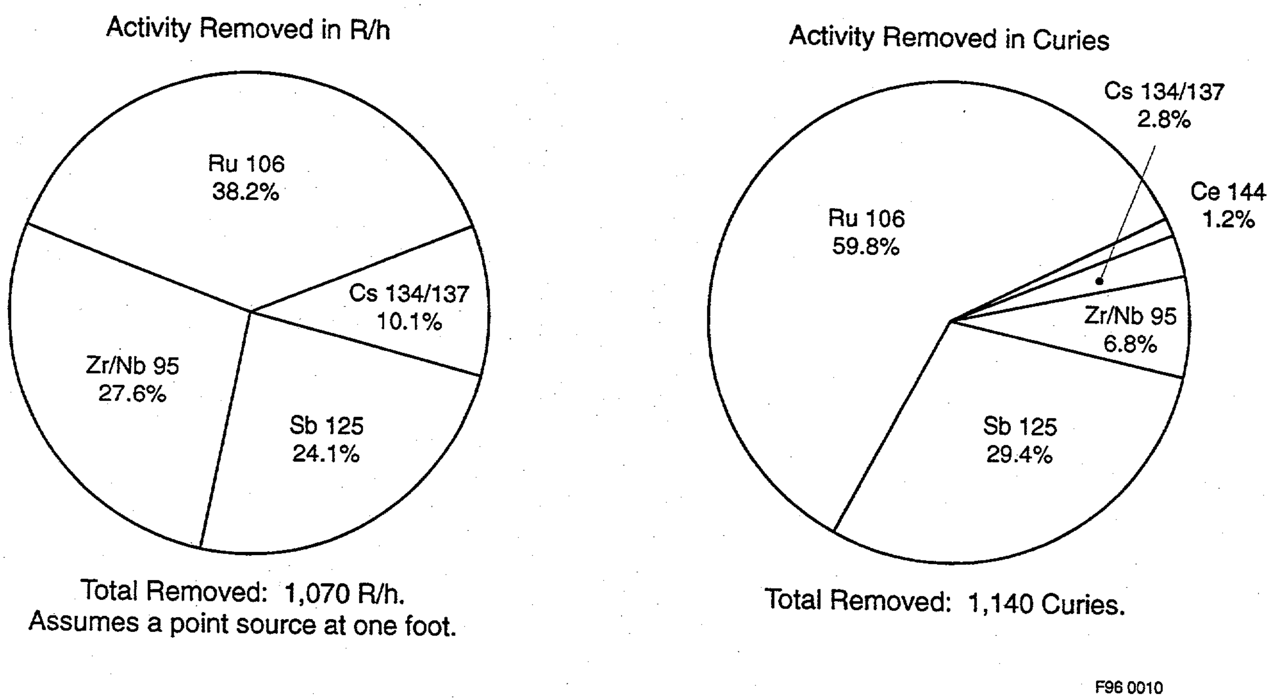


Figure 11. 1982 first cycle decontamination after Electrolytic #37.

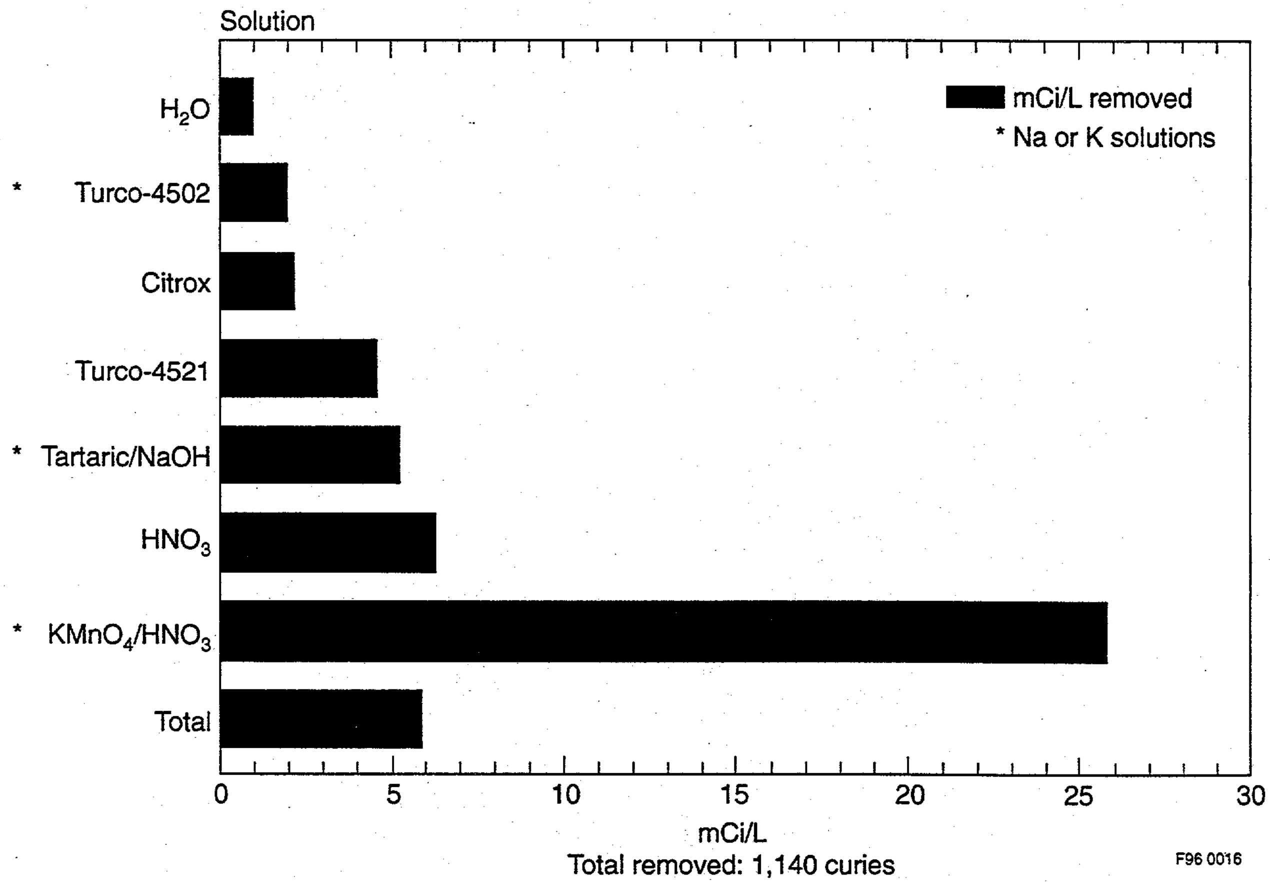


Figure 12. 1982 first cycle decontamination after Electrolytic #37, activity removed per solution.

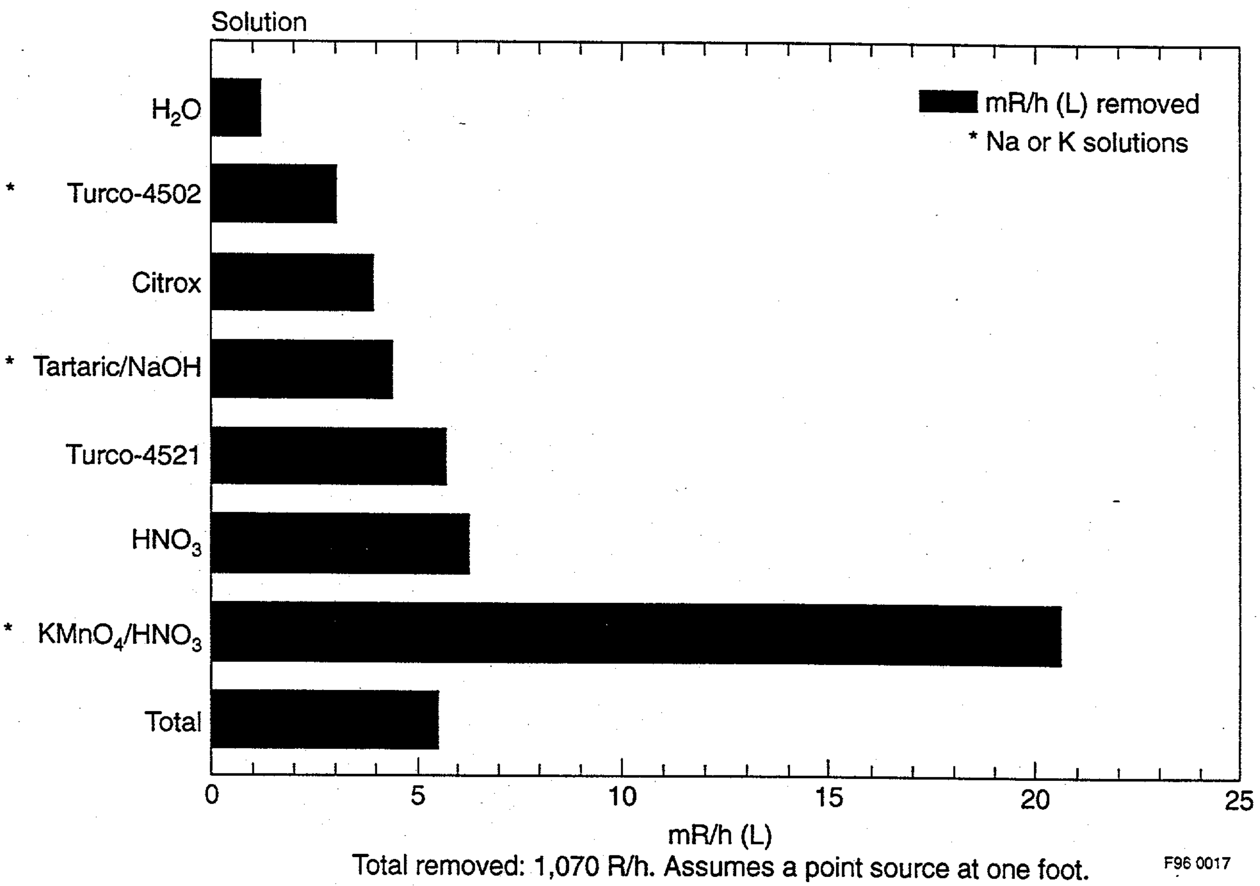


Figure 13. 1982 first cycle decontamination after Electrolytic #37, activity removed per solution.

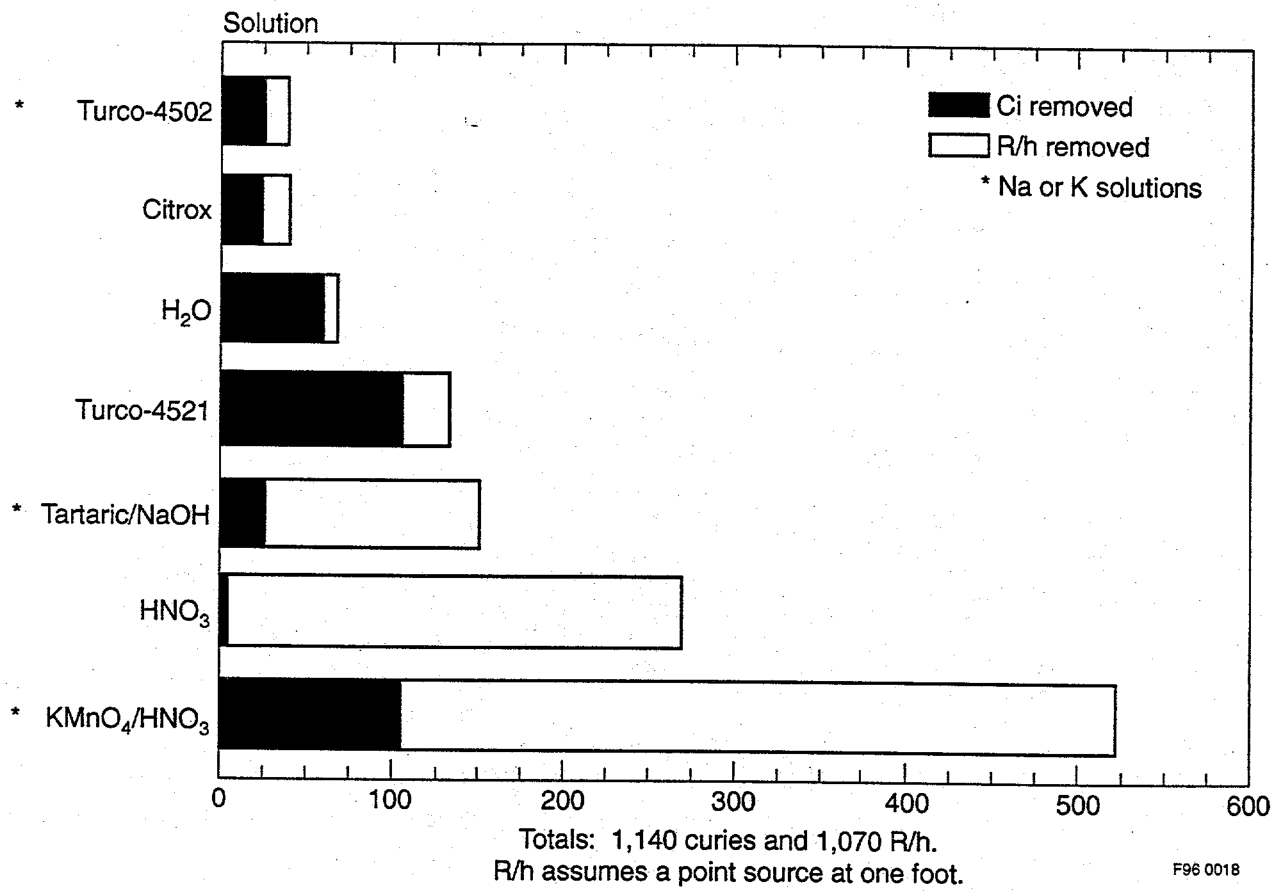


Figure 14. 1982 first cycle decontamination, total curies and R/h removed per solution.

1983 ALUMINUM DECONTAMINATION (FUEL CAMPAIGN #38)

Decontamination following this aluminum fuel campaign was one of the most extensive. It included, in order performed, F, J, G, H, and E cells. It took 174 flushes and 5 months to complete the vessels and piping flushes.

Each individual flush solution was sampled to monitor the solution's effectiveness, rather than flush and sample each major process vessel, as was done in 1982. It was decided to flush all piping and vessels within a cell and then sample the solution just before being sent to the waste tanks. This approach increased sample compliance from 65% to 82%. Figures 15 through 19 show the individual solution sequences in each cell and the activity removed during each flush. Appendix D gives a complete data analysis and the sample data.

All samples were analyzed and the radionuclide distribution was determined. Table 7 summarizes the results.

Figure 20 graphically displays the above results. It is readily seen that the major radionuclide removed was Zr-95 and its daughter Nb-95. This was a major change from the Electrolytic decontamination, where Ru-106 was the main isotope removed, accounting for 60% of the curies and 38% of the R/h.

Each flush solution was analyzed to learn what isotopes it removed and if there may be a preferential removal by any one solution. Table 8 summarizes the data.

Decontamination of complex equipment and cell systems generally required several procedures. Figures 15 through 19 show each procedure by vertical lines with the procedure number centered near the top of the graph. It is interesting to note the logarithmic nature of these graphs. Large quantities of contamination are removed with the first few flushes and then the amounts removed decrease logarithmically.

Table 7. Radioactivity removed during the 1983 Aluminum decontamination.

Isotope	% Ci	% R/h	% mg
Zr/Nb-95	69.5	82.8	1.0
Ru-106	4.1	0.6	0.6
Sb-125	6.6	1.4	3.3
Cs-134/137	16.8	15.1	94.6
Ce-144	3.1	0.1	0.5
Total	5,730 Ci	21,500 R/h	10,800 mg

Table 8. Isotopic activity removed by 1983 Aluminum decontamination solutions.

	% Ci, mg, R/h shown down columns[a]				
Ce-144	Cs-134/137	Zr/Nb-95	Ru-106	Sb-125	Solution
45.3	23.9	4.6	11.6	5.7	H_2O
2.4	2.0	21.7	19.0	18.8	HNO_3
1.0	1.0	0.4	2.9	0.6	$KMnO_4/HNO_3$
1.4	8.5	3.1	3.6	1.5	Turco 4521
2.1	29.3	0.9	21.6	6.7	Turco 4502
46.3	7.5	3.8	5.2	1.0	Citrox
0.8	22.3	64.6	31.9	64.2	Tartaric/NaOH
0.0	4.2	0.0	3.3	0.0	Turco 4324
0.7	1.4	1.0	0.7	1.3	Oxalic
0.1	0.0	0.0	0.2	0.1	Citric

a. Since each column contains just one isotope, the percentage values down the column will not change when referring to curies, milligrams or R/h. The reason for this is that when converting curies into mg or R/h, the same conversion factor will be used for all the values in the same column. Therefore, the percent will not change since all the values were multiplied by the same conversion factor.

Zr-95 and Nb-95 are the major radionuclides removed. They accounted for over 82% of the R/h and nearly 70% of the curies removed. The above information shows that sodium hydroxide in tartaric acid was effective in removing the zirconium and niobium isotopes. It also removed Sb-125 and Ru-106. The acidic permanganate solution was not nearly as effective as in the 1982 Electrolytic decontamination (where Ru-106 was the major radionuclide). The following general summaries may be made from the data.

- Sodium hydroxide in tartaric acid was effective in removing Zr/Nb-95
- Sodium hydroxide in tartaric acid removed most of the Sb-125.

The data from each flush was compiled so that a comparison could be made between the chemical solutions. This information is shown as a Pareto analysis in Figure 21 and 22. The Pareto analysis shows that the sodium hydroxide in tartaric acid was the most effective solution used to remove internal contamination. This solution was about three times more effective in removing contamination than the next-best solution. The activity removed by each solution and the number of times the solutions were used is given in Table 9.

The total activity removed by each solution is compared by a Pareto chart in Figure 23. The caustic tartaric solution removed the most contamination. However, nitric acid and water came in second and third. A large volume of these two solutions was used. They were not extremely effective on a per liter basis, but given enough time and flushing, they can remove large quantities of contamination. Not all contamination can be removed by nitric acid and water. This is why caustic solutions were used and helps to illustrate why they were so effective.

Table 9. Total activity removed by chemical solutions during the 1983 Aluminum decontamination.

Solution	% Ci	% R/h	Number of flushes
H_2O	9.4	7.5	58
HNO_3	17.5	18.1	37
$KMnO_4/HNO_3$	0.6	0.5	6
Turco 4521	3.9	3.9	15
Turco 4502	6.9	5.4	14
Citrox	5.6	4.3	5
Tartaric/NaOH	54.1	58.6	31
Turco 4324	0.8	0.7	4
Oxalic	1.1	1.1	1
Citric	0.03	0.01	3
Total	5,730 Ci	21,500 R/h	174

The decontamination activities following the Aluminum campaign generated 59,000 gal unprocessed waste. There was approximately 2,320 kg of sodium and potassium sent to waste. The average beta activity of the decontamination solutions was $3.6 \times 10^{+7}$ β/min/mL.

Lessons Learned

The first observation was that decontamination solutions that were effective in the Electrolytic cleanup were not effective in removing contamination after this Aluminum campaign. The acidic permanganate that was so good following Electrolytic proved to be almost the least effective in removing contamination following this Aluminum process.

The major radionuclides contributing to the radiation fields were Zr/Nb-95 (83%) and Cs-134/137 (15%) as measured in R/h. These isotopes totaled 98% of the R/h removed, whereas Ru-106 was the predominate isotope following Electrolytic. This major change in radionuclide distribution was probably the single most important factor in the difference in the decontamination chemical's effectiveness between the Electrolytic and Aluminum decontaminations.

Sampling compliance increased from 65% in the Electrolytic decontamination to 82% here. One major factor contributing to this increase was that samples were taken as solutions left a cell rather than sampling each vessel within a cell.

The bottom of vessel F-101 was approximately 500 R/h and it was assumed to be due to an accumulation of solids. Extensive efforts failed to remove the contamination until it was discovered that the lines from the bottom of F-101 extended up approximately 2 inches from the floor of the vessel. The only line that was flush with the vessel floor drained to centrifuge F-400. Flushing through this line effectively removed the contamination from the bottom of F-101. Previous knowledge of this construction could have saved hundreds of gal of solution.

After all the lines were flushed in F cell, an HP entered and found two lines reading over 400 R/h. These lines were later identified as the main process lines from the G cell dissolvers to the E cell settling tanks. The lines originate in G cell and then dogleg into F cell to get to E cell. These lines were missed because G and E cells were not decontaminated until after F cell.

Solids from the floor of F cell were taken to the lab where it was discovered that nitric acid would not dissolve them. Additional testing showed that the solids were soluble in sodium hydroxide. This would help explain why the sodium hydroxide flush solutions were so effective.

Table 10 summarizes the removal efficiency of the decontamination solutions used during the 1983 Aluminum decontamination. The table is provided in contamination removed per L of solution used. This will give a better picture of which solutions were the most efficient in removing contamination.

The caustic tartaric solution proved to be very effective. This solution removed over half of all the contamination. Nearly 80% of the contamination in this solution was Zr/Nb-95.

Table 10. Solution's effectiveness during the 1983 Aluminum decontamination.

Solution	mCi/L	(mR/h)/L	µg/L
H_2O	6.8	20.2	31.0
HNO_3	21.0	81.9	6.5
$KMnO_4/HNO_3$	5.2	15.1	15.8
Turco 4521	13.2	49.8	52.3
Turco 4502	19.2	55.8	148
Citrox	36.6	106	87.3
Tartaric/NaOH	90.4	367	75.7
Turco 4324	20.1	59.0	181
Oxalic	28.6	108	68.5
Citric	0.5	1.1	0.6
Total	25.8	97.8	48.5

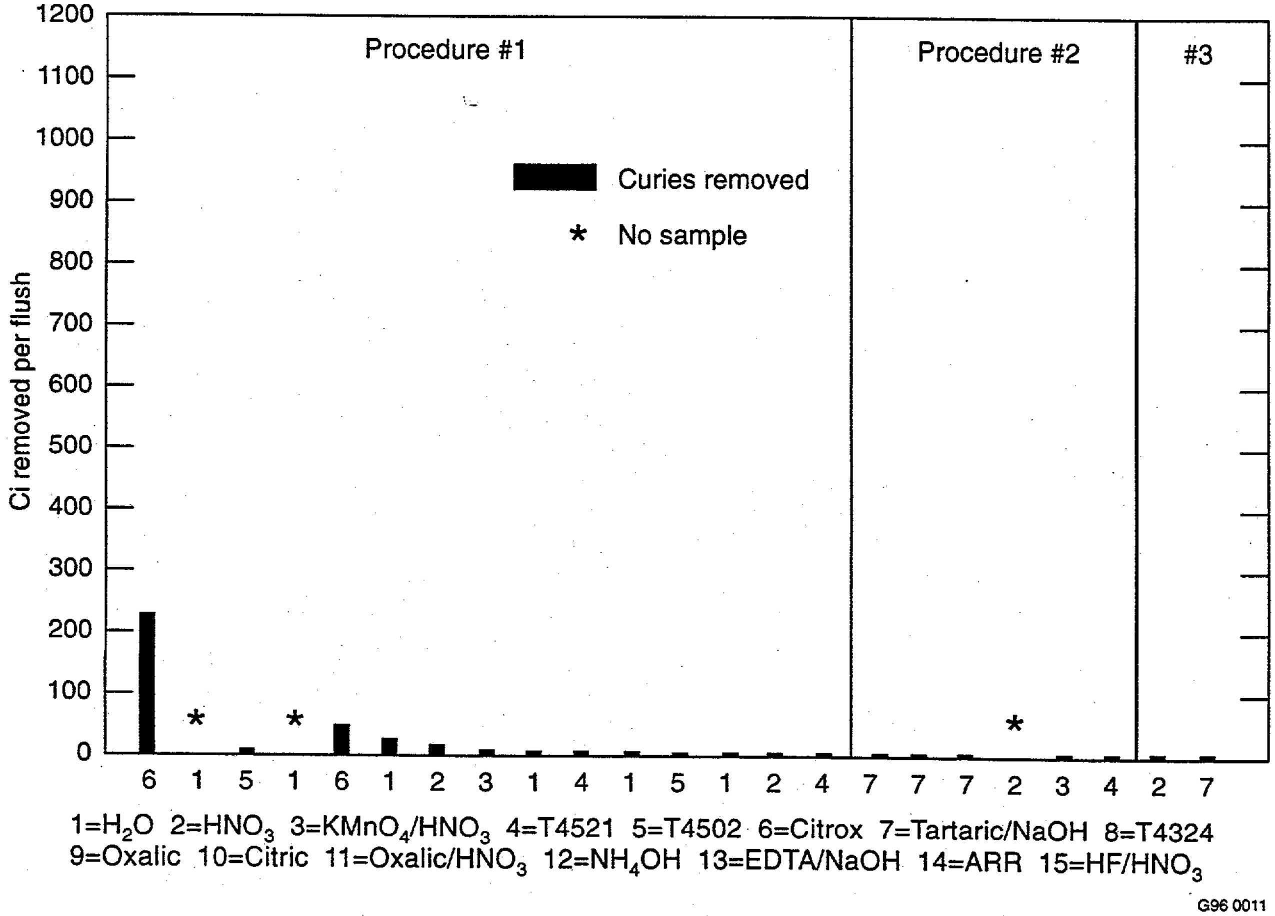


Figure 15a. 1983 decontamination of F cell following Aluminum #38 (Part I).

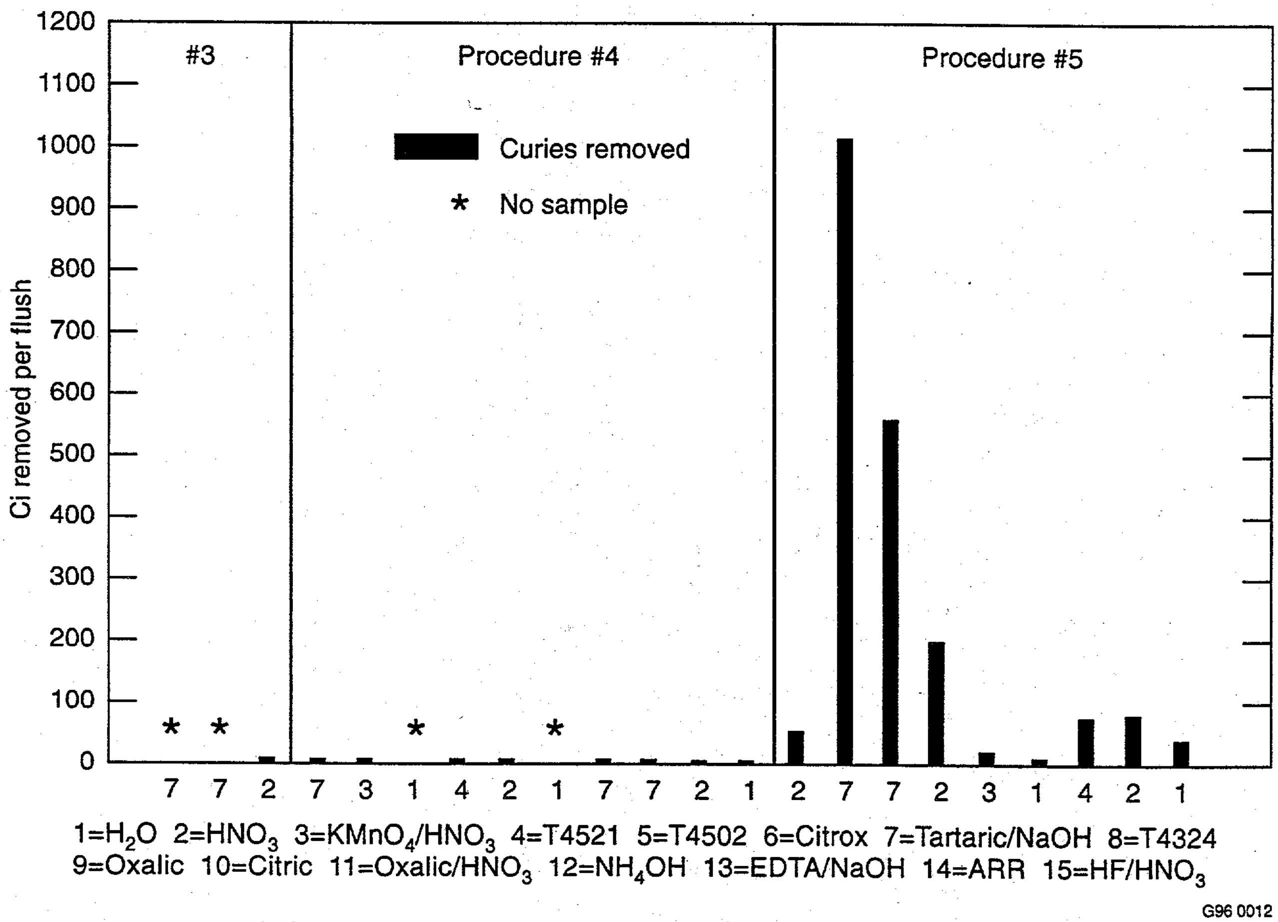


Figure 15b. 1983 decontamination of F cell following Aluminum #38 (Part II).

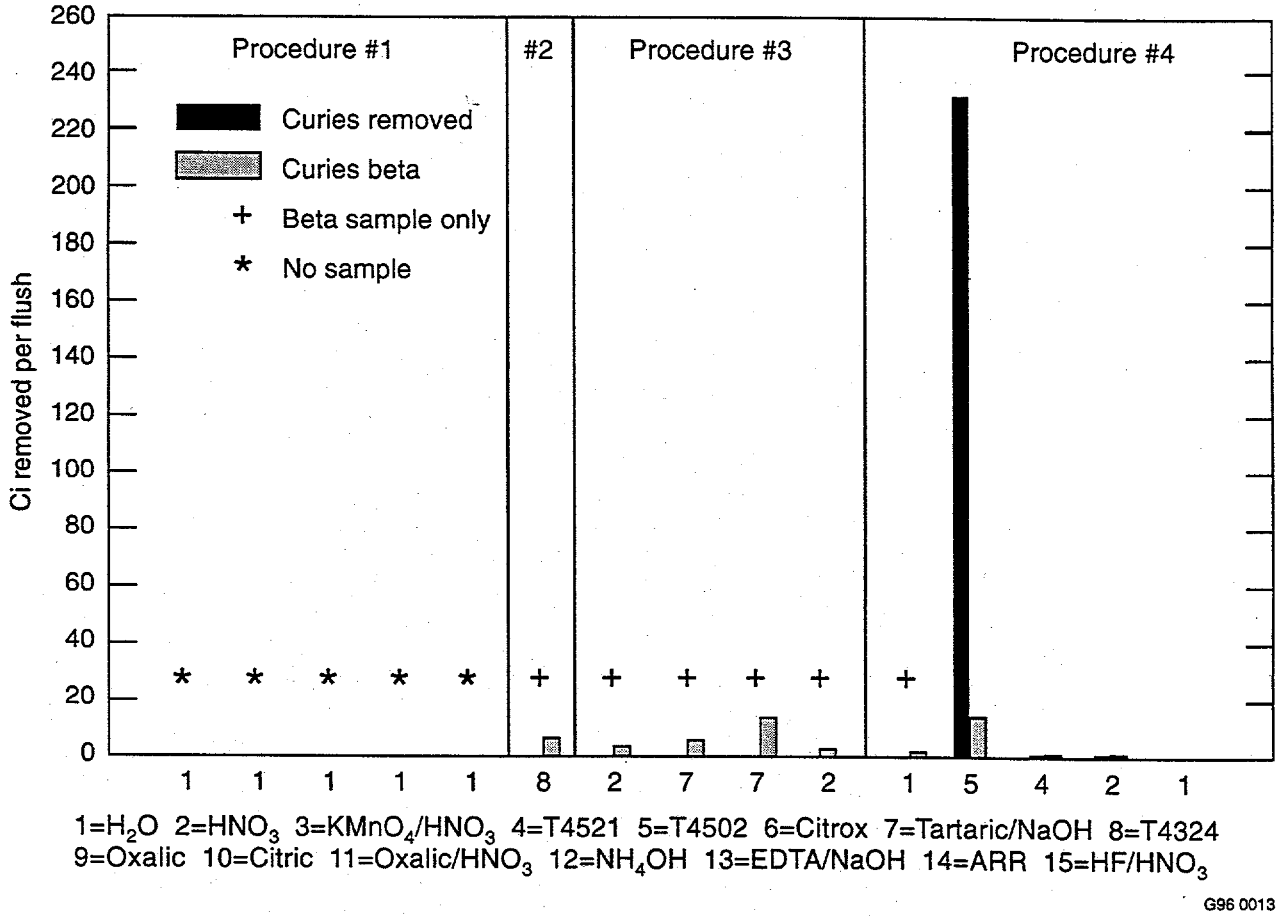


Figure 16. 1983 decontamination of J-135 following Aluminum #38, curies removed per flush.

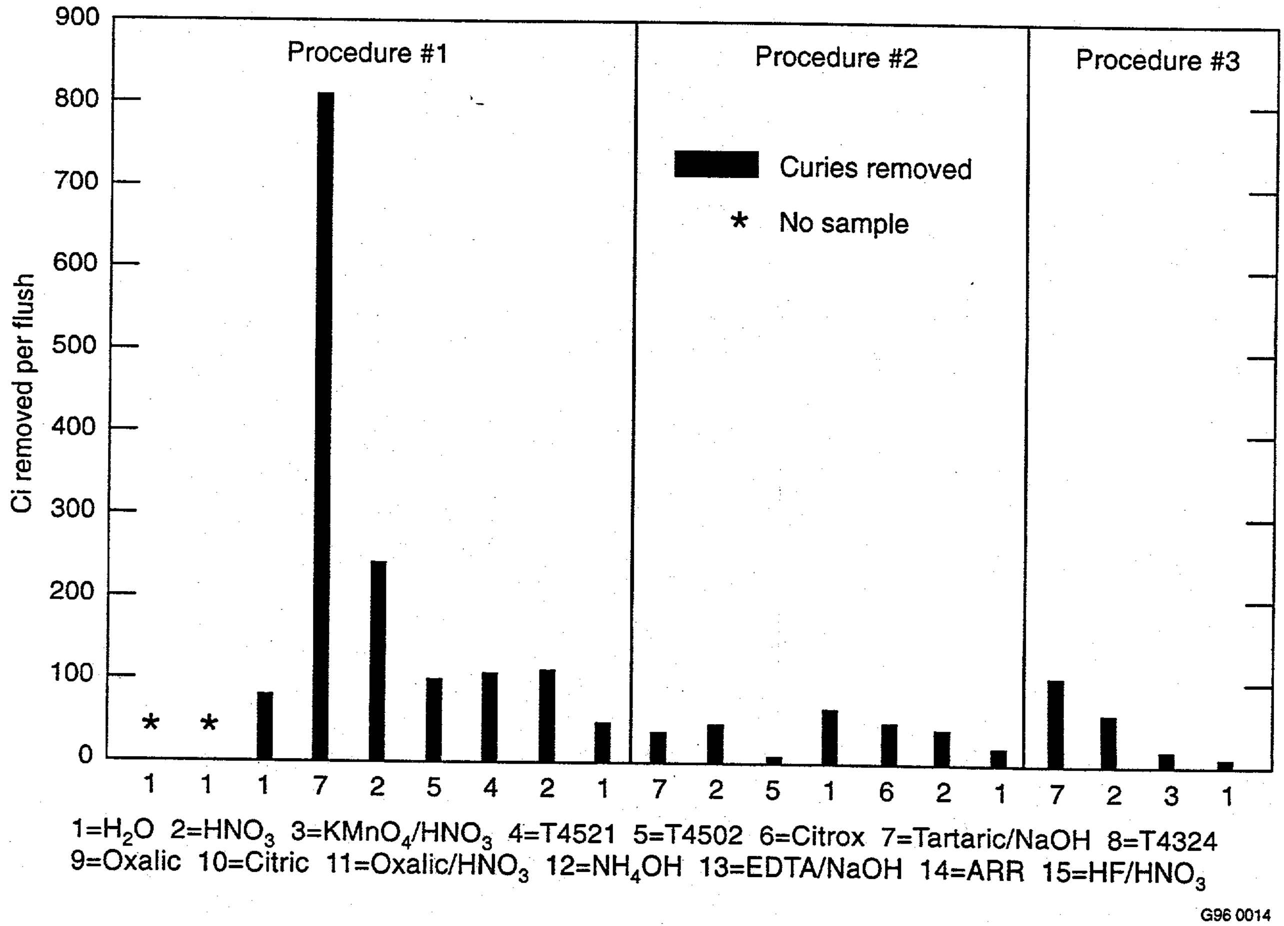


Figure 17a. 1983 decontamination of G cell following Aluminum #38, curies removed per flush (Part I).

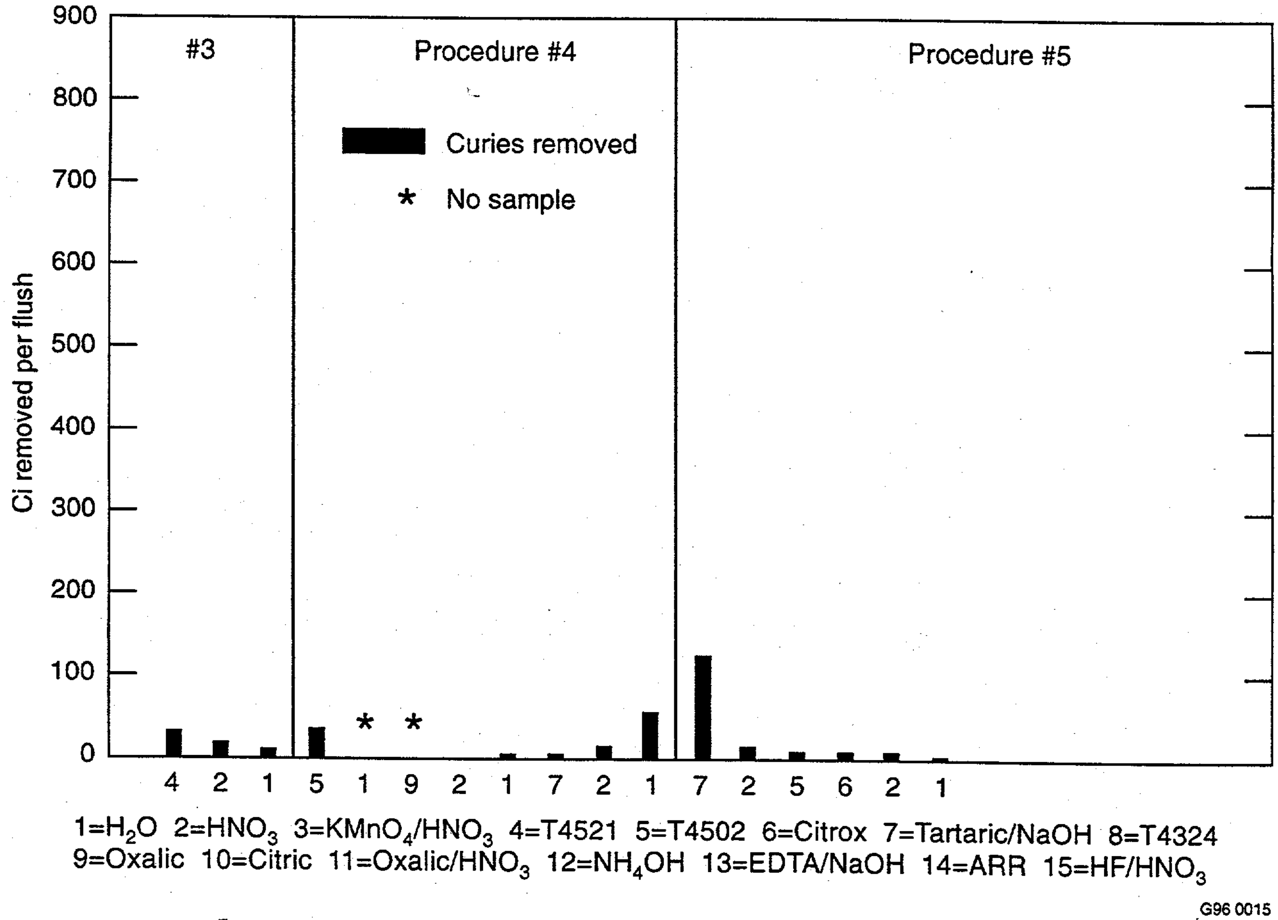


Figure 17b. 1983 decontamination of G cell following Aluminum #38, curies removed per flush (Part II).

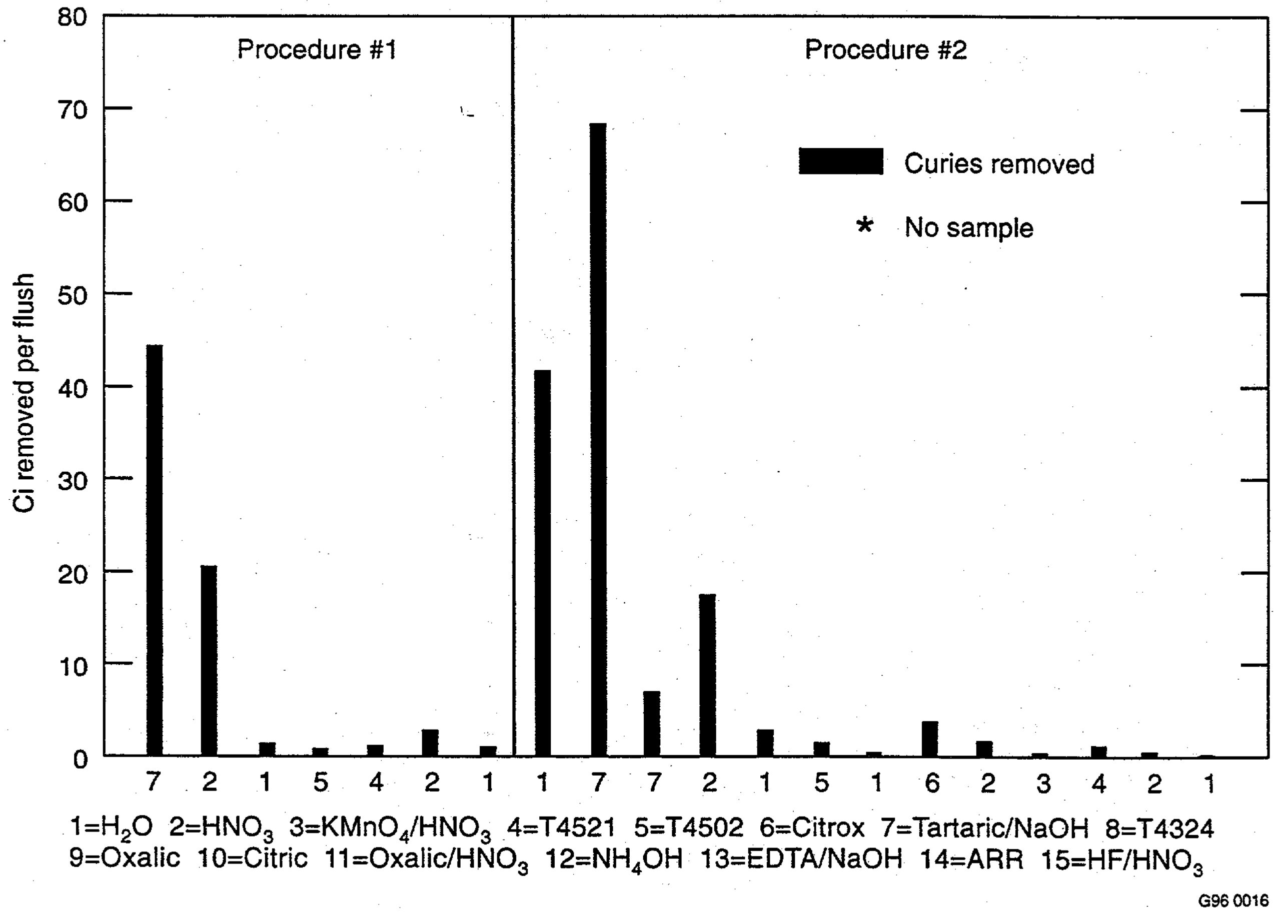


Figure 18. 1983 decontamination of H cell following Aluminum #38, curies removed per flush.

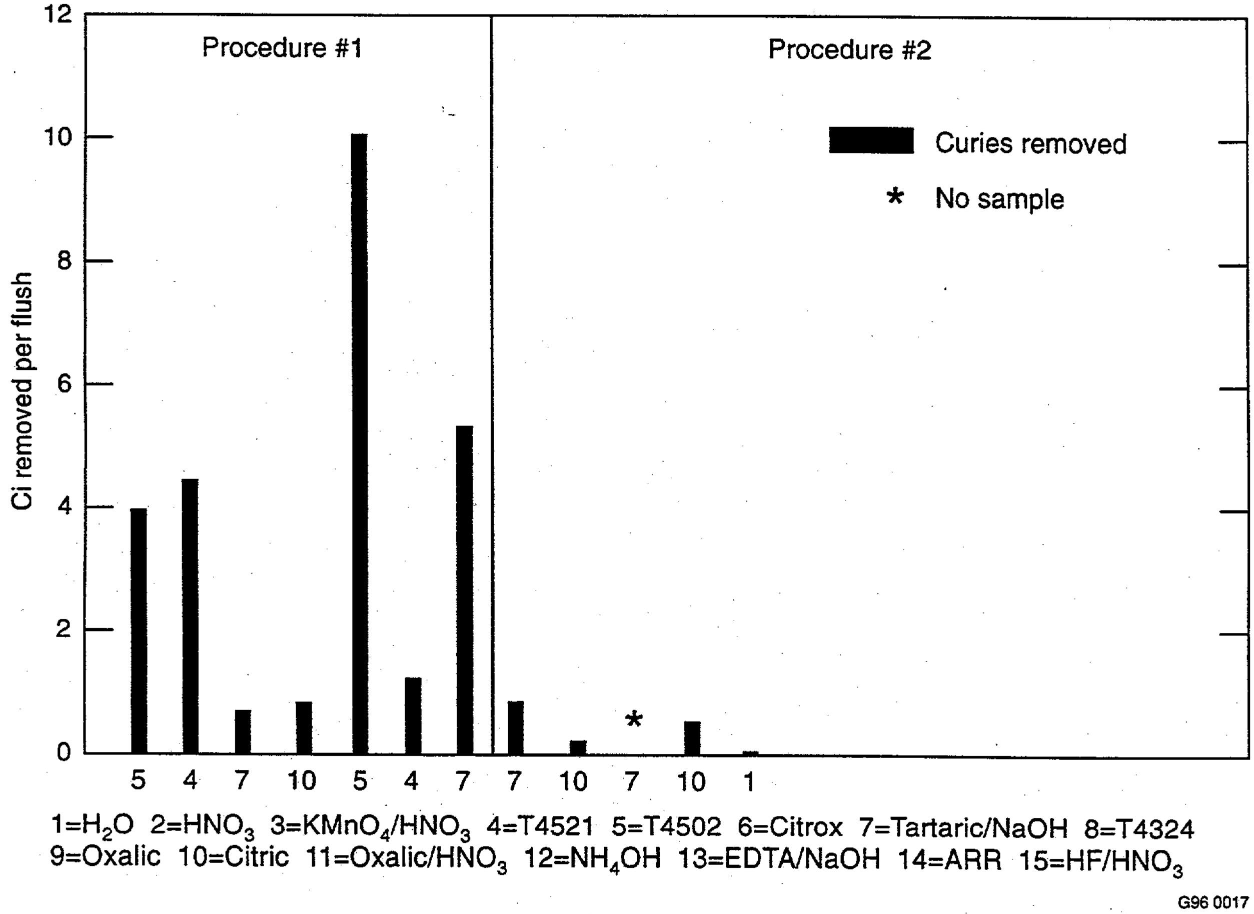


Figure 19. 1983 decontamination of E cell following Aluminum #38, curies removed per flush.

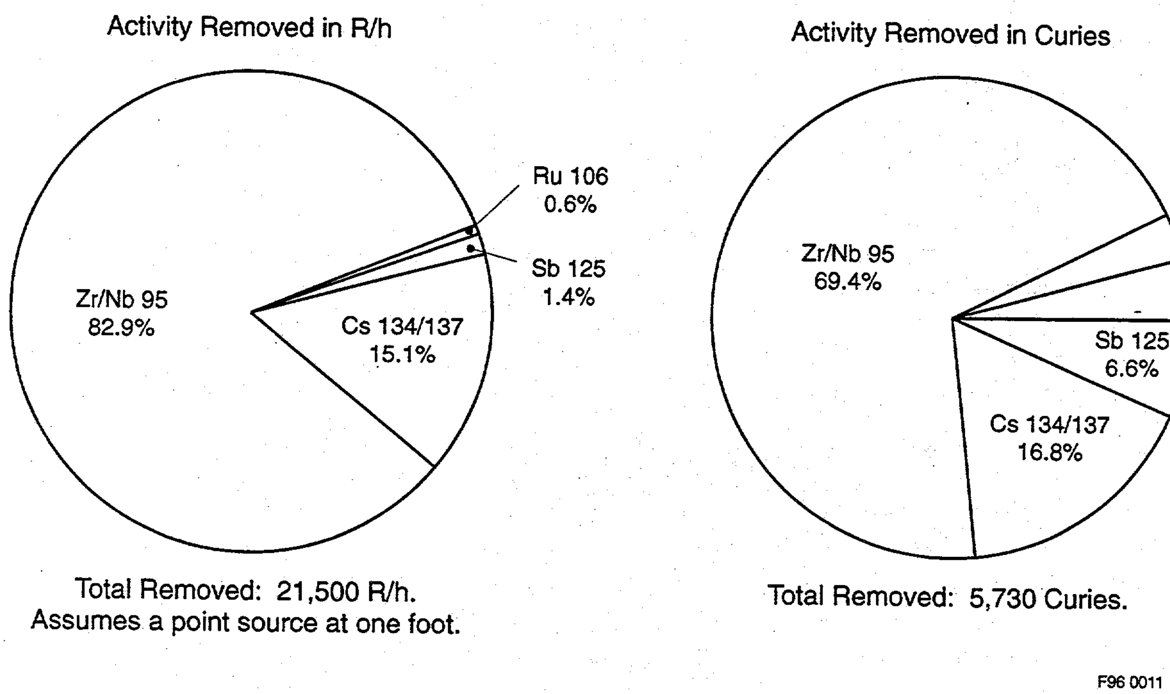


Figure 20. 1983 First Cycle decontamination after Aluminum #38, curies and R/h removed by radionuclide.

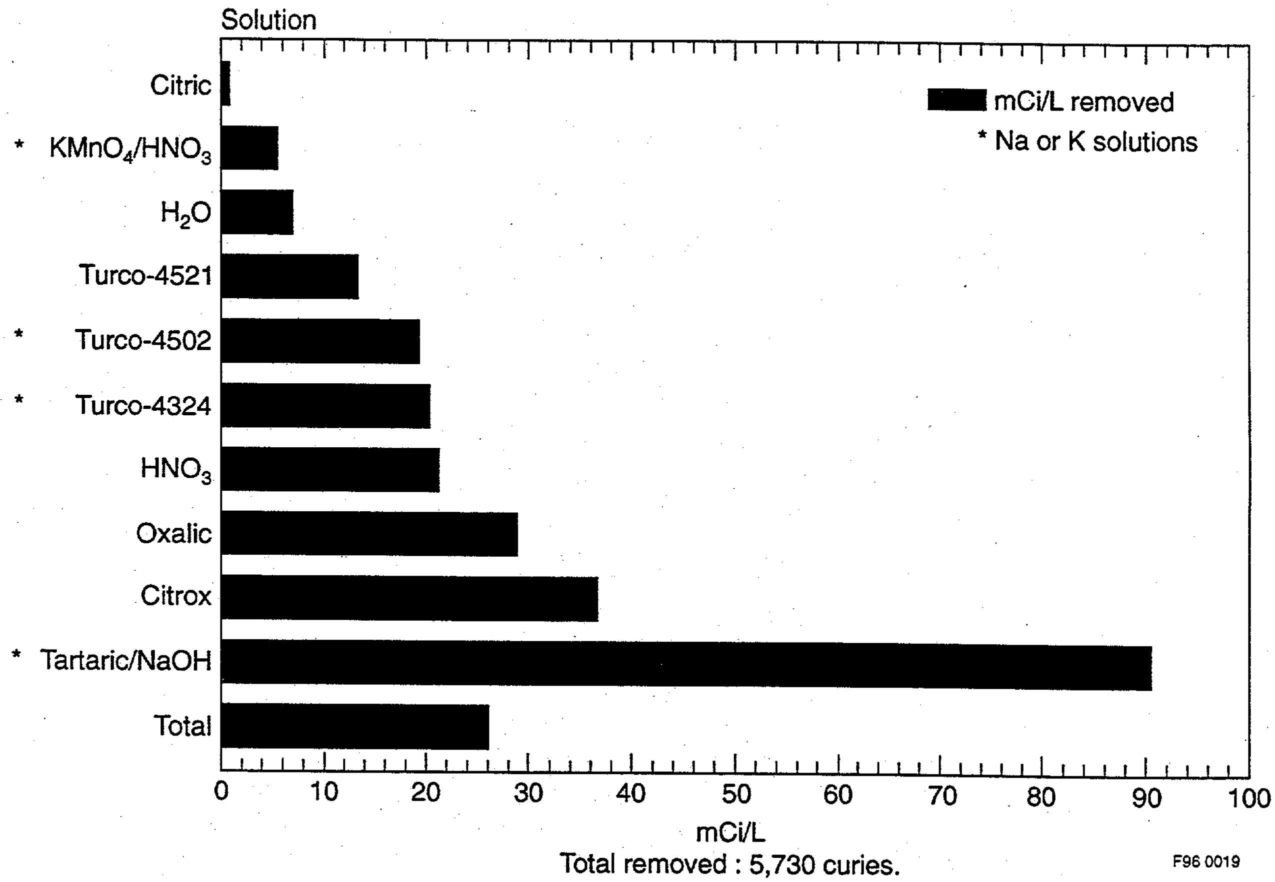


Figure 21. 1983 First Cycle decontamination after Aluminum #38, curies and mCi/L removed per solution.

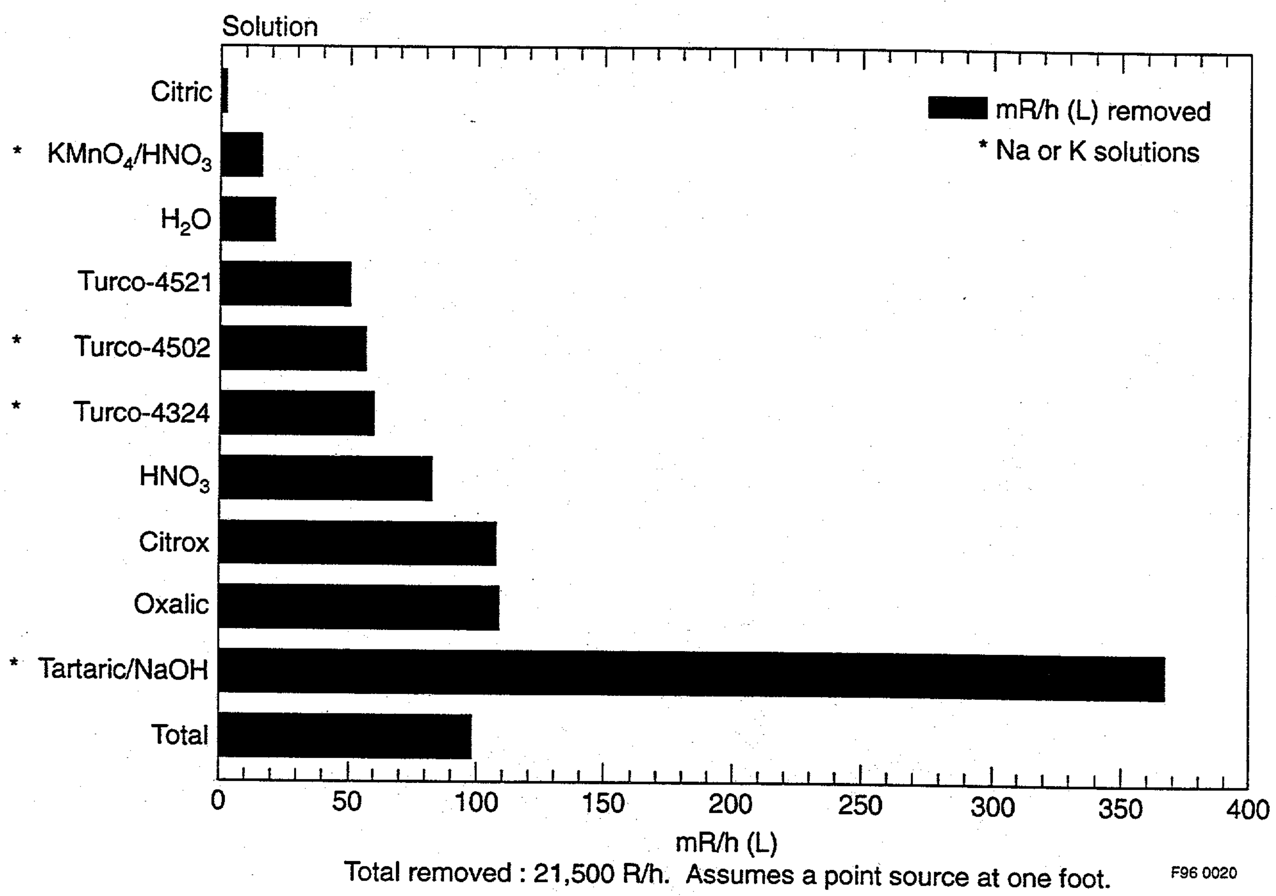


Figure 22. 1983 First Cycle decontamination after Aluminum #38, curies and (mR/h)/L removed per solution.

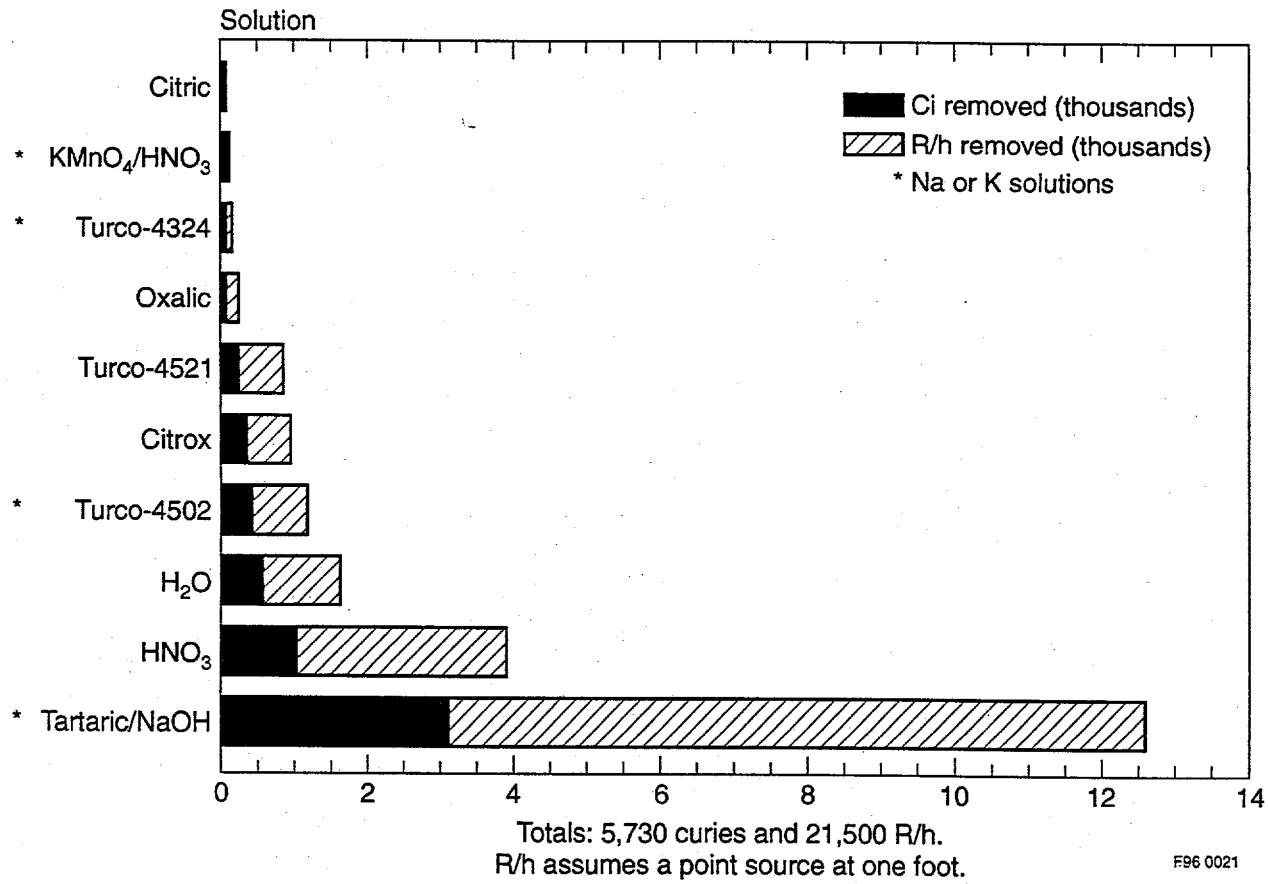


Figure 23. 1983 First Cycle decontamination, total curies and R/h removed per solution.

1984 ROVER DECONTAMINATION (FUEL CAMPAIGN #39)

Decontamination following the Rover campaign included G and H cells and only took twelve chemical flushes. Additional water flushes were used to remove solids from the process columns.

Very little radioactivity was removed. Table 11 provides a summary of activity removed.

Individual flush solutions were sampled and the results of the activity removed in curies are shown in Figure 24. Vertical lines represent separate procedures with the procedure number centered at the top.

This decontamination generated approximately 10,000 gal of unprocessed waste and about 300 kg of sodium and potassium. The average beta activity was $4.5 \times 10^{+5}$ β/min/mL. Appendix E gives a complete sample analysis and sample data.

Lessons Learned

Contamination levels were not a major problem following Rover. However, plugged lines, jets and airlifts were. When the extraction columns were flushed with caustic solution the lines, jets or airlifts would plug. This showed that the caustics were breaking up and moving solids.

Due to the low radiation fields, workers were able to enter the cells and cut the lines at the bottom of the G cell vessels and the G and H cell columns. Water was used to flush the solids from the vessels and onto the floor. Large amounts of a white sand-like material was flushed to the cell floors. This was assumed to be the Rover bed material.

Table 12 summarizes the removal efficiency of the decontamination solutions used during the 1984 Rover decontamination. The table is provided in activity removed per L of solution used. This will give a better picture of which solutions were the most efficient in removing contamination.

Table 11. Radioactivity removed during the 1984 Rover decontamination.

Isotope	Curies	R/h	mg
Zr/Nb-95	0	0	0
Ru-106	1	0	0
Sb-125	4	3	4
Cs-134/137	4	14	46
Ce-144	0	0	0
Total	9	17	50

Table 12. Solution's effectiveness during the 1984 Rover decontamination.

Solution	mCi/L	(mR/h)/L	μg/L
HNO_3	0.21	0.51	1.6
$KMnO_4/HNO_3$	0.21	0.58	1.9
Turco 4521	0.41	0.78	2.2
Turco 4502	0.35	0.47	1.2
Citrox	0.13	0.12	0.22
Oxalic	0.14	0.41	1.3
Total	0.27	0.54	1.6

The major difficulty encountered was the removal of solids within the process equipment from Rover bed material. These solids could not be flushed to waste. Instead, they were removed by cutting process lines and flushing them out onto the cell floor where they could be collected and removed.

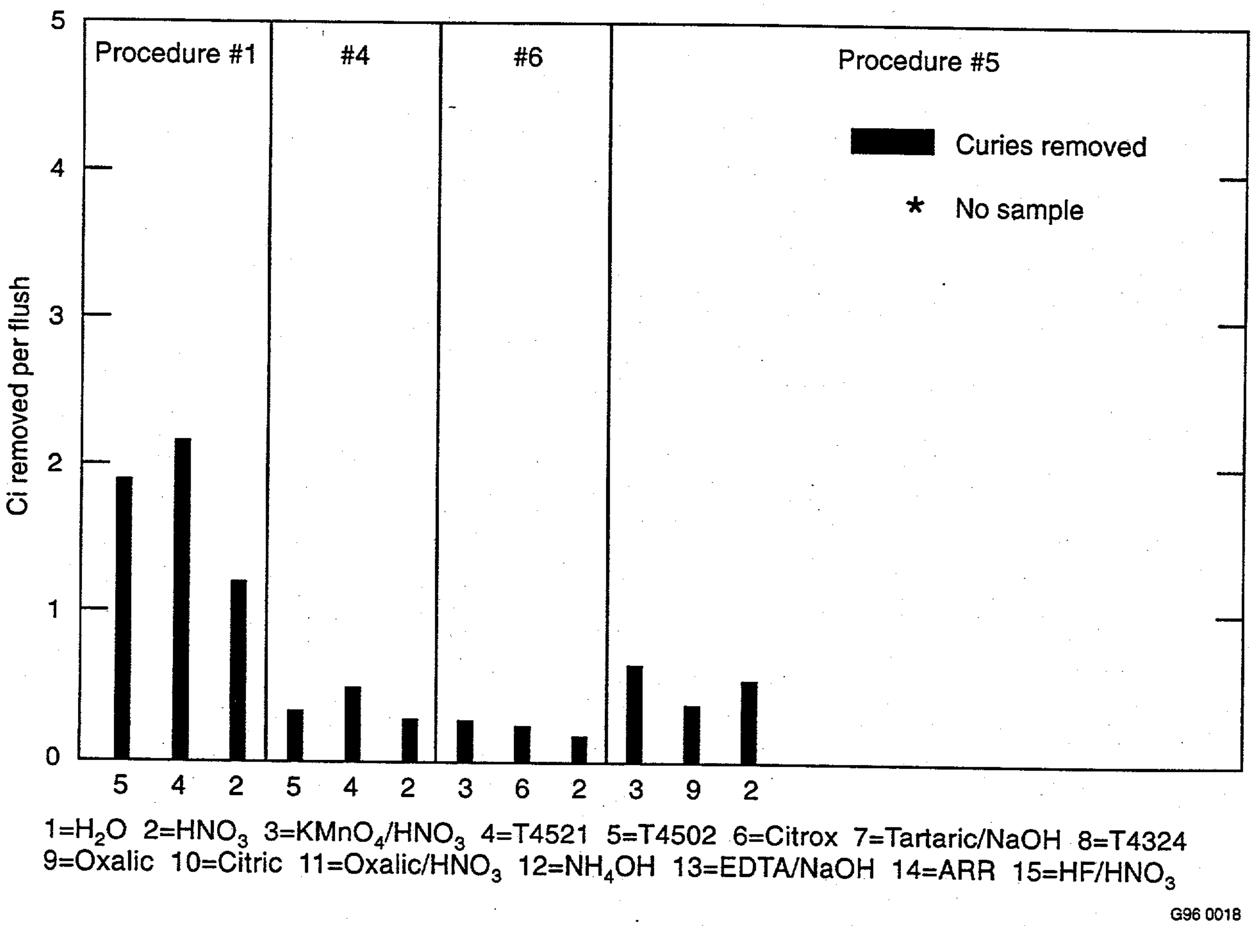


Figure 24. 1984 decontamination of G and H cells following Rover #39.

1986 ALUMINUM DECONTAMINATION (FUEL CAMPAIGN #40)

Following the Aluminum fuel dissolution, E, F, G and H cells were decontaminated in that sequence. A total of 145 flushes were used to clean these cells. Of these flushes, 54% were sampled for radionuclide activity. Figures 25 through 27 show the individual flush results and the sequence of chemical solutions. Individual procedures are separated by vertical lines with the procedure number centered at the top. Flushes without sample analysis are marked with an (*). Towards the end of the decontamination, flushing was directed by instructions contained in the daily Plan of the Day (POD) rather than formalized procedures.

Radionuclide analysis was done on each sample to establish what isotopes were present and which solutions were removing specific nuclides. Table 13 gives the isotopic distribution from the total decontamination.

Figure 28 illustrates the radionuclide distribution. This graph shows that the units of measuring radionuclide activity should be an important consideration. If curies were used as the sole measure of activity, then the major contributors are:

Sb-125	40%	curies
Zr/Nb-95	27%	curies
Cs-134/137	23%	curies

However, if the activity is measured in R/h, then the order of the major contributors is significantly changed as shown below.

Zr/Nb-95	51%	R/h
Cs-134/137	33%	R/h
Sb-125	13%	R/h

Further sample analysis and compilation of each individual solution was done to learn what radionuclides were removed by each solution. Table 14 summarizes the activity removed per solution.

Table 13. Radioactivity removed during the 1986 Aluminum decontamination.

Isotope	% Ci	% R/h	% mg
Zr/Nb-95	27.2	51.3	0.2
Ru-106	8.3	2.1	0.9
Sb-125	40.5	13.2	13.7
Cs-134/137	23.6	33.4	85.1
Ce-144	0.8	0.1	0.1
Total	1,060 Ci	2,510 R/h	2,980 mg

Table 14. Isotopic activity removed by 1986 Aluminum decontamination solutions.

% Ci, mg, R/h shown down columns[a]					
Ce-144	Cs-134/137	Zr/Nb-95	Ru-106	Sb-125	Solution
36.0	30.8	14.1	16.3	17.1	H_2O
11.4	25.1	9.9	21.3	12.4	HNO_3
0.8	2.0	0.4	1.1	0.5	$KMnO_4/HNO_3$
0.2	0.8	0.4	0.5	0.6	Turco 4521
0.8	3.6	4.6	11.0	11.7	Turco 4502
11.4	2.4	5.6	2.0	4.8	Tartaric/NaOH
1.7	1.2	11.7	7.2	5.9	Oxalic
30.1	17.0	43.5	28.8	29.3	Oxalic/HNO_3
0.0	0.4	1.1	3.1	2.0	NH_4OH
5.5	7.3	1.4	1.6	4.7	EDTA/NaOH
2.1	9.3	8.1	7.3	11.1	Turco ARR

a. Since each column contains just one isotope, the percentage values down the column will not change when referring to curies, milligrams or R/h. The reason for this is that when converting curies into mg or R/h , the same conversion factor will be used for all the values in the same column. Therefore, the percent will not change since all the values were multiplied by the same conversion factor.

The above information clearly shows that the oxalic acid in dilute nitric acid was effective in removing Zr/Nb-95. A Pareto analysis was done on the solution effectiveness in removing contamination and is shown in Figures 29 and 30. Appendix F gives more sample results and the sample data.

The oxalic acid in nitric acid solution proved to be the most efficient decontamination solution. This was the first time since 1982, when data was collected, that a nonsodium or nonpotassium solution was not the most effective. This also was the first year the oxalic nitric acid solution was used. Continued usage of this solution was dependent on corrosion testing. However, these results were very encouraging, particularly with the potential of reducing sodium waste.

The sequence of cell decontamination, decontamination time, flushes, and samples taken is given in Table 15. G and H cells were decontaminated with the same solution.

As the decontamination progressed, less work was performed under special procedures. Instead, the Plan of the Day (POD) was used to provide direction and instructions. A major result of this change was a drastic reduction in the number of flushes sampled as can be seen above during G and H cell decontamination.

Another problem was the repetitive use of caustic flush solutions. Data from 1982 showed that using a caustic solution more than twice in a row did very little good. However, in G and H cells caustic solutions were used nine times in a row, Figure 27. No samples were taken so the actual effect of these flushes cannot be learned. The total activity removed by each solution and the number of times the solutions were used is listed in Table 16.

Table 15. Aluminum cell flush data, 1986.

Cell	Month/day	Number of flushes	Number sampled	% sampled
E	2/16–4/1	21	19	90
F	3/19–6/19	57	42	74
G and H	6/26–7/24	67	18	27
Total	22/16–7/24	145	79	54

Table 16. Total activity removed by chemical solutions during the 1986 Aluminum decontamination.

Solution	% Ci	% R/h	Number of flushes
H_2O	19.5	20.0	32
HNO_3	15.3	15.4	50
$KMnO_4/HNO_3$	0.9	1.0	5
Turco 4531	0.5	0.5	2
Turco 4502	7.7	5.2	11
Tartaric/NaOH	4.3	4.4	2
Oxalic	6.5	7.3	6
Oxalic/HNO_3	30.1	32.1	11
NH_4OH	1.6	1.2	1
EDTA/NaOH	4.1	3.8	20
Turco ARR	9.5	9.0	5
Total	1,060 Ci	2,510 R/h	145

Figure 31 compares the total amount of activity removed by each solution. The acidic oxalic solution removed the most contamination and it was only used 11 times. Water and nitric acid came in second and third, but these two solutions were used 82 times. Water and nitric acid can remove large amounts of contamination, but it requires extensive flushing and additional time for those flushes. These first results from the acidic oxalic were encouraging because of its effectiveness and because it was a nonsodium and nonpotassium solution.

Decontamination activities generated 58,500 gal of unprocessed waste. There was approximately 1,500 kg of sodium and potassium sent to waste. The average beta activity of the decontamination solutions was $1.1 \times 10^{+7}$ β/min/mL.

Lessons Learned

We assumed that this decontamination following an Aluminum run would be similar to the last Aluminum decontamination in 1983. This was not the case. The radionuclide distribution was totally different and this affected the decontamination chemical's effectiveness. This difference stressed the importance of requesting samples of the solutions after each decontamination and analyzing the results as quickly as possible to make corrections for differences in isotopic distributions and to maximize each solution's effectiveness.

POD procedures should not be used to control decontamination flushes. This bypasses adequate review from appropriate organizations. Also, repetitive flushes with caustic solutions should be avoided, but if they are used, samples should be taken to monitor their effectiveness.

The sequence of cell decontamination is very important. Process lines run from cell to cell to such an extent that it becomes impossible to adequately decontaminate one cell without cleaning the lines entering from other cells. To minimize flush solutions, cleaning the entire First Cycle system should be done. This would allow each flush solution to pass from one vessel to another and then continue to the next cell through interconnecting lines. This approach would help eliminate missed lines that dogleg into a cell and lines originating from another cell.

Table 17 summarizes the removal efficiency of the decontamination solutions used during the 1986 Aluminum decontamination. The table is provided in activity removed per L of solution used. This will give a better picture of which solutions were the most efficient in removing contamination.

Table 17. Solution's effectiveness during the 1986 Aluminum decontamination.

Solution	mCi/L	(mR/h)/L	μg/L
H_2O	3.8	9.2	15.7
HNO_3	2.5	5.9	10.5
$KMnO_4/HNO_3$	0.8	2.2	4.6
Turco 4521	2.6	5.6	11.6
Turco 4502	3.9	6.3	6.7
Tartaric/NaOH	16.8	40.9	29.7
Oxalic	4.4	12.0	4.1
Oxalic/HNO_3	19.7	49.7	34.5
NH_4OH	5.8	10.4	8.8
EDTA/NaOH	2.4	5.1	10.7
Turco ARR	9.7	21.6	27.7
Total	4.8	11.4	13.5

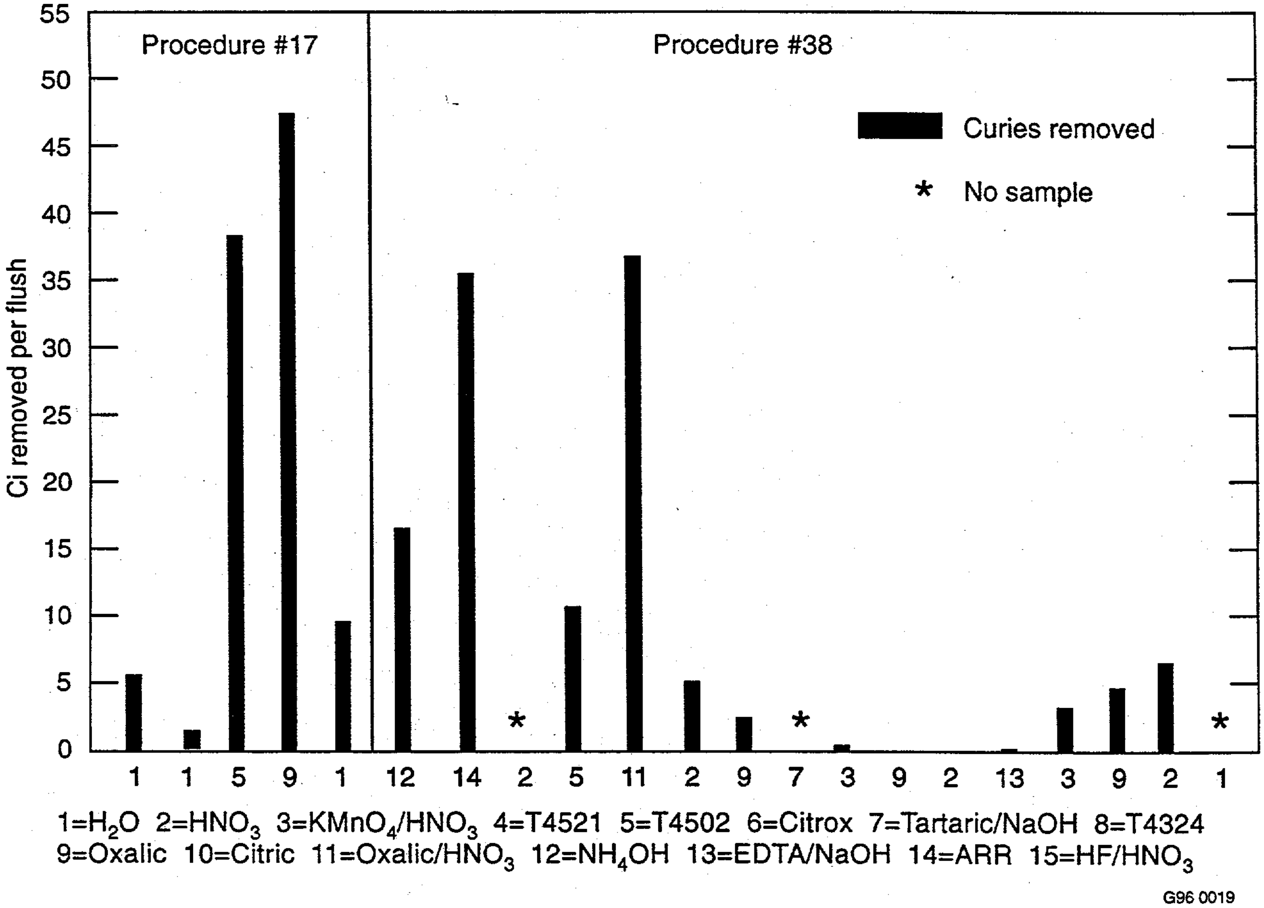


Figure 25. 1986 decontamination of E Cell following Aluminum #40, curies removed per flush.

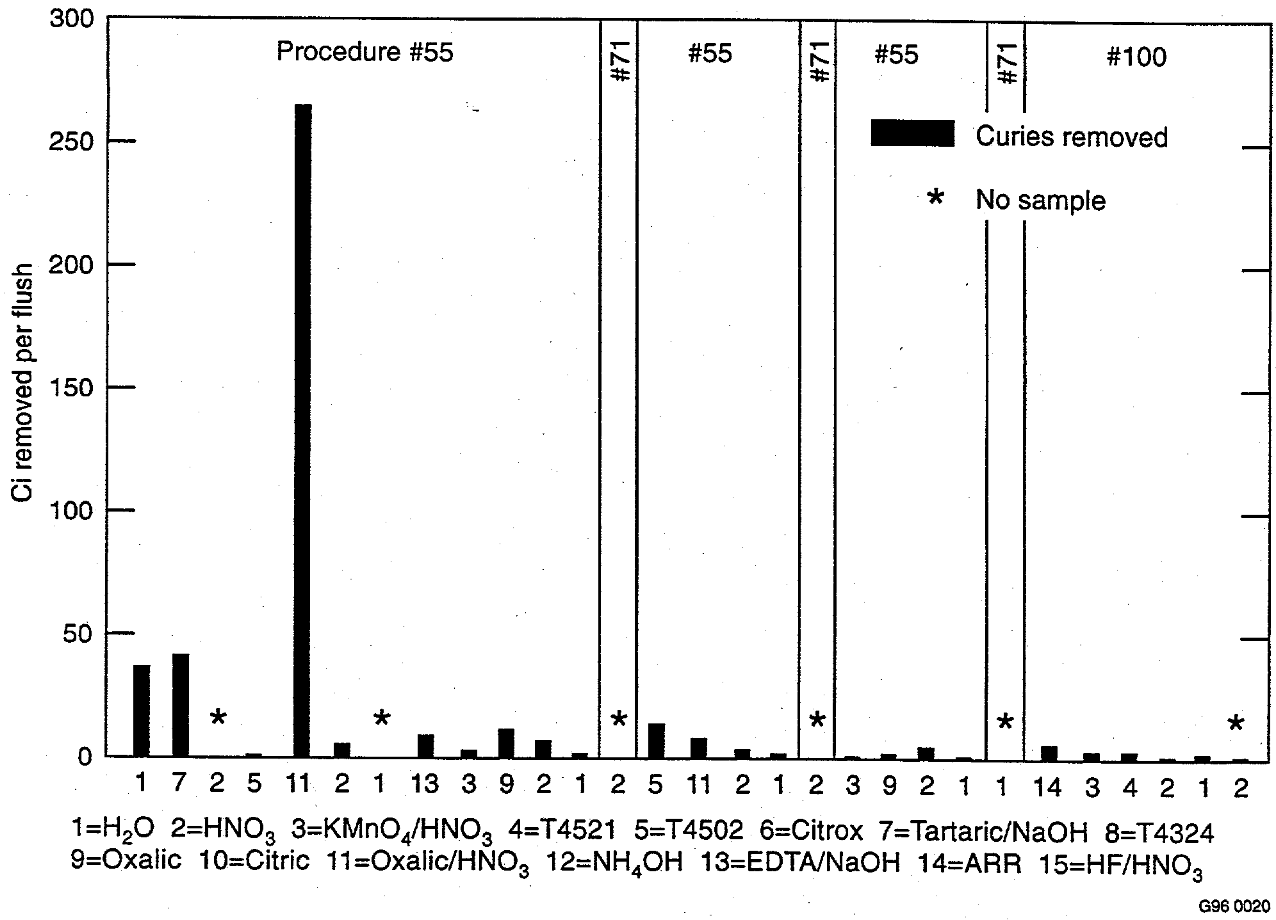


Figure 26a. 1986 decontamination of F cell following Aluminum #40 (Part I).

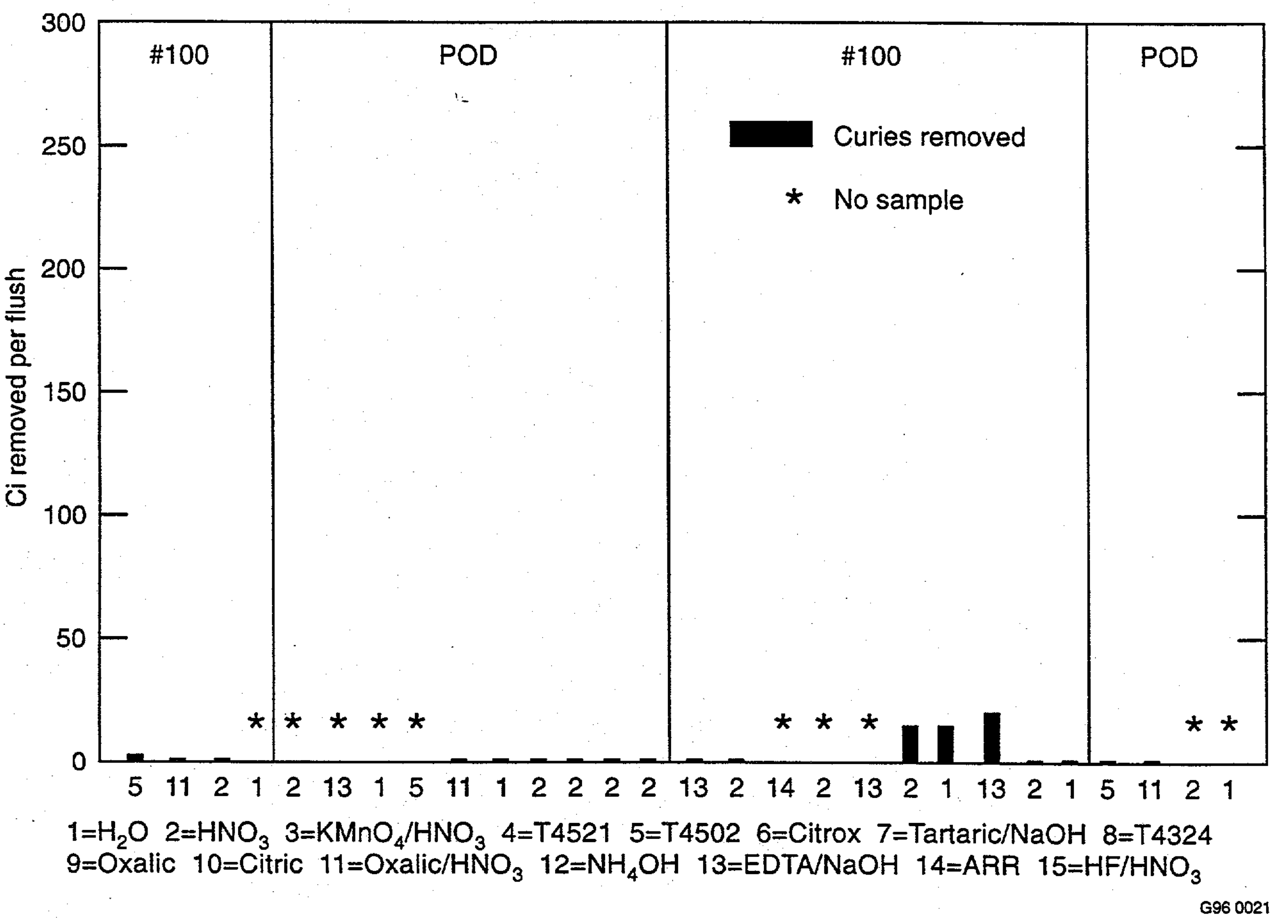


Figure 26b. 1986 decontamination of F cell following Aluminum #40 (Part II).

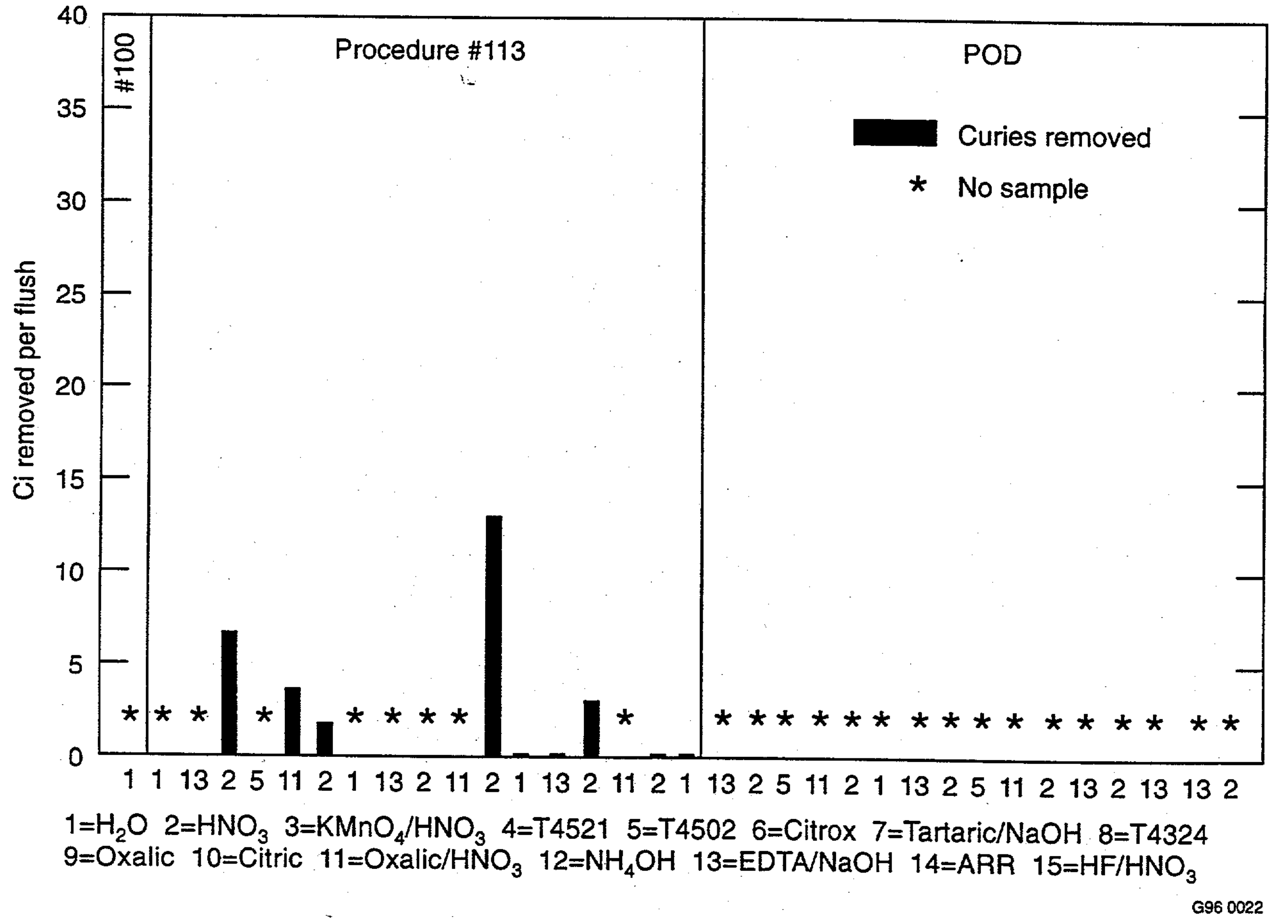


Figure 27a. 1986 decontamination of G and H cells following Aluminum #40 (Part I).

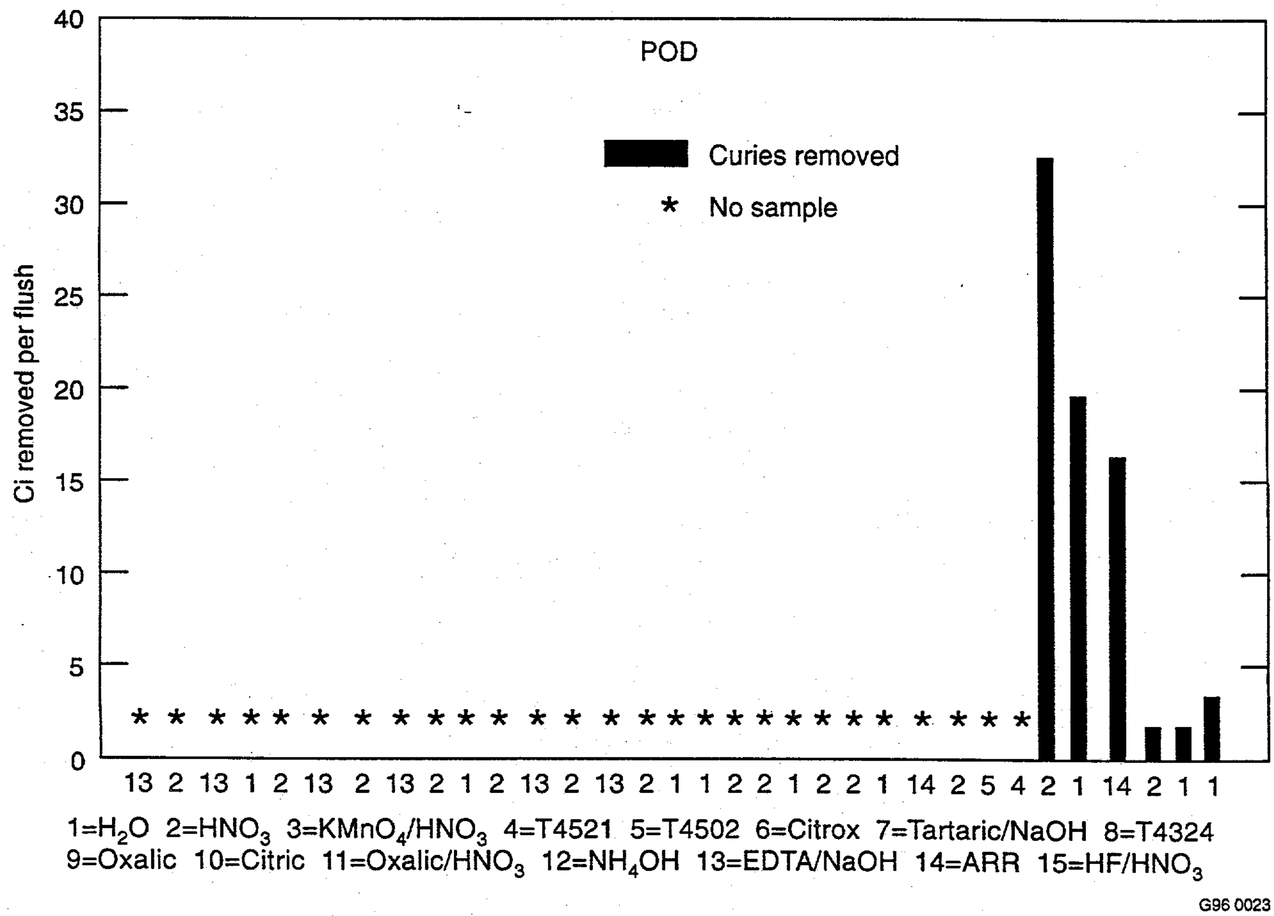


Figure 27b. 1986 decontamination of G and H cells following Aluminum #40 (Part II).

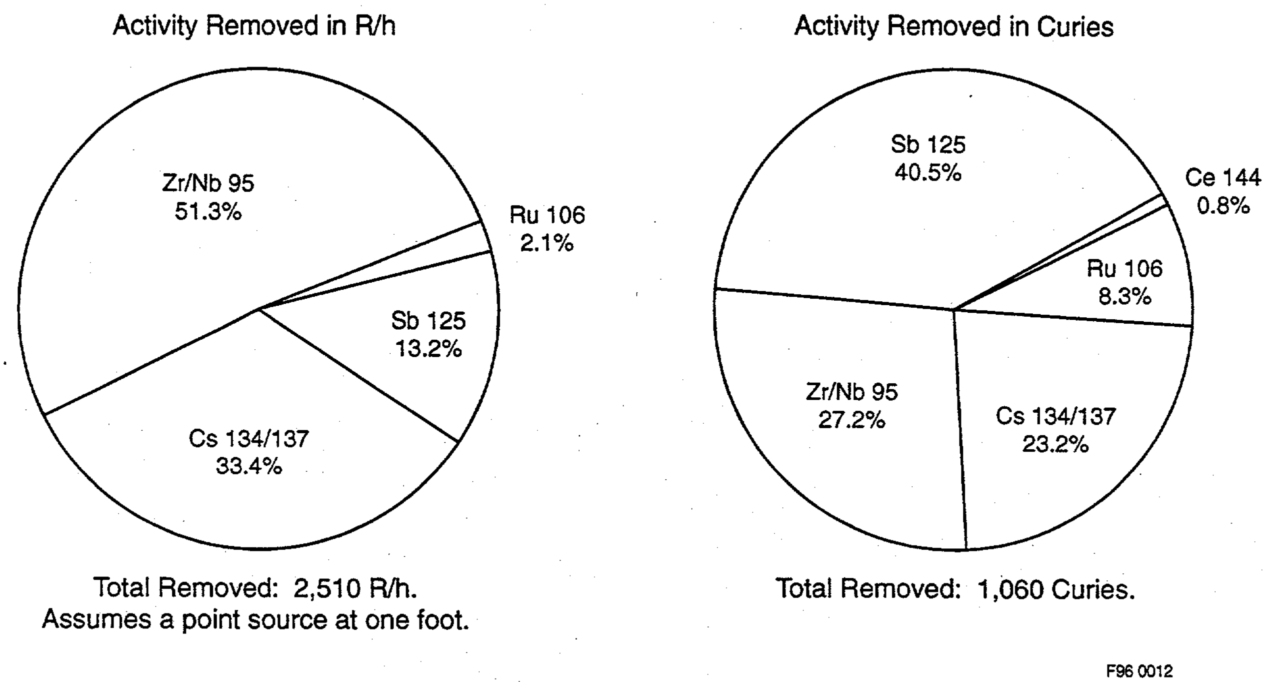


Figure 28. 1986 first cycle decontamination after Aluminum #40.

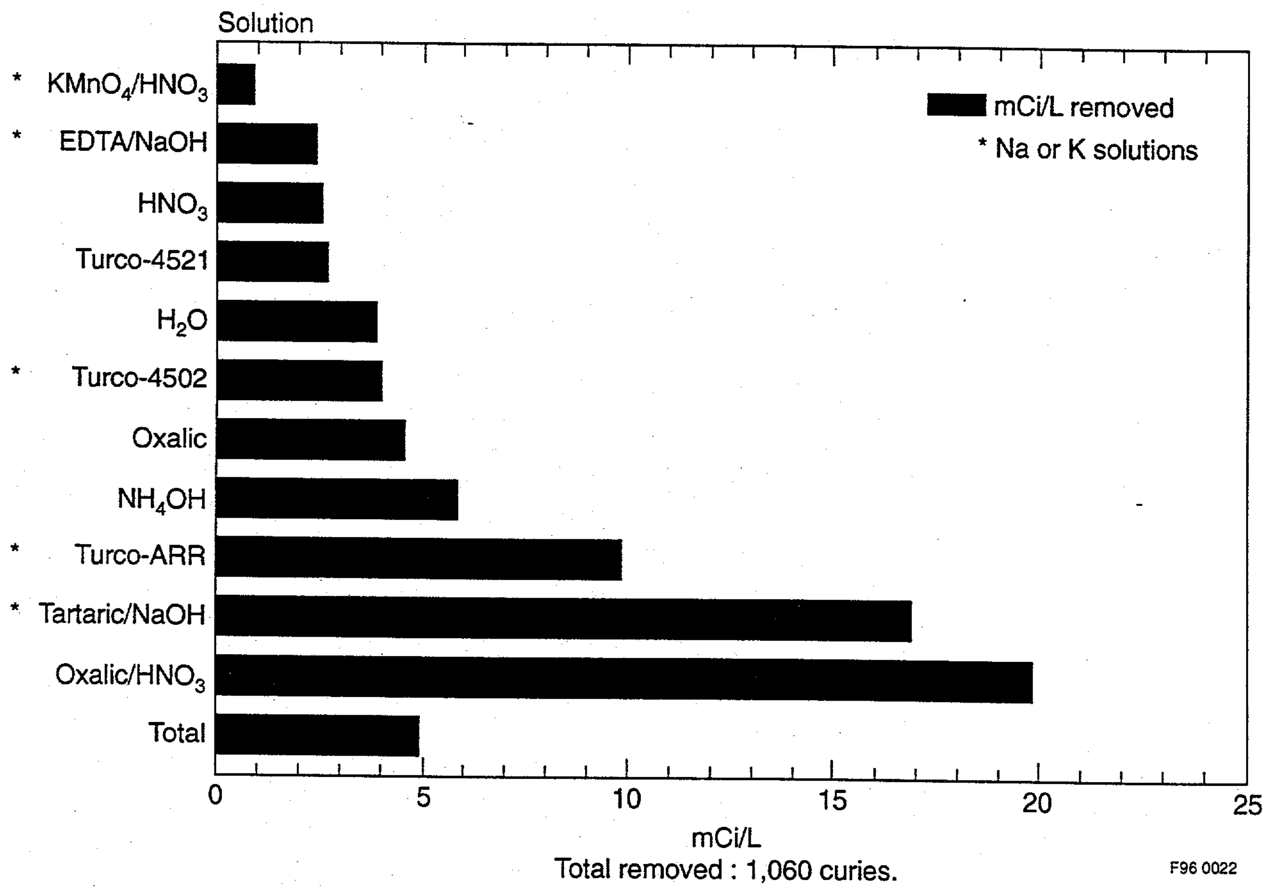


Figure 29. 1986 first cycle decontamination after Aluminum #40, activity removed per solution.

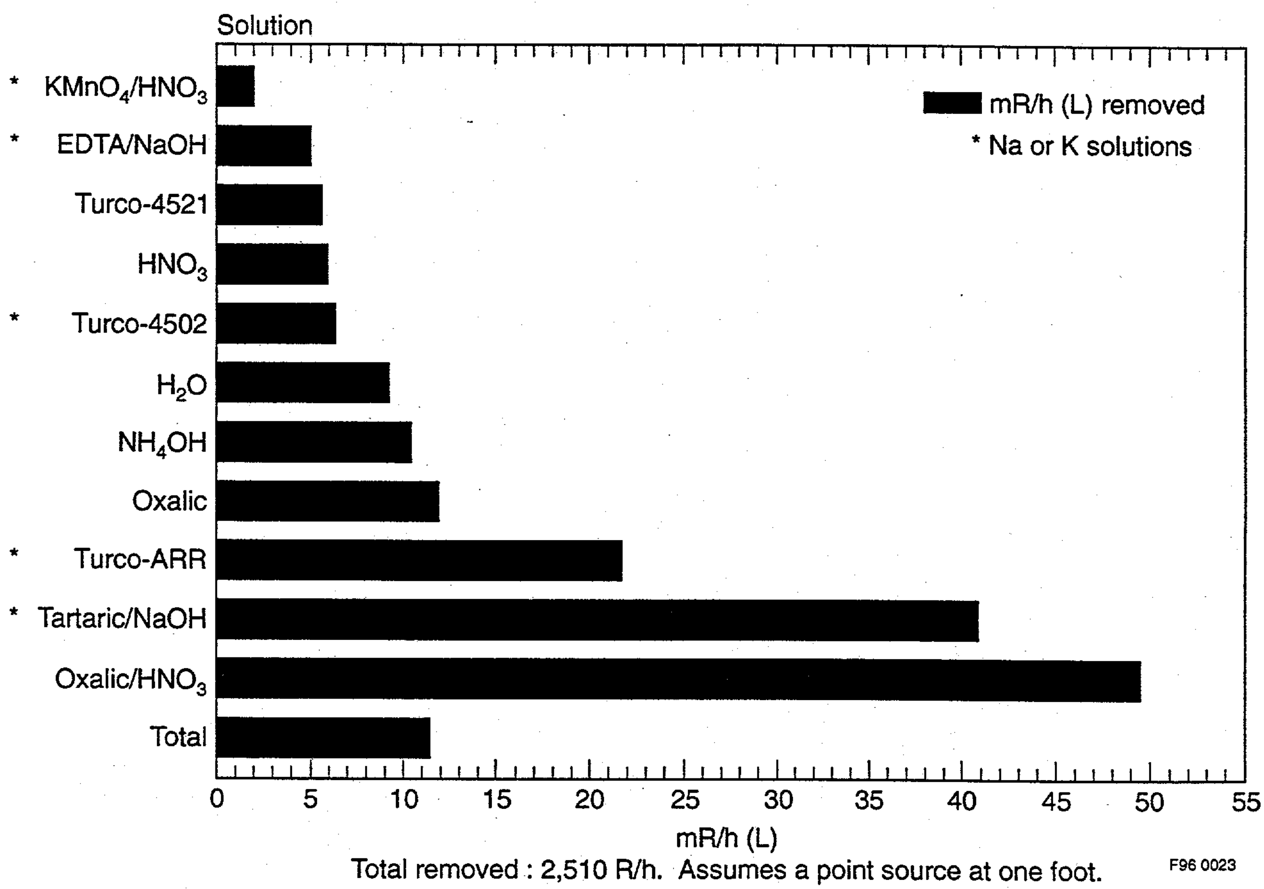


Figure 30. 1986 first cycle decontamination after Aluminum #40, activity removed per solution.

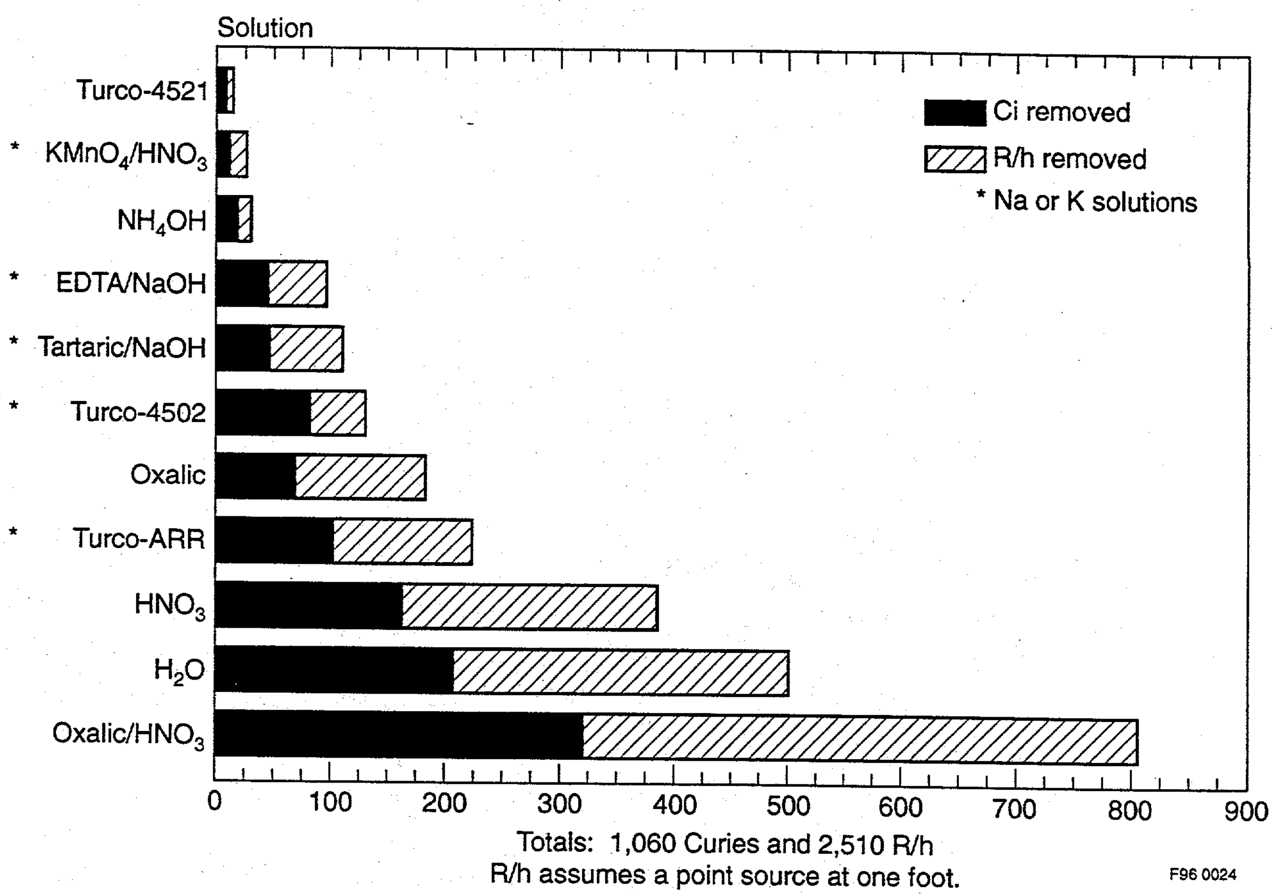


Figure 31. 1986 first cycle decontamination.

1989 FDP DECONTAMINATION (FUEL CAMPAIGN #41-42)

Decontamination following the first Fluorinel Dissolution Process (FDP) run included U, G, and H cells, in that order. U and G cells were decontaminated in 1988 while H cell was cleaned in 1989. This decontamination was the longest, taking 174 days for internal vessel and piping flushes.

During the decontamination, each flush solution was sampled to monitor the solution's effectiveness. Of the 132 flushes, 92% were sampled. The sample results for the individual flushes are shown in Figures 32 through 34. The figures also show the sequence that the chemicals were used and the decontamination procedure is shown by vertical lines. Flushes lacking sample analysis are shown with an (*). Appendix G provides the sample data and analysis.

All samples were analyzed for the radionuclides present. Table 18 summarizes the results.

Figure 35 illustrates the above results. Clearly, the major contributors to the radiation fields were Cs-134 and Cs-137, which accounted for nearly 78% of what was removed. When the distribution of curies is compared, Ru-106 accounts for 45% and Cs-134/137 for about 36%. It is also important to note the lack of Zr/Nb-95 activity. This is interesting because the Zr/Nb-95 isotopes have been major contributors to radiation fields during past decontaminations, excluding Electrolytic.

Each flush solution was analyzed to learn what isotopes it removed and if there might have been a preferential removal of an isotope by a solution. The data is summarized in Table 19.

Turco 4502 appears to have done well in removing cesium, ruthenium, and antimony. Its effectiveness was surprising when compared with other decontamination cycles. Figures 36 and 37 compare the activity removed by each solution on a per-liter basis. These Pareto graphs show that for the first time, Turco 4502 solution was the most efficient in removing contamination.

Since this was the first time these cells had been decontaminated following an FDP run, there were several unanticipated discoveries. The almost total lack of zirconium and niobium isotopes was a surprise. These isotopes had been present in the dissolution solution in anticipated quantities but they had not been retained in the system. This may have been due to the large quantities of nonradioactive zirconium from the fuel cladding filling the sites on the stainless steel where radioactive Zr-95 normally would fill. This competition for sites resulted in the almost total replacement of Zr-95 with nonradioactive zirconium. It would not take much nonradioactive zirconium to bring about this effect when it is realized that from 1982 through this decontamination, only 120 mg of Zr-95 and Nb-95 were present. Yet this small amount accounted for 60% of the R/h removed.

The next unusual finding was the presence of large quantities of Ru-106. Over 2,100 curies of Ru-106 was removed following the FDP run. The last time ruthenium was present in such large quantities was following the Electrolytic run where 680 curies were removed. The Ru-106 following Electrolytic was removed by acidic permanganate, while Turco 4502 (caustic permanganate) worked the best following FDP.

Several factors led to a conclusion that the Ru-106 following the FDP run was in a particulate form. During the decontamination following Electrolytic, there were problems with releasing Ru-106 out the stack. Yet following FDP, where over three times as much Ru-106 was removed, there were no stack release problems. Again, acidic permanganate proved effective where Ru-106 had been in a volatile form, at WCF and after Electrolytic. The acidic permanganate was not effective in removing Ru-106 following FDP. Caustics have been shown effective in breaking up and removing solids. Turco 4502 is caustic

Table 18. Radioactivity removed during the 1989 FDP decontamination.

Isotope	% Ci	% R/h	% mg
Zr/Nb-95	0.0	0.1	0.0
Ru-106	45.3	16.6	3.5
Sb-125	10.8	5.2	2.6
Cs-134/137	36.3	77.6	93.3
Ce-144	7.6	0.4	0.6
Total	4,650 Ci	7,400 R/h	18,000 mg

Table 19. Isotopic activity removed by the 1989 FDP decontamination solutions.

% Ci, mg, R/h shown down columns[a]					
Ce-144	Cs-134/137	Zr/Nb-95	Ru-106	Sb-125	Solution
38.9	14.6	0	11.7	4.9	H_2O
18.1	14.0	0	17.3	9.9	HNO_3
5.2	2.8	0	2.4	2.0	$KMnO_4/HNO_3$
0.2	0.1	0	0.2	0.1	Turco 4521
7.9	33.0	0	29.5	27.9	Turco 4502
0.0	0.1	0	0.0	0.1	Citrox
5.0	14.3	0	10.8	7.4	Tartaric/NaOH
4.3	5.1	0	6.8	4.9	Turco 4321
0.5	2.4	0	0.8	1.3	Oxalic
19.5	13.3	0	20.3	40.5	Oxalic/HNO_3
0.4	0.2	0	0.3	0.9	HF/HNO_3

a. Since each column contains just one isotope, the percentage values down the column will not change when referring to curies, milligrams or R/h. The reason for this is that when converting curies into mg or R/h, the same conversion factor will be used for all the values in the same column. Therefore, the percent will not change since all the values were multiplied by the same conversion factor.

permanganate and it apparently helped break up the solids containing the Ru-106. Finally, work on synthetic FDP solids showed that Turco 4502 followed by a solution of oxalic acid would dissolve some solids. This apparently held true for the actual FDP solids remaining in First Cycle.

The last item to be discussed is hydrofluoric acid, which was used in all three cells for decontamination. HF was first used in U cell on piping that was to be torn out. The 0.5 molar HF solution appeared to be effective in reducing radiation levels; however, no samples were taken so little more can be said.

HF was next used in G cell. Extensive flushing of G cell removed large quantities of contamination, but HP surveys of the cell showed gamma radiation coming from the vessels. Continued flushing failed to remove any significant quantities of contamination. At this point, an HF/HNO_3 flush was used. Figure 33 shows G cell flushes and that this HF flush was significantly less effective than the preceding Turco 4502 and oxalic/HNO_3 flushes. Internal flushing was then stopped and external decontamination begun. It was soon discovered that the high gamma readings were not from internal vessel contamination, but from removable external contamination.

It was questioned if HF would be effective at the beginning of a decontamination, since G cell had shown it was not effective at the very end. To answer this question, HF was used in H cell and Figure 34 shows the flush results. Flushes of Turco 4502 and oxalic/HNO_3 were performed to establish a base to compare HF with. Next, an HF flush was done and this was followed by another Turco 4502 and oxalic/HNO_3 sequence. The results show that the HF flush was significantly less effective than the Turco 4502 and oxalic/HNO_3 sequence.

The conclusion was that HF was not effective as a decontamination solution following this FDP run. This should not be surprising, especially if the other indications were correct that particulate contamination was the problem. Since HF is used to dissolve the fuel at FDP and these solid particles did not dissolve in that HF process, then they would not be expected to dissolve in the dilute HF flush solution.

The high gamma readings created significant problems. Normally, high gamma with a low beta reading suggests the contamination is inside a vessel. The vessel will stop the beta but the gamma will pass through the walls. This general rule proved to be misleading following FDP, where the high gamma levels and low beta were the result of external contamination. The most likely explanation is that the external contamination contained a large amount of Ru-106. Apparently the high-energy beta from the Ru-106 was being read as a gamma through the shut window. This effect has been noted before and may be the result of Bremsstrahlung radiation. Therefore, external contamination should be considered if continued flushing fails to be effective and Ru-106 is known to be present in large quantities.

Internal flushing of H cell failed to reduce some radiation fields. These high fields were coming from the bellows of some valves. Decontamination solution could not reach here. However, radiation was reduced by simply placing shielding over the valves. The identification of these sources took significant time and resulted in the generation of large amounts of liquid waste.

The total activity removed by each solution and the number of times the solutions were used is given in Table 20. Turco 4502 is caustic (KOH) permanganate and has not been very effective in the past.

Figure 38 compares the total activity removed by each solution. Again, water and nitric acid are near the top. However, they were used 57 times. The acidic oxalic solution was only used 20 times and the Turco 4502 was used 16 times. This illustrates that water and nitric acid will remove contamination, but it requires many flushes and large quantities of solution.

This decontamination generated 91,000 gal of unprocessed waste. There were 4,600 kg of sodium and potassium sent to waste. The average beta activity of the flush solutions was $5.8 \times 10^{+7}$ β/min/mL.

Table 20. Total activity removed by chemical solutions during the 1989 FDP decontamination.

Solution	% Ci	% R/h	Number of flushes
H_2O	14.1	13.8	22
HNO_3	15.4	14.4	35
$KMnO_4/HNO_3$	2.7	2.7	5
Turco 4521	0.1	0.1	1
Turco 4502	28.9	32.0	18
Oxalic	0.04	0.1	1
Tartaric/NaOH	11.3	13.3	16
Turco 4324	5.8	5.4	6
Oxalic	1.4	2.1	4
Oxalic/HNO_3	19.9	15.9	20
HF/HNO_3	0.4	0.3	4
Total	4,650 Ci	7,400 R/h	132

Lessons Learned

It appears that Turco 4502 followed by oxalic/HNO_3 is effective in removing contamination following an FDP run. Some early research on synthetic FDP solids showed that these solids might somehow be conditioned by Turco 4502, allowing for easier removal or even encourage their dissolution.

Hydrofluoric acid was not effective in removing contamination following this FDP campaign. It proved ineffective both at the end of a decontamination and at the beginning.

Care should be taken when Ru-106 is present as most of the contamination. False indications of internal contamination may prolong flushing without lowering the radiation fields.

A large volume of waste solution was generated. Some of this was the result of continued internal flushing when the contamination source was external. The other main reason for this large waste volume was G and H cells were decontaminated separately. This approach resulted in generating twice as much waste as would have been generated by flushing G and H cells with the same solution.

Large volumes of solutions were used in trying to reduce the radiation levels around some vessels. The source of this radiation came from the interior of some valves. These valves were easily shielded, which greatly reduced the radiation fields. Identification of the radiation source required a cell entry. If this cell entry had occurred earlier when the samples from the solutions showed they were no longer effective, considerable time and waste could have been saved.

Table 21 summarizes the removal efficiency of the decontamination solutions used during the 1989 FDP decontamination. The table is provided in activity removed per L of solution used. This will give a better picture of which solutions were the most efficient in removing contamination.

Table 21. Solution's effectiveness during the 1989 FDP decontamination.

Solution	mCi/L	(mR/h)/L	$\mu g/L$
H_2O	11.6	18.0	41.4
HNO_3	9.4	14.0	33.5
$KMnO_4/HNO_3$	11.3	17.9	46.2
Turco 4521	3.9	4.2	8.8
Turco 4502	24.6	43.2	110
Citrox	1.4	2.7	7.2
Tartaric/NaOH	14.1	26.5	68.8
Turco 4324	13.4	19.9	46.7
Oxalic	4.2	9.8	27.2
Oxalic/HNO_3	16.9	21.5	47.8
HF/HNO_3	1.1	1.3	2.9
Total	13.5	21.5	52.4

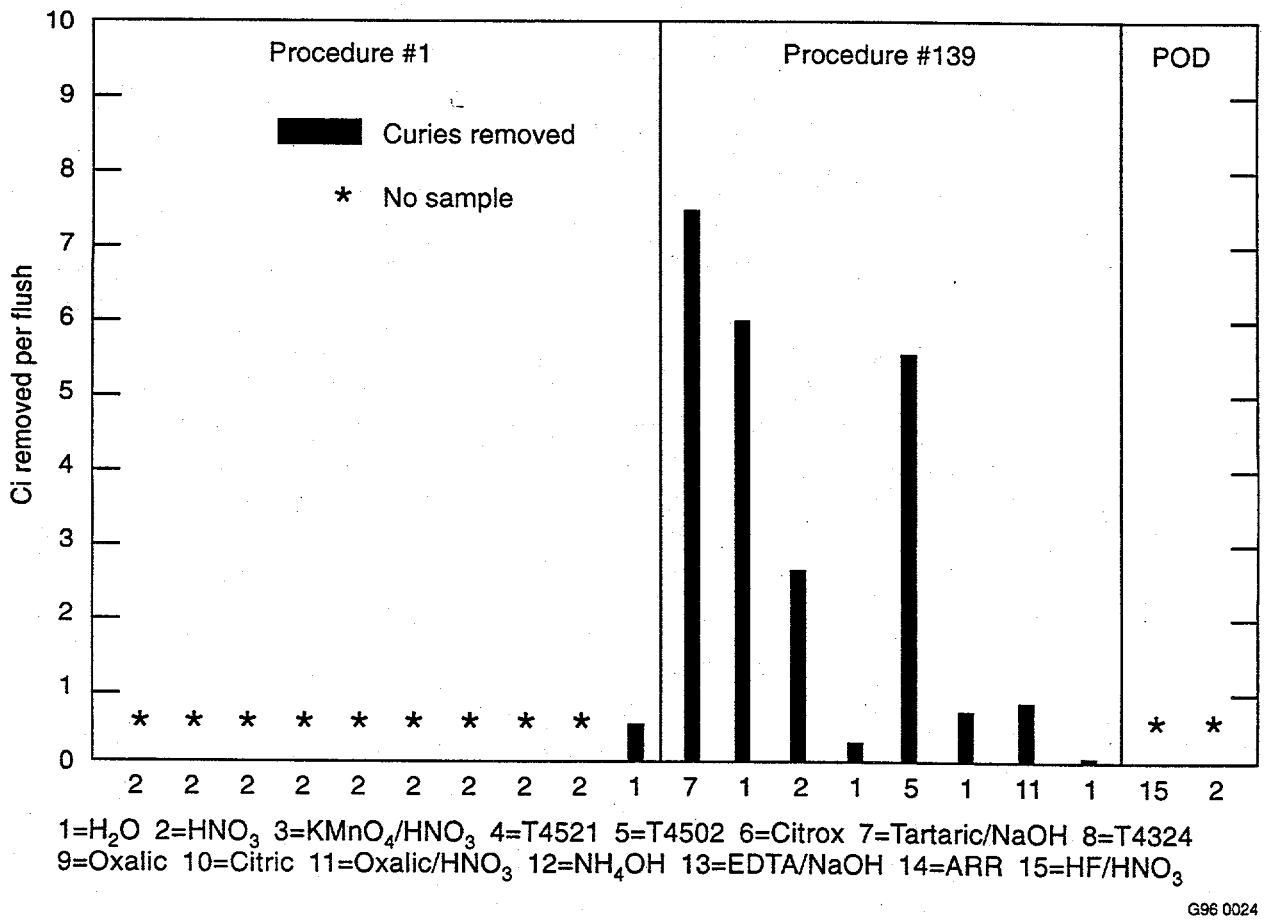


Figure 32. 1988 decontamination of U cell following FDP #41-42.

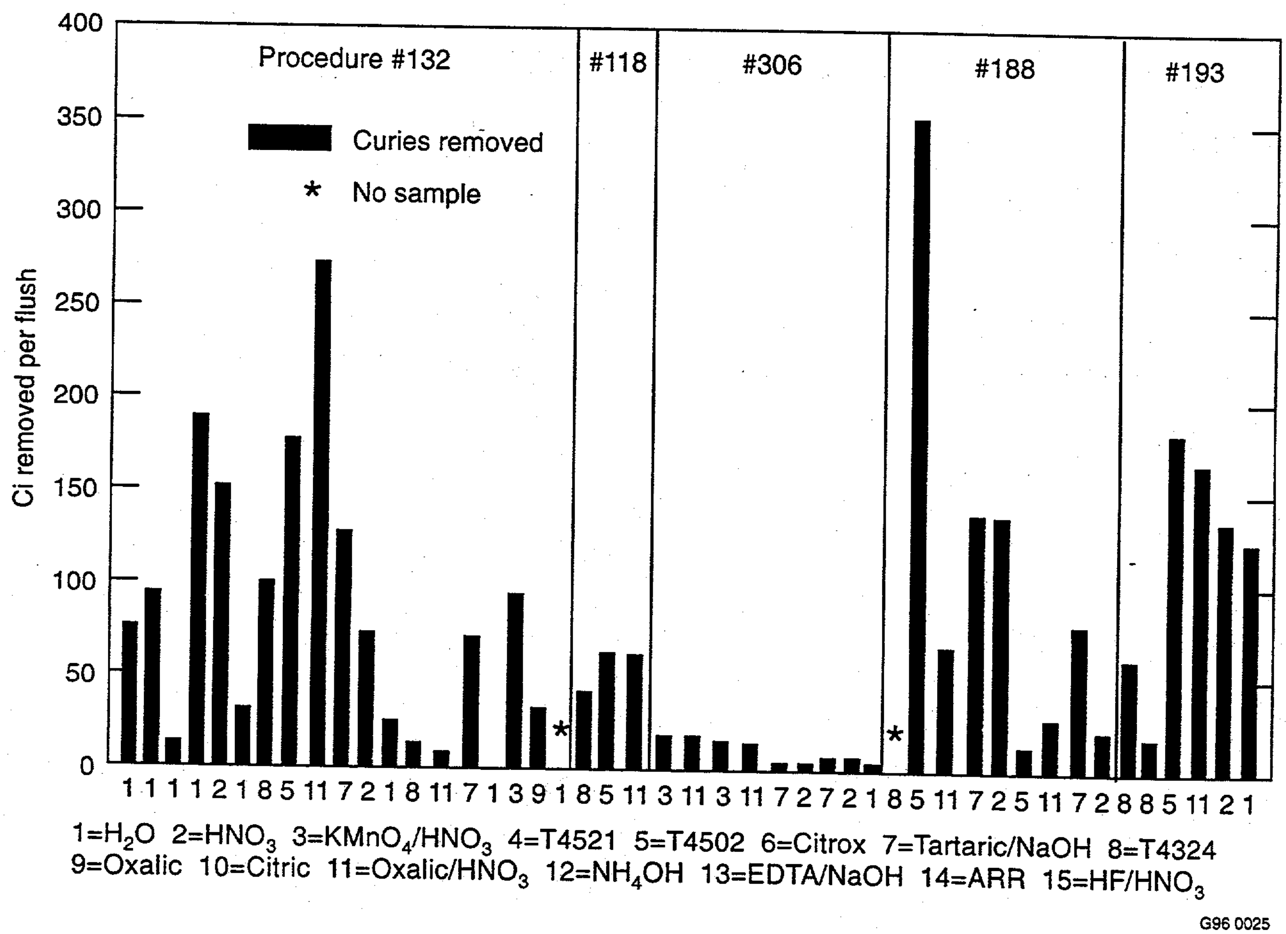


Figure 33a. 1988 decontamination of G cell following FDP #41-42 (Part 1).

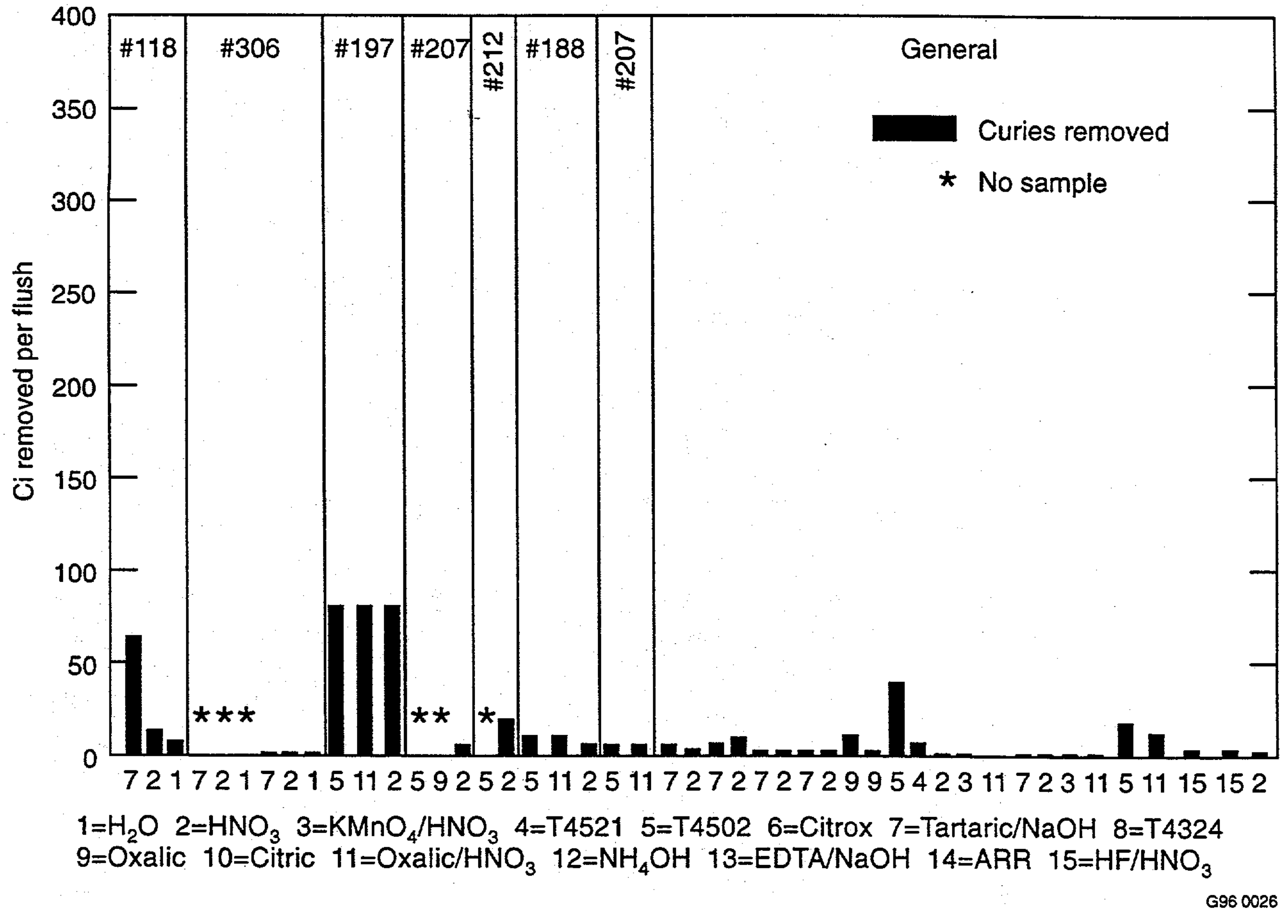


Figure 33b. 1988 decontamination of G cell following FDP #41-42 (Part II).

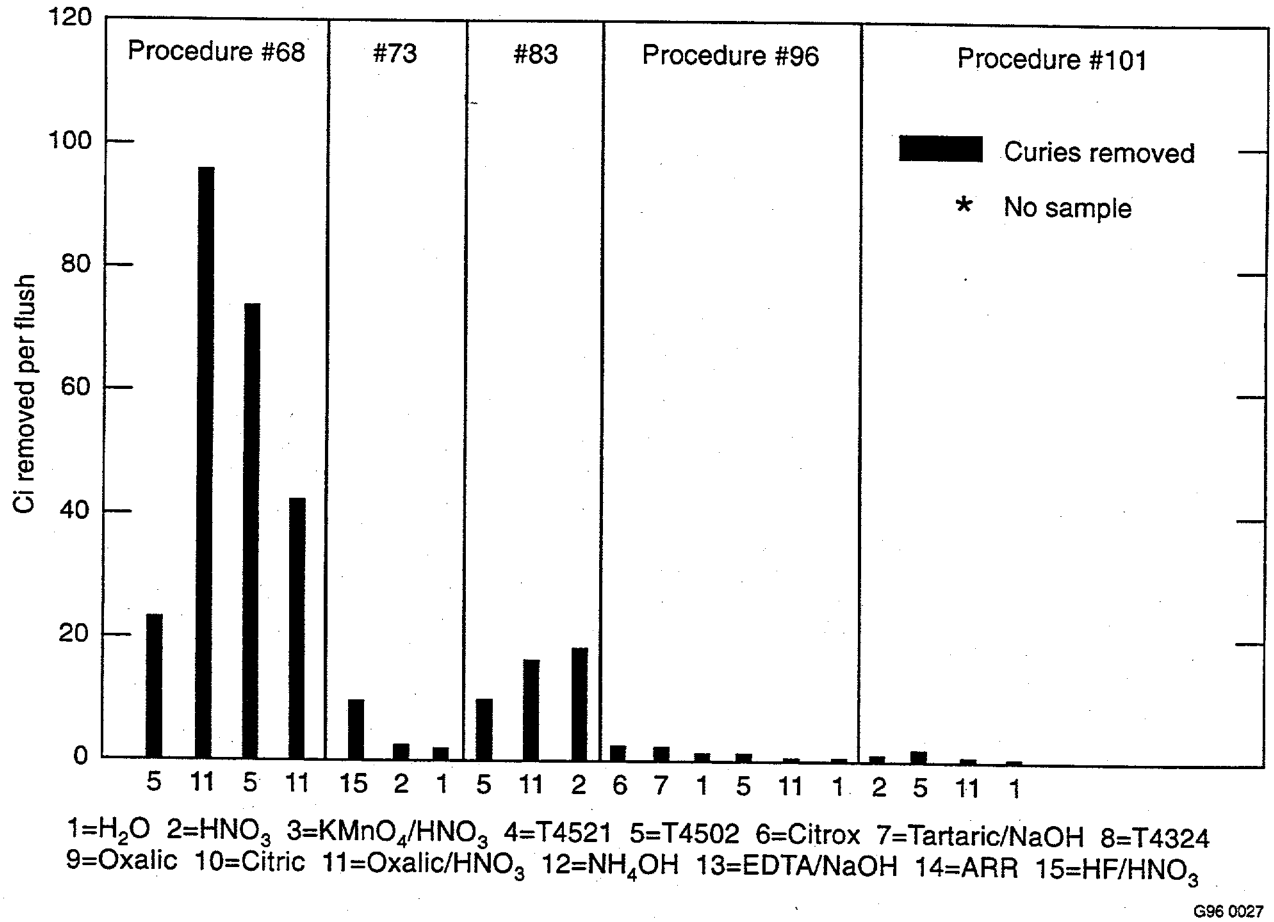


Figure 34. 1989 decontamination of H cell following FDP #41-42.

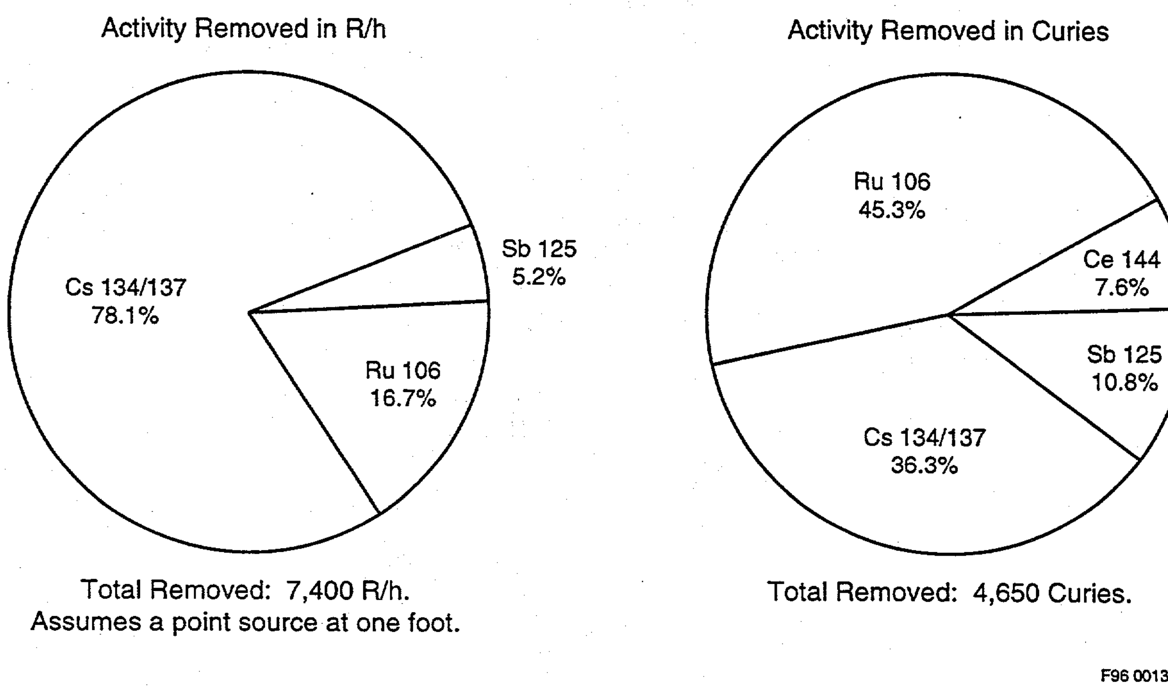


Figure 35. 1989 first cycle decontamination after FDP #41-42.

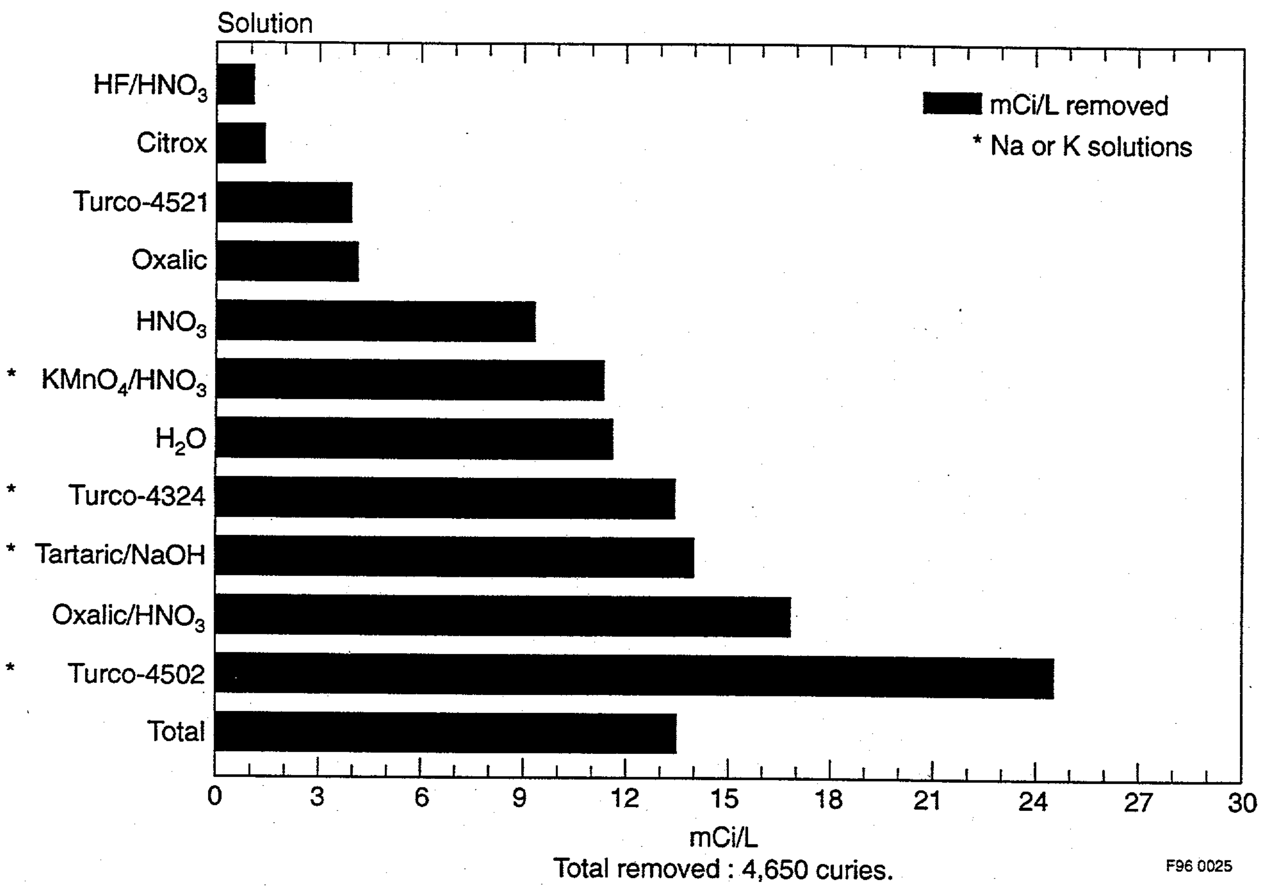


Figure 36. 1989 first cycle decontamination after FDP #41-42 activity removed per solution.

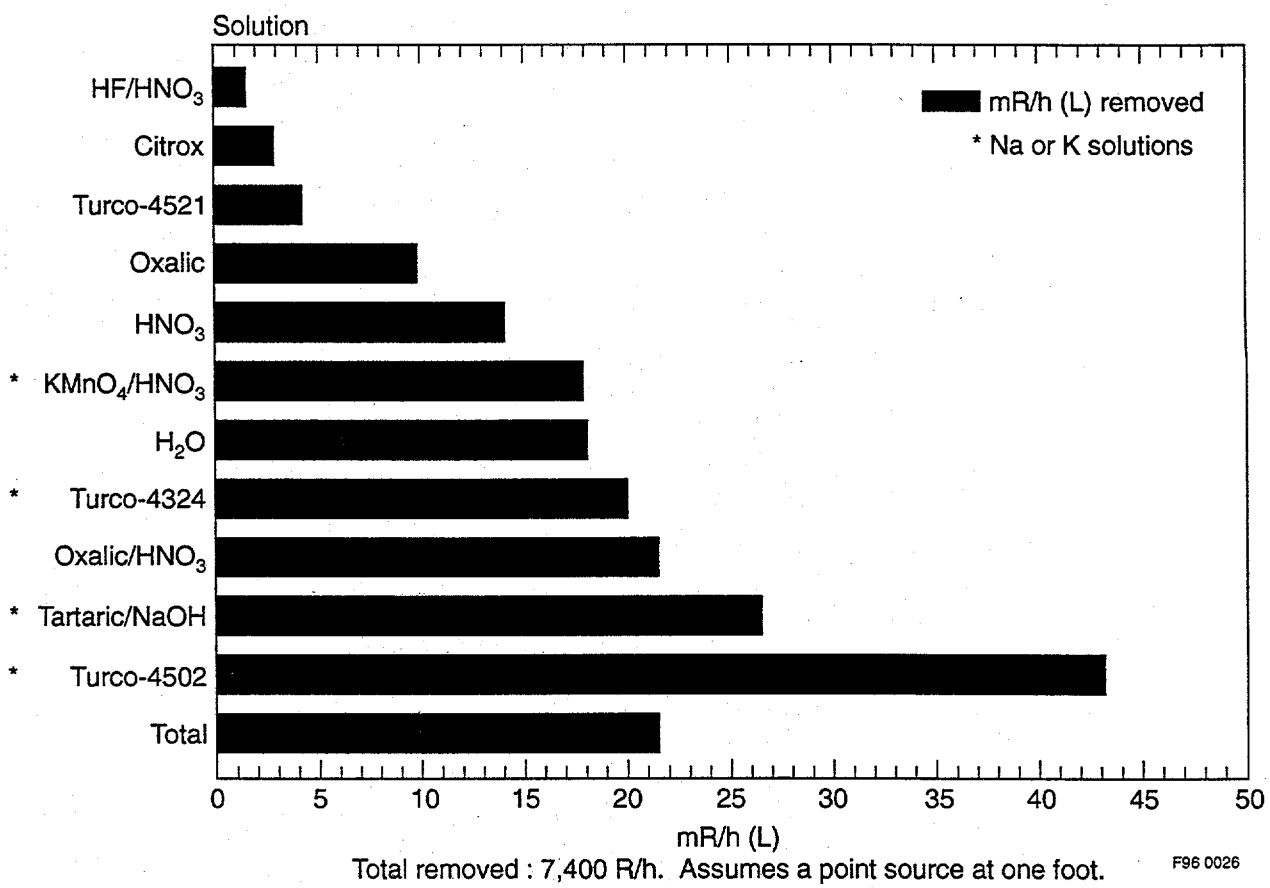


Figure 37. 1989 first cycle decontamination after FDP #41-42 activity removed per solution.

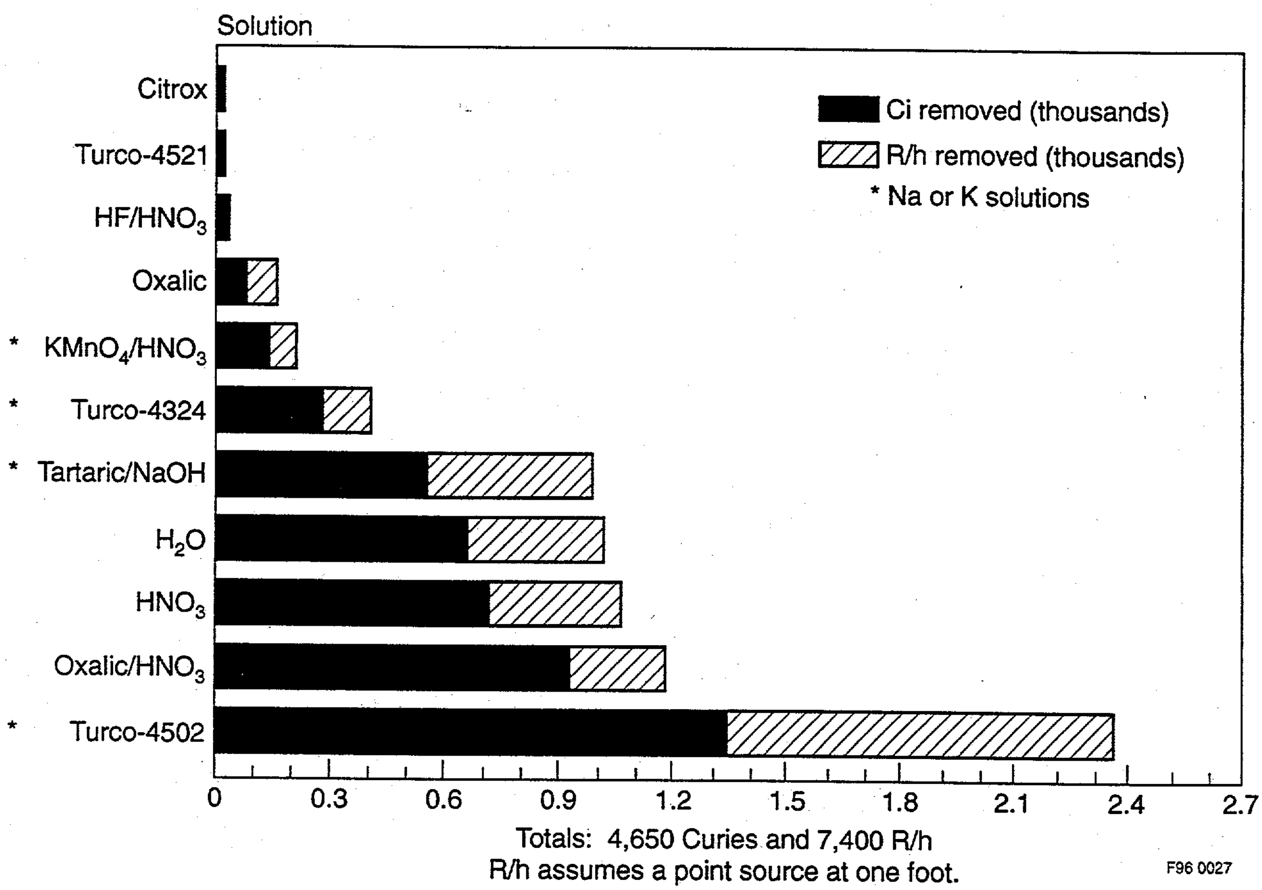


Figure 38. 1989 first cycle decontamination, total curies and R/h removed per solution.

1982-1990 FIRST CYCLE DECONTAMINATION SUMMARY

There is no such thing as a typical decontamination. Decontamination activities such as selection of flush solutions cannot be made strictly based on what worked well last time. The effectiveness of solutions is not only dependent on fuel type but also on fuel cooling time, cladding material, the acid used in cladding/fuel dissolution, the presence of solids and particulates, and radionuclide distribution. Due to these factors, it was important to sample the solutions after flushing. Without these samples, ineffective solutions cannot be identified and more effective solutions substituted, nor can it be adequately decided when to stop internal flushing.

Each major decontamination effort was compared in Figure 2. The radionuclide distribution was also shown in Figure 4. Figures 39 and 40 compare all decontamination solution's effectiveness on a per-liter basis, while Figures 41 and 42 show the total amount of activity removed by each solution. Appendix H provides as analysis of the data from 1982 through 1989. Actual data has already been given in previous appendixes.

Figure 43 compares the total activity removed by each solution from 1982 through 1989 as measured in curies and R/h. Caustic tartaric removed the most contamination and was used 71 times. Nitric acid was a distant second but it took 164 flushes to reach that position. Table 22 shows the total volume, the activity removed, and the number of times each solution has been used since 1982.

Table 22. Total activity removed by decontamination solutions from 1982 to 1990.

	Activity removed			
Solution	Curies	R/h	Volume (gal)	Number of flushes
H_2O	1,461	3,199	66,200	169
HNO_3	2,144	5,608	64,000	164
Tartaric/NaOH	3,799	13,807	27,100	71
Turco 4502	1,850	3,688	30,300	55
Turco 4521	340	993	13,200	39
$KMnO_4/HNO_3$	690	741	14,200	35
Oxalic/HNO_3	1,245	1,985	18,800	31
EDTA/NaOH	44	96	5,000	20
Citrox	343	973	5,800	15
Oxalic	198	575	9,500	12
Turco 4324	318	541	6,000	10
Turco ARR	101	225	2,700	5
HF/HNO_3	16	19	4,000	4
Citric	2	3	800	3
NH_4OH	17	30	760	1
Total	12,600	32,500	268,000	634

Decontamination data following each fuel campaign is summarized in Table 23. This table allows quick comparisons of one turnaround with another. Sometimes general conclusions about past usage provide a handle for what is happening. Here are some results based on the data from 1982 through 1990 that may be useful. Some useful averages are listed below.

The average volume of a flush was 425 gal (1,610 L).
The average activity removed was 20 curies per flush or 12 mCi/L.
The average activity removed per flush was 51 R/h or 32 (mR/h)/L.
The average amount of sodium and potassium generated was 2,600 kg/turnaround.

The sodium and potassium generated from each First Cycle turnaround is shown in Figure 44. The average amount generated (excluding Rover because it was so small) is 2,600 kg per turnaround.

Table 24 summarizes the removal efficiency of the decontamination solutions used during First Cycle decontamination from 1982-1992. The table is provided in activity removed per L of solution used. This will give a better picture of which solutions were the most efficient in removing contamination.

The fission products removed during each decontamination depend on the type of fuel processed, the fuel burn up, the cooling time, fuel cladding type, and acid used in dissolution. It is difficult to make generalizations because each of the above factors were so different during the period of this report. For example, it was assumed that HF acid would strip the metal surface on equipment and piping thus removing any contamination. This was tried following the FDP fuel dissolution and the HF proved to be ineffective. Since the FDP process dissolves fuel in HF, then anything that was going to dissolve in HF would have already been removed.

Table 23. Comparison of First Cycle decontaminations from 1982 to 1990[a].

Fuel campaign	Waste volume (gal)	Sodium (kg)[b]	Activity Ci	Activity R/h	Days	Cells	Beta[c]
#37	52,000	1,950	1,140	1,070	102	G,H	1.5E+8
#38	59,000	2,320	5,730	21,500	151	E,F,G,H,J	3.6E+7
#39	10,000	300	9	17	30	G,H	4.5E+5
#40	58,500	1,500	1,060	2,510	158	E,F,G,H	1.1E+7
#41–42	91,000	4,600	4,650	7,400	174	U,G,H	5.8E+7
Total	270,000	10,600	12,600	32,500			5.9E+7

a. Data is only for internal vessel flushes. External cell cleaning is not included.

b. Sodium numbers also include potassium.

c. This is a measure of the gross beta in the solution and is measured in beta counts per minute per milliliter.

Table 24. Solution's effectiveness during First Cycle decontamination, 1982–1990.

Solution	mCi/L	(mR/h)/L	μg/L
H_2O	5.8	12.8	22.8
HNO_3	8.9	23.2	15.6
$KMnO_4/HNO_3$	12.8	13.8	17.8
Turco 4521	6.8	19.9	19.4
Turco 4502	16.1	32.2	81.1
Citrox	15.7	44.6	39.2
Tartaric/NaOH	37.1	135	52.2
Turco 4324	14.1	24.1	61.0
Oxalic	5.5	16.0	18.0
Citric	0.5	1.1	0.6
Oxalic/HNO_3	17.5	27.9	44.8
NH_4OH	5.8	10.4	8.8
EDTA/NaOH	2.4	5.1	10.7
Turco ARR	9.7	21.6	27.7
HF/HNO_3	1.1	1.3	2.9
Total	12.4	32.0	32.2

Another good example is the removal of Ru-106. Stainless steel fuel dissolution in Electrolytic released large quantities of Ru-106 because fuel cooling time was short. This Ru-106 was efficiently removed with acidic permanganate. Ru-106 was again a problem following the FDP zirconium-clad fuel dissolution. Acidic permanganate proved ineffective this time but a caustic solution of permanganate (Turco 4502) was effective. This helps to illustrate the importance of sampling as a means of controlling decontamination activities. Relying on past experiences is not always beneficial.

Table 25 summarizes the isotopes removed from 1982 through 1990.

Chemical usage during this 8-year period has been tracked. The ICPP waste processing facility, the NWCF, has difficulty processing sodium and potassium containing waste. Therefore, during decontamination activities, the amounts of caustics were keep as low as possible and would not have been used except these caustic solutions proved to be very effective in removing contamination on a per-liter basis. Table 26 provides a summary of the chemicals used at the ICPP and the total quantities sent to the waste stream.

Table 25. Radionuclides removed from First Cycle equipment during decontamination activities from 1982 to 1990.

Isotope	Ci	R/h	mg
Zr-95	256	635	12
Nb-95	4,092	18,772	104
Ru-103	5	13	0
Ru-106	3,101	1,813	919
Sb-125	1,626	1,252	1,534
Cs-134	347	1,228	268
Cs-137	2,585	8,723	29,651
Ce-144	555	49	174
Total	12,566	32,485	32,663

Table 26. Decontamination solutions used from 1982 to 1990.

Solution	kg	L	Flushes
H_2O	250,383	250,383	169
HNO_3	68,343	241,995	164
Turco 4502	8,965	114,628	55
Tartaric/NaOH	9,692	102,504	71
$KMnO_4/HNO_3$	7,100	53,741	35
Turco 4521	4,280	49,961	39
Oxalic/HNO_3	4,388	71,067	31
Oxalic Acid	3,024	35,931	12
HF/HNO_3	1,837	14,820	4
Citrox	1,362	21,819	15
EDTA/NaOH	1,202	18,757	20
Turco 4324	491	22,486	10
Turco ARR	428	10,394	5
Citric Acid	279	3,000	3
NH_4OH	49	2,900	1
Total	358,802	1,014,386	634

Some chemicals used in decontamination are commercial products containing specific active ingredients that are important to track. Appendix B provides a breakdown of these products. Table 27 lists the amounts of chemicals in these products and sums the total amount of that chemical used from 1982 to 1990. For example, oxalic acid is in Turco 4521. Oxalic acid was also used alone and in a solution with nitric acid. Table 27 sums oxalic acid usage from these three solutions.

Table 28 shows the activity removed by each solution on a per liter basis. This comparison is for the years of 1982 through 1990. This table provides a general summary which may be used to draw basis conclusions. To learn what nuclides were removed and for more specific information the general text or the appendix should be consulted. However, this type of summary chart is helpful to provide a feel for which solutions removed large quantities of activity and the magnitude of the activity removed per liter.

Table 27. Chemical usage from 1982 to 1990.

Chemical without water	kg
Nitric acid	78,541
Sodium hydroxide	8,470
Oxalic acid	6,716
Potassium hydroxide	6,275
Potassium	5,384
Sodium	5,206
Ammonium oxalate	3,424
Ammonium hydroxide	3,423
Potassium permanganate	2,338
Tartaric acid	2,193
Citric acid	1,286
Potassium chromate	448
Ammonium bicarbonate	246
EDTA	231
Sodium hexametaphosphate	221
Hydrofluoric acid	100
Hexavalent chrome as Cr	72

Table 28. Solution's removal efficiency from 1982 to 1990 in mCi/L and (mR/h)/L.

Solution	Activity removed mCi/L					
	1982	1983	1984	1986	1990	Total
H_2O	1.0	6.8	—	3.8	11.6	5.8
HNO_3	6.2	21.0	0.21	2.5	9.4	8.9
$KMnO_4/HNO_3$	25.8	5.2	0.21	0.8	11.3	12.8
Turco 4521	4.6	13.2	0.41	2.6	3.9	6.8
Turco 4502	2.0	19.2	0.35	3.9	24.6	16.1
Citrox	2.1	36.6	0.13	—	1.4	15.7
Tartaric/NaOH	5.2	90.4	—	16.8	14.1	37.1
Turco 4324	—	20.1	—	—	13.4	14.1
Oxalic acid	—	28.6	0.14	4.4	4.2	5.5
Citric acid	—	0.5	—	—	—	0.5
Oxalic/HNO_3	—	—	—	19.7	16.9	17.5
NH_4OH	—	—	—	5.8	—	5.8
EDTA/NaOH	—	—	—	2.4	—	2.4
Turco ARR	—	—	—	9.7	—	9.7
HF/HNO_3	—	—	—	—	1.1	1.1
Total	5.8	25.8	0.27	4.8	13.5	12.4

Solution	Activity removed (mR/h)/L					
	1982	1983	1984	1986	1990	Total
H_2O	1.1	20.2	—	9.2	18.0	12.8
HNO_3	6.2	81.9	0.51	5.9	14.0	23.2
$KMnO_4/HNO_3$	20.6	15.1	0.58	2.2	17.9	13.8
Turco 4521	5.7	49.8	0.78	5.6	4.2	19.9
Turco 4502	3.0	55.8	0.47	6.3	43.2	32.2
Citrox	3.9	106	0.12	—	2.7	44.6
Tartaric/NaOH	4.3	367	—	40.9	26.5	135
Turco 4324	—	59.0	—	—	19.9	24.1
Oxalic acid	—	108	0.41	12.0	9.8	16.0
Citric acid	—	1.1	—	—	—	1.1
Oxalic/HNO_3	—	—	—	49.7	21.5	27.9
NH_4OH	—	—	—	10.4	—	10.4
EDTA/NaOH	—	—	—	5.1	—	5.1
Turco ARR	—	—	—	21.6	—	21.6
HF/HNO_3	—	—	—	—	1.3	1.3
Total	5.5	97.8	0.54	11.4	21.5	32.0

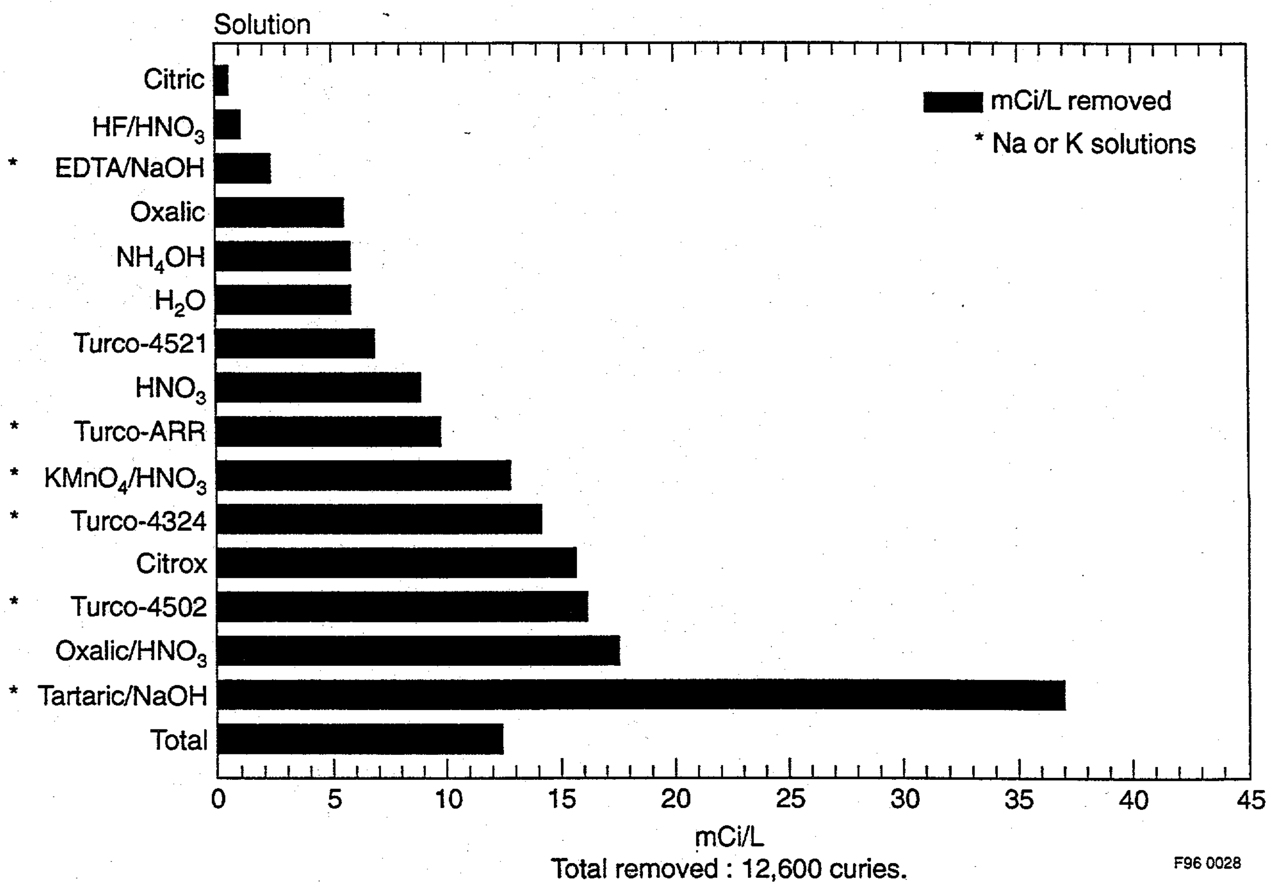


Figure 39. 1982–1990 First Cycle decontamination, activity removed per solution, mCi/L.

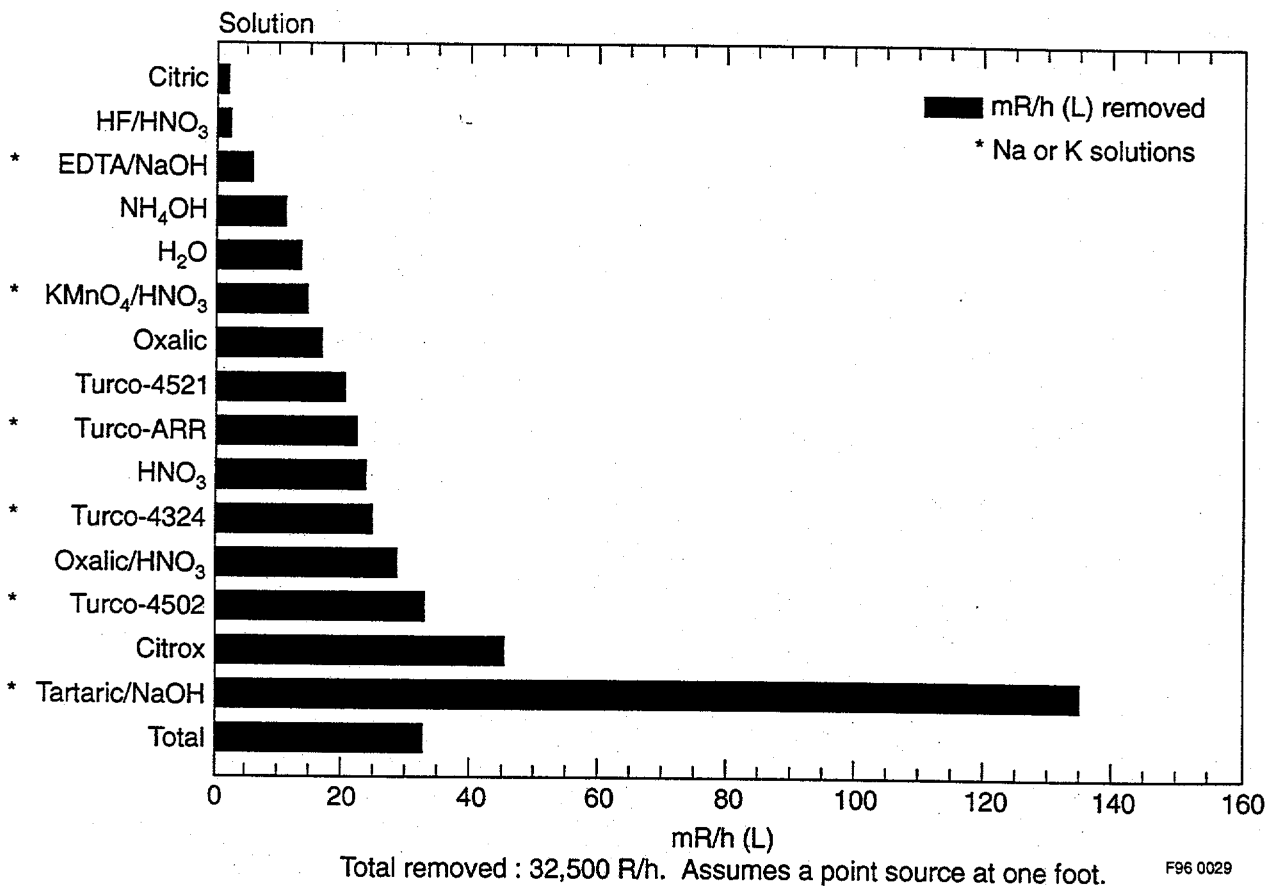


Figure 40. 1982–1990 First Cycle decontamination, activity removed per solution, mR/h (L).

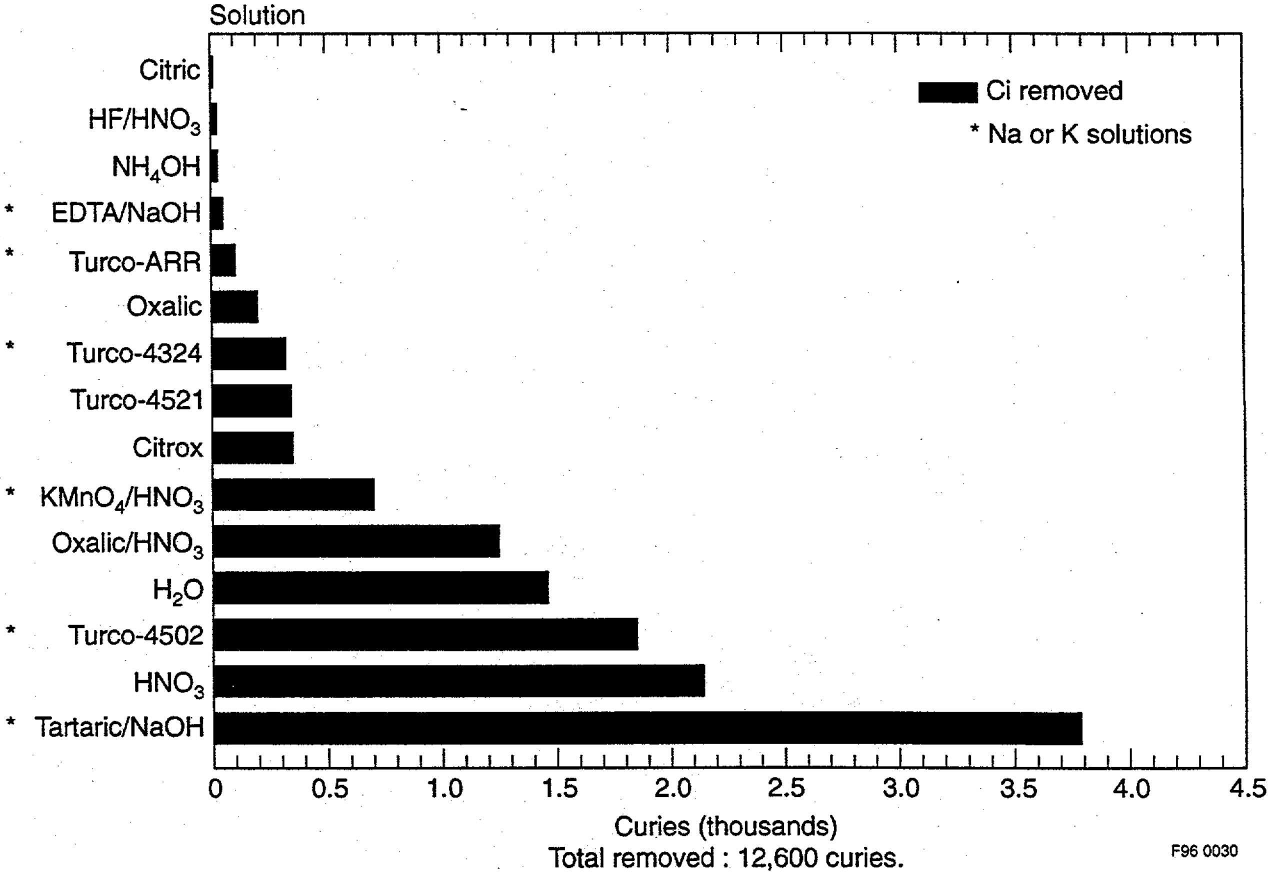


Figure 41. 1982–1990 First Cycle decontamination, activity removed per solution, curies.

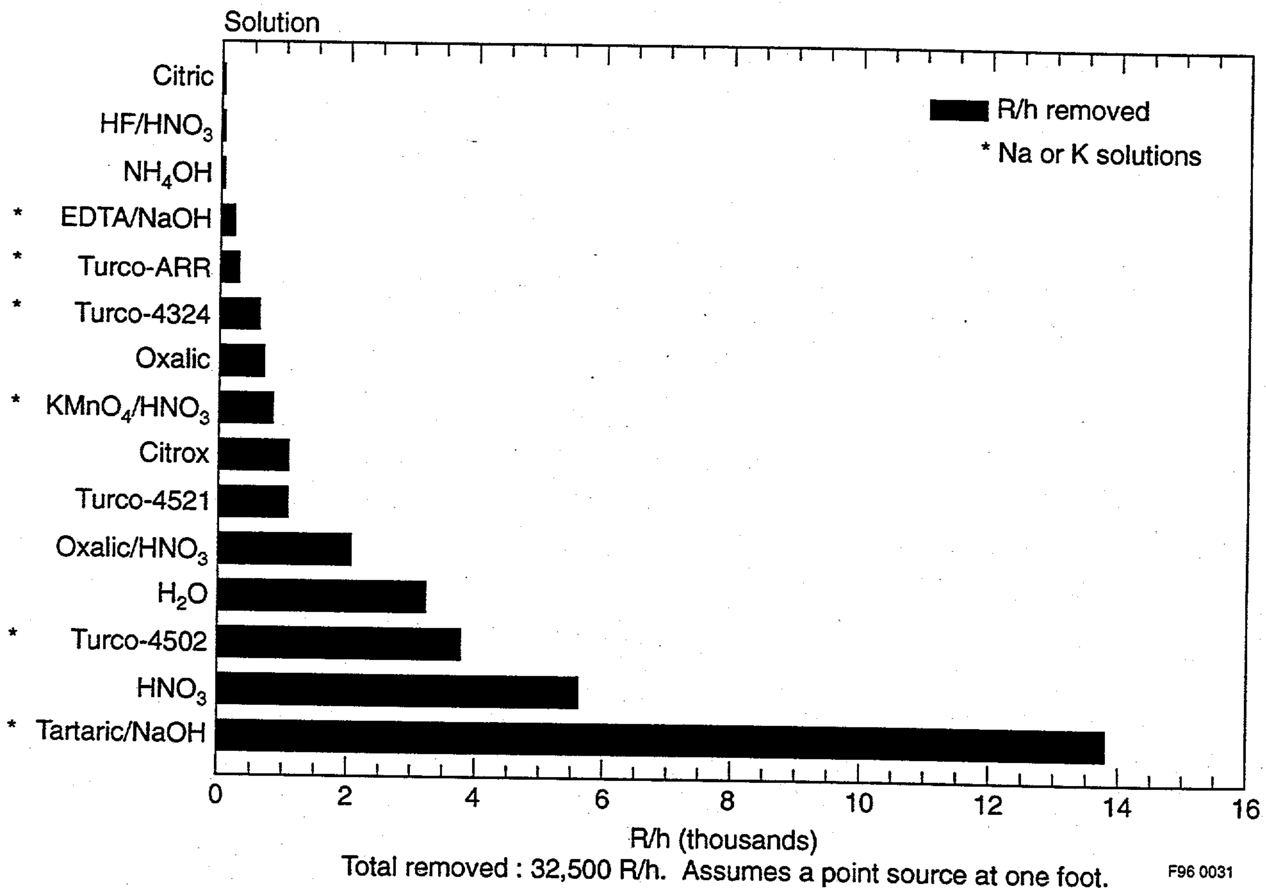


Figure 42. 1982–1990 First Cycle decontamination, activity removed per solution, R/h.

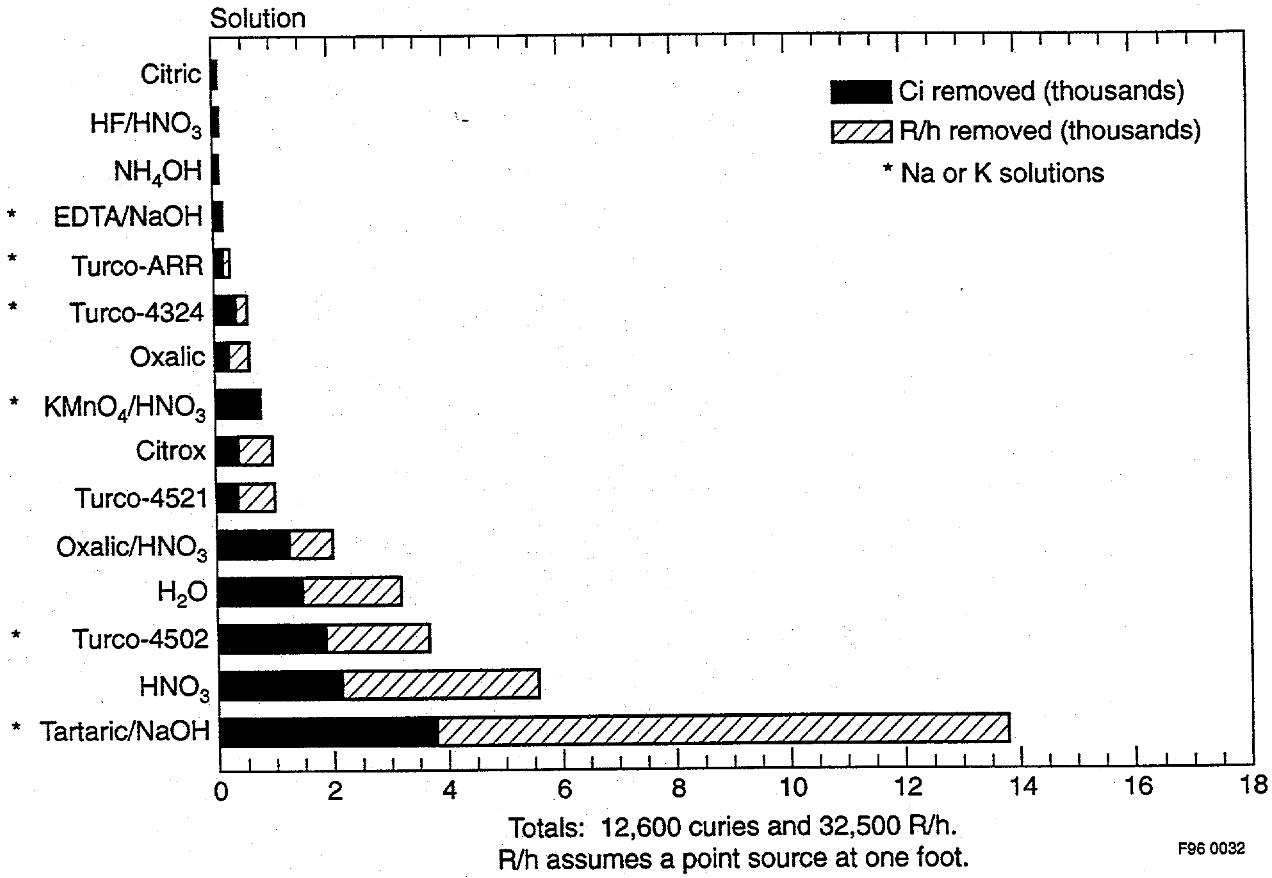


Figure 43. 1982–1990 First Cycle decontamination, total curies and R/h removed per solution.

2

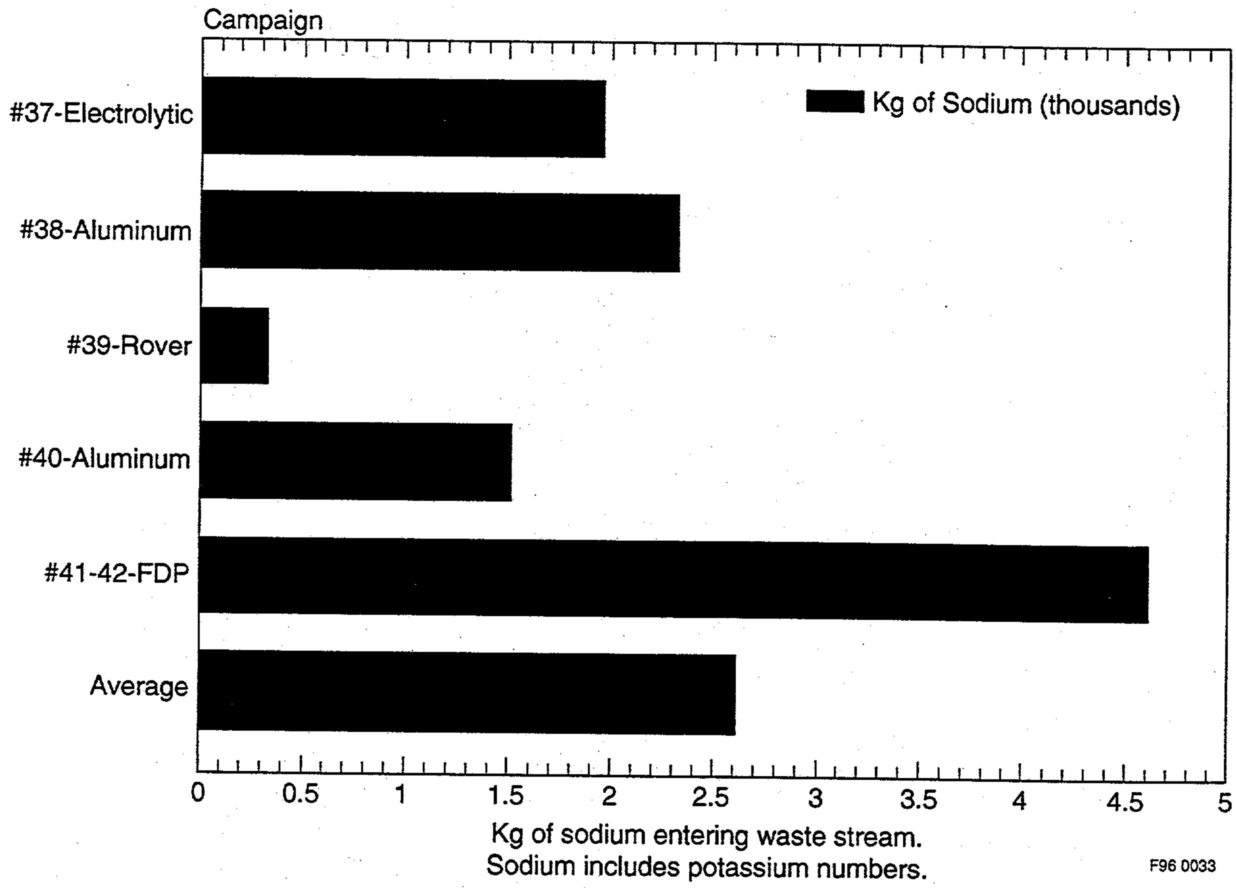


Figure 44. ICPP sodium waste generation, following each fuel campaign.

CONCLUSION

Decontamination of the ICPP First Cycle extraction process from 1982 through 1990 was conducted in five fuel campaigns that dissolved four different types of fuel. The main points from each decontamination are summarized below.

1982 Decontamination following Electrolytic #37
This was a green fuel.
Large quantities of volatile Ru-106 were present.
$KMnO_4/HNO_3$ solution was very effective.
Decontamination occurred on a per-vessel basis.

1983 Decontamination following Aluminum #38
The major radionuclides removed were Zr/Nb-95.
Tartaric/NaOH solution was very effective.
Decontamination occurred on a per-cell basis.
Solids on the floor were soluble in sodium hydroxide and not nitric acid.

1984 Decontamination following Rover #39
Rover was a graphite-based fuel.
Large amounts of cold solids were found in vessels and columns.
The activity removed was very small.

1986 Decontamination following Aluminum #40
The major radionuclides removed were Sb-125, Zr/Nb-95 and Cs-134/137.
Oxalic/HNO_3 solution worked extremely well.
Decontamination occurred on a per-cell basis.

1989 Decontamination following FDP #41-42
No Zr/Nb-95 was removed.
The major radionuclides removed were Cs-134/137 and particulate Ru-106.
Turco 4502 followed by the oxalic/HNO_3 solution proved to be very effective.
Decontamination occurred on a per-cell basis.

Decontamination of First Cycle has evolved and changed with time. The past few years have seen an increased emphasis on waste reduction. It is now recognized that the entire First Cycle system should be cleaned at one time rather than cleaning individual cells one at a time. This general cleaning reduces waste by eliminating missed lines and equipment and reduces radiation exposure in locating missed equipment. Also, a single flush solution may be used to clean several cells rather than just one.

Chemical selection is another area that has improved. It is no longer acceptable to flush repeatedly without taking samples of the solutions. Today each solution is sampled and monitored to eliminate the ineffective solutions. This saves operating time and also reduces waste.

Internal decontamination of the ICPP First Cycle extraction system is always a learning experience. Each turnaround following a fuel campaign brings a new set of problems. Of fundamental importance during such decontamination activities are solution samples and the ability to analyze and follow the progress of the decontamination. Only when this information is available can problems be identified and intelligent solutions be attempted. Finally, this information provides an historical perspective to learn from past experiences.

Appendix A

Radiochemical Data

Appendix A

Radiochemical Data

Isotope	(R/h)/dps	mg/dps	$t_{1/2}$		gamma E	QB	% gamma
H-3	----	2.79E-12	12.33	y	---	.019	---
Mn-54	1.35E-10	3.49E-12	312.	d	.835	.697	100.
Co-60	4.06E-10	2.39E-11	5.271	y	1.332	2.824	100.
					1.173		100.
Kr-85	3.58E-13	6.86E-11	10.7	y	0.514	.687	0.43
Sr-90	----	1.96E-10	28.8	y	---	.546	---
Y-90	----	4.97E-14	64.1	h	2.284		
Nb-95	1.24E-10	6.88E-13	35.	d	.766	.926	99.82
Zr-95	6.70E-11	1.26E-12	64.	d	.757	1.123	54.6
Ru-103	6.96E-11	8.53E-13	40.	d	.497	2.35	86.4
Rh-106	Ru-106	Ru-106	130.	m	.512	3.541	19
Ru-106	1.58E-11	8.01E-12	1.	y	---	.039	---
Sb-125	2.08E-11	2.55E-11	2.7	y	.428	.767	30
Cs-134	9.57E-11	2.09E-11	2.062	y	.605	2.058	97.6
Cs-137	9.12E-11	3.10E-10	30.	y	662	1.173	85
Ce-144	2.41E-12	8.49E-12	285.	d	.134	.318	11.1
Eu-154	7.33E-11	9.89E-11	8.5	y	1.274	1.978	35.5
Eu-155	3.91E-12	5.74E-11	4.9	y	.105	.246	23

$$\mu g/dps = dps(atm/dps)(mole/6.023 \times 10^{+23}\ atm)(\times\ g/mole)(1 \times 10^{+6}\ \mu g/g)(t_{1/2}/\ln 2)$$
$$= (2.40 \times 10^{-18})(MW)(t_{1/2})$$

where

$$dps = N(\lambda) \qquad = (\ln 2)/t_{1/2}$$
$$N = dps/\lambda \quad \lambda = (\ln 2)/t_{1/2}$$
$$\ln N_1/\ln N_2 \qquad = \lambda(t_2 - t_1)$$

(R/h)/dps at 1 ft (gamma)

= 6(Ci)(E)(n) this is a good approximation

$= 6(\times\ dps/3.7 \times 10^{+10}\ dps)(E)(n/100)$

$(R/h)/dps = (1.62 \times 10^{-12})(E)(\%)$

where

$Ci = 3.7 \times 10^{+10}$ dps

E = MeV/decay gamma

n = % gamma/decay

Isotope	(R/h)/Ci	mass/Ci		Ci/g
H-3	---	103	μg	9,673
Mn-54	5.0	129	μg	7,752
Co-60	15.0	884	μg	1,131
Kr-85	0.0132	2.54	mg	393
Sr-90	---	7.25	mg	138
Y-90	---	1.84	μg	543,248
Nb-95	4.59	25.5	μg	39,278
Zr-95	2.48	46.6	μg	21,480
Ru-103	2.58	31.6	μg	31,700
Ru-106	.58	296	μg	3,375
Sb-125	.77	944	μg	1,060
Cs-134	3.54	773	μg	1,295
Cs-137	3.37	11.5	mg	87
Ce-144	.09	314	μg	3,182
Eu-154	2.71	3.66	mg	273
Eu-155	.14	2.12	mg	471

Appendix B

Typical Chemical Concentrations

Appendix B

Typical Chemical Concentrations

Ref. No.[a]			
1.	Water		
2.	2-6	M	Nitric acid
3.	0.05	M	Potassium permanganate in 2.0 M nitric acid
4.	30-60	g/L	Turco 4521[b]
5.	60-160	g/L	Turco 4502[c]
6.	0.3	M	Oxalic acid in 0.2 M citric acid (Citrox)
7.	1.5	M	Sodium hydroxide in 0.15 M tartaric acid
8.	7-30	g/L	Turco 4324[d]
9.	1.0	M	Oxalic acid
10.	0.5	M	Citric acid
11.	0.5	M	Oxalic acid in 0.5 M nitric acid
12.	0.5	M	Ammonium hydroxide
13.	1.0	M	Sodium hydroxide in 0.5 g/L EDTA (0.0017 M)
14.	60-360	g/L	Turco ARR[e]
15.	0.5	M	Hydrofluoric acid in 2.0 M nitric acid

a. This number is used on the graphs and on the raw data print out to identify the solutions.

b. Turco 4521 is a commercial product composed of

ammonium oxalate	80 wt.%
oxalic acid	15 wt.%
amorphous silica	< 5 wt.%
citric acid	small amounts
2-mercaptobenzothiazole	small amounts

It is used as a reducing agent following Turco 4502.

c. Turco 4502 is a commercial product composed of

potassium hydroxide	70 wt.%
potassium permanganate	20 wt.%
potassium chromate	< 5 wt.%
Hexavalent chromium (as Cr)	is about 0.8 wt.%

This is a strong oxidizing solution.

d. Turco 4324 is a commercial detergent composed of

ammonium bicarbonate	50 wt.%
sodium hexametaphosphate	45 wt.% (approximately)
octylphenoxypoly(ethyleneoxy)ethanol	< 5 wt.%
noctylphenoxypoly(ethyleneoxy)ethanol	< 5 wt.%
sodium carboxymethyl cellulose	small amounts

It is used to clean organics.

e. Turco Alkaline Rust Remover (ARR) is a commercial product used for descaling. It is strongly caustic and is composed of

sodium hydroxide	70 wt.%
kerosine	< 5 wt.%
triethanolamine	15 wt.%
diethanolamine	< 5 wt.%
sodium gluconate may be present in small amounts	

f. The solutions were heated either with vessels heating jackets or by steam sparging. Since air or steam jets were used in transferring solutions, the temperature was restricted to be below 55°C.

Appendix C

1982 Electrolytic Decontamination Data

Appendix C

1982 Electrolytic Decontamination Data

Data is the life blood for control during decontaminations in a nuclear reprocessing plant. The samples must be taken at a place that will provide the necessary information. Assumptions should be kept to as low as possible. Sampling each solution is much better than a composite sample of several solutions. Sometimes an individual solution's volumes are so low that sampling a large vessel is not possible. In such a case, the solutions should be sent to a smaller vessel for sampling or it could be sampled before the solution was sent to a large vessel. However, a composite sample is better than no sample.

As samples were taken during decontamination, they were analyzed and the results were recorded. Several important factors were looked for. The major radionuclides were identified by a gamma scan. Sr-90 was assumed to be present in a 1:1 ratio with Cs-137. Ru-106 was identified by identifying its decay daughter Rh-106. There was no interest in identifying H-3 and other weak beta emitters. The major concern was identifying and removing those radionuclides that were contributing to the cell's radiation field. Only those nuclides that could contribute to the radiation field by passing through vessels, piping, pumps, valves, etc. were tracked.

The log number was recorded for future reference. If a sample was not taken, it was still important to account for the solution's volume and waste characteristics. Normally, for solutions that were not sampled, an average value would be used for its sample results. Averaging is not as simple as it sounds. Sampled data was weighted heavier than unsampled data, and two processes of averaging were done.

First, the average for the specific solution was used. For example, if solution C were used and one of the flushes was not sampled, then the average data for all sampled solutions C would be used for the unsampled flush. The solutions used for this averaging would only be those related to the sampling unit. The sampling unit is simply the process being decontaminated. For example, if G cell were being decontaminated and the decontamination solutions used were being sampled, then G cell should be the sample unit. In this example, only the sampled C solutions used in G cell would be used in finding the average for the solution C. The average used to fill in for unsampled data would not be based on data collected from another sampling unit.

The second type of averaging occurred if a solution were used but was never sampled in that decontamination unit. An example of this would be if solution D were used several times in cell F and no samples were obtained. Here, the average for all decontamination solutions used in F cell would be used to fill in for the unsampled data. Only solutions used in this sampling unit would be used to find the average. In this example, only sampled solutions from F cell would be used.

There is the possibility that no solutions in the sampling unit were sampled. In this case, the average of the specific solution used in that decontamination campaign would be used. If for example, solution D were used in E cell but no samples of any solution were taken, then the program would average all sampled D solutions used in that decontamination. If solution D had not been sampled in that decontamination, then the average of all solutions would be used. If no solutions have been sampled, then the decontamination is proceeding in the dark and those in charge need a good crystal ball.

The purpose of averaging was to obtain an estimate of what was removed. It is much better to have actual data for making decisions concerning what solutions should not be used and which are being effective. For historical purposes, averaging helps to provide a reasonable estimate of the general effectiveness of the decontamination. This appendix contains averaged data. It may be recognized by the sample log number 1. Sampled solutions will have a log number specifying the year the sample was taken, the date the sample was taken, and a unique sample number for that day.

It is possible to run the program without the averaged data. This is sometimes useful while the decontamination is in progress so that the data will not be skewed.

The data in this appendix is arranged in two parts. The first part is a long analysis of the data. It consists of 21 tables, each of which look at the information collected by sampling in a unique way. These tables provide many different ways of looking at the data. It is hoped that considerable time will be spent reviewing these tables by those who want more detail concerning many aspects of the decontamination. Many of the figures and tables used in the body of the report came from this section. However, these tables provide in-depth analysis and allow the researcher to identify trends or effects that may not have been discussed in the report.

The second part of this appendix contains the raw data. This is the unmodified, unmanipulated sample results. In this section, the averages have been included and can be identified by a log number of 1. Actual log numbers are given so that a researcher can obtain original sample results or is some way verify any questions that may arise. The sample results for the isotopes are recorded as dps/mL. Beta results are a gross beta count and are in dpm/mL.

Solutions were tracked and the quantities of chemicals used were recorded. A weight percent was used to calculate chemical quantities. To simplify the tracking of chemical quantities, the weight percent was calculated assuming a liter of solution weighted one kg. Thus, if 300 grams of chemical A were taken and water was added to make one liter, then this solution would be 30 wt% chemical A. The calculation simply becomes:

$$(300\ \text{g}/1000\ \text{mL})(1\ \text{mL}/1\ \text{g})(100) = 30\ \text{wt\%}$$

This ignores the actual density of the solution. However, the error introduced by this simplifying approach was decided to be acceptable due to other errors such as measuring quantities of bulk chemicals used and in the volume measurements of the liquids. This seems to be acceptable because large errors were created by inaccuracies in weighing large quantities of bulk chemicals and in errors in measuring volumes of large tanks.

The tables contained in this appendix are based on averaged data from the 1982 decontamination of First Cycle following Electrolytic campaign #37. Below is a summary of the data tables. The actual raw data is also included and is listed under data below.

1982 Electrolytic Decontamination Data

Table 1	Individual isotope information
Table 2	x/L isotope information
Table 3	% isotope information
Table 4	Solution information - mCi/L
Table 5	Solution information - μg/L
Table 6	Solution information - mR/h*L
Table 7	Solution information - curies
Table 8	Solution information - mg
Table 9	Solution information - R/hr

&k2S

ESTIMATED VALUES BASED ON AVERAGES

DECON INFORMATION ON 1982 Decon

TABLE 1

Individual Isotope Information

	Ci	mg	R/hr
Zr 95	28	1	69
Nb 95	49	1	226
Ru103	5	0	12
Ru106	676	200	395
Sb125	334	315	257
Cs134	3	2	11
Cs137	29	330	97
Ce144	13	4	1
Total	1137	855	1069
Beta	13052		

TABLE 2

X/L Isotope Information

	mCi/L	ug/L	mR/hr*L
Zr 95	.1	.0	.4
Nb 95	.3	.0	1.2
Ru103	.0	.0	.1
Ru106	3.5	1.0	2.0
Sb125	1.7	1.6	1.3
Cs134	.0	.0	.1
Cs137	.1	1.7	.5
Ce144	.1	.0	.0
Total	5.8	4.4	5.5
Beta	66.8	Beta/min/ml=	1.5E+08

TABLE 3

% Isotope Information

	Ci	mg	R/hr
Zr 95	2.5	.2	6.5
Nb 95	4.3	.1	21.1
Ru103	.4	.0	1.1
Ru106	59.4	23.4	37.0
Sb125	29.4	36.9	24.1
Cs134	.3	.3	1.0
Cs137	2.5	38.6	9.1
Ce144	1.2	.5	.1

TABLE 4

Solution Information - mCi/L

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.01	.00	.03	.08	.00	.67	.11	.04	.96	H2O	59950
	.09	.01	.12	.31	.02	2.26	3.22	.20	6.23	HNO3	42450
	.30	.00	.33	.69	.16	19.86	4.02	.49	25.84	KMnO4/HNO3	20100
	.04	.00	.01	.60	.02	3.10	.53	.25	4.56	4521	22900
	.06	.08	.52	.03	.00	1.20	.05	.02	1.95	4502	12000
	.08	.11	.69	.09	.00	1.09	.03	.03	2.14	CITROX	9600
	.02	.01	.06	.09	.01	1.57	3.43	.03	5.22	Tartaric/NaOH	28250
Tot	.07	.02	.15	.25	.02	3.46	1.71	.14	5.82		195250

TABLE 5

Solution Information - ug/L

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.00	.00	.38	.00	.00	.20	.11	.00	.70	H2O	59950
	.03	.01	1.37	.01	.00	.67	3.04	.01	5.13	HNO3	42450
	.09	.00	3.84	.02	.01	5.88	3.79	.02	13.65	KMnO4/HNO3	20100
	.01	.00	.12	.02	.00	.92	.50	.01	1.58	4521	22900
	.02	.06	6.01	.00	.00	.35	.04	.00	6.49	4502	12000
	.03	.09	7.95	.00	.00	.32	.02	.00	8.42	CITROX	9600
	.00	.01	.73	.00	.00	.46	3.24	.00	4.45	Tartaric/NaOH	28250
Tot	.02	.01	1.69	.01	.00	1.03	1.62	.01	4.38		195250

TABLE 6

Solution Information - mR/hr*L

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.00	.02	.11	.37	.01	.39	.09	.10	1.08	H2O	59950
	.01	.04	.40	1.43	.04	1.32	2.48	.49	6.21	HNO3	42450
	.03	.00	1.13	3.15	.42	11.61	3.09	1.22	20.64	KMnO4/HNO3	20100
	.00	.00	.03	2.73	.05	1.81	.41	.63	5.67	4521	22900
	.00	.29	1.77	.13	.01	.70	.03	.04	2.98	4502	12000
	.01	.41	2.34	.40	.01	.64	.02	.08	3.90	CITROX	9600
	.00	.03	.21	.42	.01	.92	2.64	.09	4.32	Tartaric/NaOH	28250
Tot	.01	.06	.50	1.16	.06	2.02	1.32	.35	5.47		195250

TABLE 7

Solution Information - curies

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
1	0	2	5	0	40	7	2	57	H2O	59950
4	0	5	13	1	96	137	8	264	HNO3	42450
6	0	7	14	3	399	81	10	519	KMnO4/HNO3	20100
1	0	0	14	0	71	12	6	104	4521	22900
1	1	6	0	0	14	1	0	23	4502	12000
1	1	7	1	0	11	0	0	21	CITROX	9600
0	0	2	3	0	44	97	1	147	Tartaric/NaOH	28250

TABLE 8

Solution Information - mg

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
0	0	23	0	0	12	6	0	42	H2O	59950
1	0	58	0	0	28	129	0	218	HNO3	42450
2	0	77	0	0	118	76	0	274	KMnO4/HNO3	20100
0	0	3	0	0	21	11	0	36	4521	22900
0	1	72	0	0	4	1	0	78	4502	12000
0	1	76	0	0	3	0	0	81	CITROX	9600
0	0	21	0	0	13	92	0	126	Tartaric/NaOH	28250

TABLE 9

Solution Information - R/hr

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
0	1	7	22	0	24	5	6	65	H2O	59950
0	2	17	61	2	56	105	21	264	HNO3	42450
1	0	23	63	8	233	62	24	415	KMnO4/HNO3	20100
0	0	1	63	1	42	9	14	130	4521	22900
0	3	21	2	0	8	0	0	36	4502	12000
0	4	22	4	0	6	0	1	37	CITROX	9600
0	1	6	12	0	26	75	2	122	Tartaric/NaOH	28250

TABLE 10

% Solution Information curies % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
1.1	.5	3.5	8.3	.3	70.3	11.7	4.2	5.0	H2O	30.7
1.4	.2	1.9	5.0	.3	36.4	51.8	3.1	23.2	HNO3	21.7
1.1	.0	1.3	2.7	.6	76.8	15.5	1.9	45.7	KMnO4/HNO3	10.3
1.0	.0	.2	13.1	.4	68.1	11.7	5.6	9.2	4521	11.7
2.9	4.2	26.9	1.5	.2	61.3	2.3	.8	2.1	4502	6.1
3.9	5.4	32.4	4.1	.2	51.2	1.2	1.6	1.8	CITROX	4.9
.3	.1	1.2	1.8	.1	30.0	65.8	.7	13.0	Tartaric/NaOH	14.5

TABLE 11

% Solution Information mg % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
.5	.6	54.6	.3	.0	28.6	15.2	.3	4.9	H2O	30.7
.5	.2	26.7	.2	.0	13.1	59.2	.2	25.5	HNO3	21.7
.7	.0	28.1	.1	.0	43.1	27.8	.2	32.1	KMnO4/HNO3	10.3
.9	.0	7.3	1.0	.0	58.2	31.8	.7	4.2	4521	11.7
.3	1.0	92.6	.0	.0	5.5	.7	.0	9.1	4502	6.1
.3	1.1	94.4	.0	.0	3.9	.3	.0	9.5	CITROX	4.9
.1	.1	16.3	.1	.0	10.4	72.9	.0	14.7	Tartaric/NaOH	14.5

TABLE 12

% Solution Information R/hr % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
.1	1.6	10.4	33.8	.7	36.3	8.0	9.1	6.1	H2O	30.7
.1	.6	6.5	23.0	.7	21.3	40.0	7.8	24.7	HNO3	21.7
.1	.0	5.5	15.3	2.0	56.2	15.0	5.9	38.8	KMnO4/HNO3	10.3
.1	.1	.6	48.1	.8	32.0	7.2	11.1	12.2	4521	11.7
.2	9.7	59.4	4.4	.3	23.5	1.2	1.3	3.3	4502	6.1
.2	10.4	59.9	10.2	.3	16.4	.5	2.1	3.5	CITROX	4.9
.0	.6	4.9	9.8	.3	21.2	61.2	2.0	11.4	Tartaric/NaOH	14.5

TABLE 13

% Solution Info. curies,mg,R/hr % down columns

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Soln	Total Vol
4.9	9.7	6.9	9.7	3.6	6.0	2.0	8.6	H2O	30.7
27.6	15.1	17.6	26.9	14.2	14.2	40.9	29.8	HNO3	21.7
45.3	.3	23.4	28.0	68.4	59.1	24.2	35.4	KMnO4/HNO3	10.3
7.6	.7	.8	27.7	8.9	10.5	3.6	20.9	4521	11.7
5.1	31.9	21.9	.7	1.0	2.1	.2	.7	4502	6.1
6.1	35.7	23.1	1.7	.9	1.6	.1	1.2	CITROX	4.9
3.4	6.7	6.2	5.3	3.0	6.5	29.0	3.5	Tartaric/NaOH	14.5

TABLE 14

% Solution Info. curies/tot curies

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.1	.0	.2	.4	.0	3.5	.6	.2	5.0	H2O	30.7
	.3	.0	.4	1.2	.1	8.5	12.0	.7	23.2	HNO3	21.7
	.5	.0	.6	1.2	.3	35.1	7.1	.9	45.7	KMnO4/HNO3	10.3
	.1	.0	.0	1.2	.0	6.2	1.1	.5	9.2	4521	11.7
	.1	.1	.6	.0	.0	1.3	.0	.0	2.1	4502	6.1
	.1	.1	.6	.1	.0	.9	.0	.0	1.8	CITROX	4.9
	.0	.0	.2	.2	.0	3.9	8.5	.1	13.0	Tartaric/NaOH	14.5
Tot	1.2	.3	2.5	4.3	.4	59.4	29.4	2.5			

TABLE 15

% Solution Info. mg/tot mg

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.0	.0	2.7	.0	.0	1.4	.7	.0	4.9	H2O	30.7
	.1	.0	6.8	.0	.0	3.3	15.1	.0	25.5	HNO3	21.7
	.2	.0	9.0	.0	.0	13.8	8.9	.1	32.1	KMnO4/HNO3	10.3
	.0	.0	.3	.0	.0	2.5	1.3	.0	4.2	4521	11.7
	.0	.1	8.4	.0	.0	.5	.1	.0	9.1	4502	6.1
	.0	.1	8.9	.0	.0	.4	.0	.0	9.5	CITROX	4.9
	.0	.0	2.4	.0	.0	1.5	10.7	.0	14.7	Tartaric/NaOH	14.5
Tot	.5	.3	38.6	.1	.0	23.4	36.9	.2			

TABLE 16

% Solution Info. R/hr/tot R

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.0	.1	.6	2.1	.0	2.2	.5	.6	6.1	H2O	30.7
	.0	.2	1.6	5.7	.2	5.3	9.9	1.9	24.7	HNO3	21.7
	.0	.0	2.1	5.9	.8	21.8	5.8	2.3	38.8	KMnO4/HNO3	10.3
	.0	.0	.1	5.9	.1	3.9	.9	1.3	12.2	4521	11.7
	.0	.3	2.0	.1	.0	.8	.0	.0	3.3	4502	6.1
	.0	.4	2.1	.4	.0	.6	.0	.1	3.5	CITROX	4.9
	.0	.1	.6	1.1	.0	2.4	7.0	.2	11.4	Tartaric/NaOH	14.5
Tot	.1	1.0	9.1	21.1	1.1	37.0	24.1	6.5			

TABLE 17

Solution Summary

	gamma R/hr	gamma mg	UDS g	gamma curie	beta curie	Cost $	Soln	Vol-L
	65	42	171	57	153	0	H2O	59950
	264	218	265	264	302	4540	HNO3	42450
	415	274	65	519	12156	1953	KMnO4/HNO3	20100
	130	36	222	104	191	20943	4521	22900
	36	78	68	23	35	5299	4502	12000
	37	81	137	21	30	1263	CITROX	9600
	122	126	304	147	186	3388	Tartaric/NaOH	28250
Total	1069	855	1231	1137	13052	37386		195250

TABLE 18

Solution Summary %

gamma R/hr	gamma mg	UDS g	gamma curie	beta curie	Cost $	Soln	Vol-L
6.1	4.9	13.9	5.0	1.2	.0	H2O	30.7
24.7	25.5	21.5	23.2	2.3	12.1	HNO3	21.7
38.8	32.1	5.3	45.7	93.1	5.2	KMn04/HNO3	10.3
12.2	4.2	18.0	9.2	1.5	56.0	4521	11.7
3.3	9.1	5.5	2.1	.3	14.2	4502	6.1
3.5	9.5	11.1	1.8	.2	3.4	CITROX	4.9
11.4	14.7	24.7	13.0	1.4	9.1	Tartaric/NaOH	14.5

TABLE 19

Solution Summary x/L

gamma mR/hr*L	gamma ug/L	UDS g/L	gamma mcurie/L	beta mcurie/L	B/L	Cost $/L	Soln	Tot Vol-L
1.1	.7	2.9	1.0	2.55	2.5	.00	H2O	59950
6.2	5.1	6.2	6.2	7.11	7.1	.11	HNO3	42450
20.6	13.7	3.2	25.8	604.78	604.8	.10	KMn04/HNO3	20100
5.7	1.6	9.7	4.6	8.32	8.3	.91	4521	22900
3.0	6.5	5.7	2.0	2.89	2.9	.44	4502	12000
3.9	8.4	14.2	2.1	3.16	3.2	.13	CITROX	9600
4.3	4.4	10.7	5.2	6.59	6.6	.12	Tartaric/NaOH	28250
5.5	4.4	6.3	5.8	66.85		.19		195250

TABLE 20

Cost Summary x/$

	gamma mR/hr/$	gamma ug/$	UDS g/$	gamma mcurie/$	beta mcurie/$	cost $	Soln	Tot Vol-L
	0	0	0	0	0	0	H2O	59950
	58	48	58	58	66	4540	HNO3	42450
	212	141	33	268	6225	1953	KMn04/HNO3	20100
	6	2	11	5	9	20943	4521	22900
	7	15	13	4	7	5299	4502	12000
	30	64	108	16	24	1263	CITROX	9600
	36	37	90	44	55	3388	Tartaric/NaOH	28250
Total	29	23	33	30	349	1.00		5.22

TABLE 21

Waste Analysis

Volume of Waste	195250	L	51585	gal
Wt of chemicals w/o HNO3	6855	Kg	15081	lbs
Moles of Na+ ; Molarity	53391	moles	.27	M
Moles of K+ ; Molarity	18225	moles	.09	M
Moles Na+ plus K+ ; Molarity	71616	moles	.37	M
Chemical cost 1982 $	37386	$		

Chemical Analysis (Kg)

	KMnO4	Citric	Oxalic	NH Oxal	Tart A	K+	Na+	Kg	L	# of Flushes
H2O									59950	57
HNO3								16216	42450	38
KMnO4/HNO3	156					38		2729	20100	17
4521		108	325	1734				2168	22900	19
4502	230					675	10	1152	12000	10
Citrox		365	259					624	9600	8
Tart A/NaOH					636		1218	2754	28250	22
Totals	386	473	584	1734	636	713	1228	6855	195250	171

Approx. pH	-.1
Number of flushes	171
Samples taken	112

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H-100 1982 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
1	.31E+03	.30E+03	.19E+04	.49E+03	.12E+03	.30E+05	.46E+03	.41E+03	1200	1	5.3E+06	2.2	.00	.00	0	1
30603	.72E+04	.28E+03	.44E+04	.20E+05	.76E+03	.80E+05	.74E+04	.20E+05	1200	2	1.0E+07	.7	38.20	.00	600	1
30816	.33E+05	.00E+00	.00E+00	.14E+06	.16E+05	.17E+07	.60E+05	.78E+05	1200	3	1.1E+10	5.3	.78	12.80	3000	1
40604	.70E+04	.00E+00	.00E+00	.19E+06	.65E+04	.95E+06	.30E+05	.81E+05	1200	4	9.3E+07	6.3	10.00	.00	800	1
1	.24E+04	.55E+03	.49E+04	.58E+04	.20E+03	.27E+05	.22E+04	.53E+04	1200	2	5.7E+06	2.1	38.20	.00	0	1
1	.31E+03	.30E+03	.19E+04	.49E+03	.12E+03	.30E+05	.46E+03	.41E+03	1200	1	5.3E+06	2.2	.00	.00	0	1
41101	.51E+03	.00E+00	.00E+00	.20E+04	.19E+03	.46E+05	.55E+03	.64E+03	1200	4	1.1E+06	2.4	10.00	.00	0	1
1	.37E+05	.00E+00	.50E+05	.79E+05	.14E+05	.18E+07	.40E+05	.60E+05	1200	3	5.5E+09	3.5	.78	12.80	0	1
1	.41E+03	.00E+00	.00E+00	.19E+04	.87E+02	.20E+05	.26E+03	.51E+03	1200	6	1.7E+06	37.5	3.80	2.70	0	1
41609	.30E+03	.38E+02	.44E+03	.14E+04	.41E+02	.96E+04	.36E+03	.53E+03	1200	1	9.2E+05	.3	.00	.00	200	1
41803	.34E+03	.00E+00	.60E+02	.16E+04	.43E+02	.96E+04	.78E+03	.59E+03	1200	2	9.7E+06	1.1	38.20	.00	100	1
41905	.40E+05	.00E+00	.10E+06	.17E+05	.12E+05	.18E+07	.19E+05	.42E+05	1200	3	6.7E+07	1.7	.78	12.80	150	1
42015	.43E+04	.00E+00	.00E+00	.35E+05	.25E+03	.49E+05	.47E+04	.14E+05	1200	4	6.5E+06	3.2	10.00	.00	80	1
42207	.57E+02	.00E+00	.00E+00	.86E+03	.55E+02	.14E+05	.17E+03	.54E+03	1200	1	5.3E+06	.5	.00	.00	10	1
1	.24E+04	.55E+03	.49E+04	.58E+04	.20E+03	.27E+05	.22E+04	.53E+04	1200	2	5.7E+06	2.1	38.20	.00	0	1
1	.31E+03	.30E+03	.19E+04	.49E+03	.12E+03	.30E+05	.46E+03	.41E+03	1200	1	5.3E+06	2.2	.00	.00	0	1
42611	.00E+00	.00E+00	.00E+00	.00E+00	.50E+03	.11E+06	.00E+00	.10E+04	1200	5	7.2E+06	10.4	10.00	.00	10	1
42816	.00E+00	.00E+00	.15E+03	.00E+00	.45E+03	.11E+06	.17E+04	.00E+00	1200	1	1.5E+07	1.0	.00	.00	100	1
42922	.41E+03	.00E+00	.00E+00	.19E+04	.87E+02	.20E+05	.26E+03	.51E+03	1200	6	1.7E+06	37.5	3.80	2.70	50	1
1	.31E+03	.30E+03	.19E+04	.49E+03	.12E+03	.30E+05	.46E+03	.41E+03	1200	1	5.3E+06	2.2	.00	.00	0	1
50206	.18E+04	.19E+04	.15E+05	.13E+04	.00E+00	.13E+05	.47E+03	.48E+03	1200	2	2.9E+06	2.6	38.20	.00	50	1
1	.31E+03	.30E+03	.19E+04	.49E+03	.12E+03	.30E+05	.46E+03	.41E+03	1200	1	5.3E+06	2.2	.00	.00	0	1
50314	.00E+00	.18E+03	.12E+04	.00E+00	.62E+02	.13E+05	.13E+03	.00E+00	1200	5	1.3E+07	1.4	10.00	.00	10	1
50411	.11E+04	.14E+04	.89E+04	.00E+00	.32E+02	.12E+05	.00E+00	.00E+00	1200	1	1.6E+06	7.0	.00	.00	40	1
50508	.42E+03	.44E+02	.32E+03	.17E+04	.63E+02	.17E+05	.10E+04	.25E+03	1200	4	2.2E+05	13.6	10.00	.00	20	1
50714	.68E+02	.80E+02	.38E+02	.21E+03	.19E+02	.42E+04	.74E+02	.10E+04	1200	1	3.9E+06	2.1	.00	.00	5	1
51014	.10E+03	.00E+00	.70E+02	.14E+03	.16E+02	.50E+04	.70E+02	.57E+02	1200	2	3.7E+05	4.1	38.20	.00	40	1
1	.31E+03	.30E+03	.19E+04	.49E+03	.12E+03	.30E+05	.46E+03	.41E+03	600	1	5.3E+06	2.2	.00	.00	0	1
1	.37E+05	.00E+00	.50E+05	.79E+05	.14E+05	.18E+07	.40E+05	.60E+05	1200	3	5.5E+09	3.5	.78	12.80	0	1
1	.31E+04	.11E+02	.80E+02	.57E+05	.18E+04	.27E+06	.91E+04	.24E+05	1200	4	2.5E+07	6.4	10.00	.00	0	1
1	.31E+03	.30E+03	.19E+04	.49E+03	.12E+03	.30E+05	.46E+03	.41E+03	600	1	5.3E+06	2.2	.00	.00	0	1
1	.24E+04	.55E+03	.49E+04	.58E+04	.20E+03	.27E+05	.22E+04	.53E+04	600	2	5.7E+06	2.1	38.20	.00	0	1
1	.31E+03	.30E+03	.19E+04	.49E+03	.12E+03	.30E+05	.46E+03	.41E+03	600	1	5.3E+06	2.2	.00	.00	0	1
52208	.00E+00	.00E+00	.95E+03	.67E+04	.13E+04	.37E+06	.58E+05	.97E+03	1200	7	3.3E+07	2.1	2.25	7.50	350	1
52304	.82E+03	.00E+00	.26E+02	.41E+04	.14E+03	.49E+05	.40E+04	.11E+04	1200	7	4.8E+06	1.4	2.25	7.50	35	1
52313	.11E+03	.00E+00	.00E+00	.11E+04	.36E+02	.12E+05	.13E+04	.26E+03	1200	7	2.1E+06	7.5	2.25	7.50	20	1
52405	.35E+02	.00E+00	.14E+02	.20E+03	.11E+02	.38E+04	.35E+03	.36E+02	1200	7	6.2E+05	3.3	2.25	7.50	25	1

Solutions

1. H2O
2. HNO3
3. KMnO4/HNO3
4. 4521
5. 4502
6. Citrox
7. Tartaric/NaOH
8. 4324
9. Oxalic
10. Citric A
11. Oxalic/HNO3
12. NH4OH
13. EDTA/NaOH
14. ARR
15. HF/HNO3

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H-103 1982 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
30324	.38E+03	.00E+00	.32E+02	.13E+04	.51E+02	.39E+04	.55E+03	.43E+03	1200	1	3.4E+05	.4	.00	.00	95	2
1	.11E+04	.48E+03	.38E+04	.21E+04	.15E+03	.30E+05	.47E+03	.85E+03	1200	2	2.0E+06	2.3	38.20	.00	0	2
1	.14E+03	.00E+00	.10E+02	.15E+02	.56E+02	.98E+04	.39E+02	.72E+02	1200	3	5.2E+05	1.7	.78	12.80	0	2
1	.12E+04	.37E+02	.23E+03	.17E+03	.15E+01	.11E+04	.74E+02	.12E+03	1200	4	3.9E+06	9.1	10.00	.00	0	2
1	.11E+04	.48E+03	.38E+04	.21E+04	.15E+03	.30E+05	.47E+03	.85E+03	1200	2	2.0E+06	2.3	38.20	.00	0	2
1	.26E+03	.25E+03	.15E+04	.28E+03	.96E+02	.22E+05	.40E+03	.98E+02	1200	1	3.0E+06	1.9	.00	.00	0	2
41204	.00E+00	.00E+00	.00E+00	.37E+03	.00E+00	.14E+04	.11E+03	.23E+03	1200	4	1.3E+06	2.6	10.00	.00	80	2
1	.14E+03	.00E+00	.10E+02	.15E+02	.56E+02	.98E+04	.39E+02	.72E+02	1200	3	5.2E+05	1.7	.78	12.80	0	2
41503	.13E+04	.00E+00	.00E+00	.55E+04	.43E+03	.81E+05	.35E+04	.22E+04	1200	6	6.1E+06	3.1	3.80	2.70	80	2
1	.26E+03	.25E+03	.15E+04	.28E+03	.96E+02	.22E+05	.40E+03	.98E+02	1200	1	3.0E+06	1.9	.00	.00	0	2
41804	.14E+04	.00E+00	.28E+03	.67E+04	.51E+03	.90E+05	.12E+04	.28E+04	1200	2	4.3E+06	1.1	38.20	.00	35	2
41913	.14E+03	.00E+00	.10E+02	.15E+02	.56E+02	.98E+04	.39E+02	.72E+02	1200	3	5.2E+05	1.7	.78	12.80	30	2
42103	.24E+02	.00E+00	.48E+00	.48E+02	.46E+01	.82E+03	.14E+02	.27E+02	1200	4	8.5E+06	12.0	10.00	.00	70	2
42216	.00E+00	.00E+00	.00E+00	.54E+02	.83E+01	.14E+04	.30E+02	.19E+02	1200	1	3.3E+05	.9	.00	.00	5	2
42404	.00E+00	.00E+00	.00E+00	.21E+03	.68E+02	.11E+05	.13E+03	.79E+02	1200	2	2.3E+05	1.5	38.20	.00	60	2
42503	.29E+02	.00E+00	.00E+00	.96E+02	.18E+02	.32E+04	.46E+02	.36E+02	1200	1	2.4E+05	.2	.00	.00	20	2
42614	.00E+00	.00E+00	.00E+00	.00E+00	.20E+03	.58E+05	.00E+00	.00E+00	1200	5	7.7E+06	3.4	10.00	.00	10	2
42816	.00E+00	.00E+00	.15E+03	.00E+00	.45E+03	.11E+06	.17E+04	.00E+00	1200	1	1.5E+07	1.0	.00	.00	100	2
43006	.35E+03	.00E+00	.62E+02	.23E+04	.17E+03	.32E+05	.48E+03	.68E+03	1200	6	2.9E+06	3.0	3.80	2.70	30	2
1	.26E+03	.25E+03	.15E+04	.28E+03	.96E+02	.22E+05	.40E+03	.98E+02	1200	1	3.0E+06	1.9	.00	.00	0	2
50206	.18E+04	.19E+04	.15E+05	.13E+04	.00E+00	.13E+05	.47E+03	.48E+03	1200	2	2.9E+06	2.6	38.20	.00	50	2
1	.26E+03	.25E+03	.15E+04	.28E+03	.96E+02	.22E+05	.40E+03	.98E+02	1200	1	3.0E+06	1.9	.00	.00	0	2
50321	.00E+00	.85E+02	.62E+03	.00E+00	.43E+02	.10E+05	.80E+02	.00E+00	1200	5	2.5E+06	2.4	10.00	.00	5	2
50411	.11E+04	.14E+04	.89E+04	.00E+00	.32E+02	.12E+05	.00E+00	.00E+00	1200	1	1.6E+06	7.0	.00	.00	40	2
50513	.35E+04	.11E+03	.69E+03	.96E+02	.00E+00	.12E+04	.97E+02	.97E+02	1200	4	1.8E+06	12.8	10.00	.00	40	2
50714	.68E+02	.80E+02	.38E+02	.21E+03	.19E+02	.42E+04	.74E+02	.10E+03	1200	1	3.9E+05	2.1	.00	.00	5	2
51014	.10E+04	.00E+00	.70E+02	.14E+03	.16E+02	.50E+04	.70E+02	.57E+02	1200	2	3.7E+05	4.1	38.20	.00	40	2

Solutions

1. H2O	6. Citrox	11. Oxalic/HNO3
2. HNO3	7. Tartaric/NaOH	12. NH4OH
3. KMnO4/HNO3	8. 4324	13. EDTA/NaOH
4. 4521	9. Oxalic	14. ARR
5. 4502	10. Citric A	15. HF/HNO3

&k2S

H-134 1982 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
30407	.16E+04	.41E+02	.39E+03	.55E+04	.15E+03	.14E+05	.28E+04	.20E+04	1200	1	1.1E+06	.9	.00	.00	350	3
30805	.23E+05	.00E+00	.34E+03	.44E+05	.76E+04	.79E+06	.22E+05	.27E+05	1200	2	8.0E+07	.6	38.20	.00	200	3
30913	.19E+05	.00E+00	.37E+04	.59E+05	.30E+05	.29E+07	.28E+05	.46E+05	1200	3	1.8E+08	3.8	.78	12.80	2200	3
40704	.41E+04	.00E+00	.12E+04	.12E+06	.15E+04	.25E+06	.10E+05	.82E+05	1200	2	2.8E+07	2.2	38.20	.00	800	3
40902	.13E+04	.43E+02	.15E+03	.15E+05	.12E+04	.25E+06	.32E+04	.56E+04	1200	2	2.8E+07	2.2	38.20	.00	0	3
41008	.11E+04	.00E+00	.00E+00	.73E+04	.32E+03	.54E+05	.16E+04	.31E+04	1200	1	6.3E+06	1.3	.00	.00	180	3
41304	.62E+03	.00E+00	.42E+02	.19E+04	.25E+03	.44E+05	.43E+03	.72E+03	1200	3	9.7E+06	.9	.78	12.80	200	3
41504	.16E+03	.00E+00	.57E+02	.26E+04	.85E+02	.18E+05	.11E+04	.11E+04	1200	6	8.9E+06	6.9	3.80	2.70	50	3
1	.60E+03	.22E+03	.14E+04	.22E+04	.17E+03	.35E+05	.10E+04	.87E+03	1200	1	4.5E+06	2.3	.00	.00	0	3
41811	.24E+03	.34E+02	.45E+03	.65E+03	.86E+02	.17E+05	.30E+03	.24E+03	1200	2	3.5E+06	1.2	38.20	.00	40	3
41922	.82E+03	.00E+00	.80E+02	.17E+04	.27E+03	.42E+05	.00E+00	.12E+04	1200	3	2.6E+06	3.5	.78	12.80	45	3
42106	.99E+03	.97E+02	.13E+04	.46E+04	.56E+03	.12E+06	.70E+03	.23E+04	1200	4	1.7E+07	7.4	10.00	.00	140	3
42305	.89E+02	.00E+00	.33E+02	.16E+04	.48E+02	.14E+05	.78E+03	.43E+03	1200	1	4.1E+06	2.1	.00	.00	40	3
42406	.69E+03	.00E+00	.00E+00	.22E+04	.35E+03	.98E+05	.57E+03	.93E+03	1200	2	8.7E+06	.9	38.20	.00	30	3
42507	.27E+03	.00E+00	.36E+02	.99E+03	.15E+03	.35E+05	.34E+03	.48E+03	1200	1	3.0E+06	1.5	.00	.00	40	3
1	.18E+04	.51E+04	.38E+05	.21E+03	.00E+00	.21E+05	.47E+03	.23E+03	1200	5	5.2E+06	10.0	10.00	.00	0	3
42816	.00E+00	.00E+00	.15E+03	.00E+00	.45E+03	.11E+06	.17E+04	.00E+00	1200	1	1.5E+07	1.0	.00	.00	100	3
43018	.19E+05	.32E+05	.19E+06	.12E+04	.00E+00	.43E+05	.00E+00	.80E+03	1200	6	2.5E+07	9.5	3.80	2.70	30	3
1	.60E+03	.22E+03	.14E+04	.22E+04	.17E+03	.35E+05	.10E+04	.87E+03	1200	1	4.5E+06	2.3	.00	.00	0	3
50206	.18E+04	.19E+04	.15E+05	.13E+04	.00E+00	.13E+05	.47E+03	.48E+03	1200	2	2.9E+06	2.6	38.20	.00	50	3
1	.60E+03	.22E+03	.14E+04	.22E+04	.17E+03	.35E+05	.10E+04	.87E+03	1200	1	4.5E+06	2.3	.00	.00	0	3
50403	.18E+04	.51E+04	.38E+05	.21E+03	.00E+00	.21E+05	.47E+03	.23E+03	1200	5	5.2E+06	10.0	10.00	.00	40	3
50411	.11E+04	.14E+04	.89E+04	.00E+00	.32E+02	.12E+05	.00E+00	.00E+00	1200	1	1.6E+06	7.0	.00	.00	40	3
1	.99E+03	.97E+02	.13E+04	.46E+04	.56E+03	.12E+06	.70E+03	.23E+04	1200	4	1.7E+07	7.4	10.00	.00	0	3
50714	.68E+02	.80E+02	.38E+02	.21E+03	.19E+02	.42E+04	.74E+02	.10E+03	1200	1	3.9E+05	2.1	.00	.00	5	3
51014	.10E+04	.00E+00	.70E+02	.14E+03	.16E+02	.50E+04	.70E+02	.57E+02	1200	2	3.7E+05	4.1	38.20	.00	40	3

Solutions

1. H2O	6. Citrox	11. Oxalic/HNO3
2. HNO3	7. Tartaric/NaOH	12. NH4OH
3. KMnO4/HNO3	8. 4324	13. EDTA/NaOH
4. 4521	9. Oxalic	14. ARR
5. 4502	10. Citric A	15. HF/HNO3

&k2S

H-Mix 1982 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
30505	.43E+03	.69E+02	.10E+04	.12E+04	.90E+02	.12E+05	.45E+04	.53E+03	1200	1	1.0E+08	.4	.00	.00	1800	4
30814	.40E+05	.39E+04	.50E+05	.18E+05	.39E+04	.38E+06	.96E+04	.30E+05	1200	2	3.3E+07	1.8	38.20	.00	200	4
40503	.13E+05	.00E+00	.00E+00	.43E+05	.13E+05	.20E+07	.20E+07	.13E+05	1200	3	1.8E+08	3.8	.78	12.80	9000	4
40711	.56E+04	.00E+00	.62E+03	.11E+06	.26E+04	.47E+06	.19E+05	.48E+05	1200	4	1.4E+08	6.7	10.00	.00	1000	4
40905	.54E+04	.00E+00	.35E+03	.82E+05	.21E+04	.37E+06	.11E+05	.32E+05	1200	2	2.8E+07	2.2	38.20	.00	500	4
1	.48E+03	.80E+02	.82E+03	.17E+04	.83E+02	.22E+05	.88E+03	.65E+03	1200	1	1.4E+07	6.8	.00	.00	0	4
41404	.62E+03	.39E+02	.29E+03	.99E+03	.49E+03	.97E+05	.52E+03	.55E+03	1200	3	1.1E+07	2.8	.78	12.80	200	4
41520	.00E+00	.00E+00	.00E+00	.28E+04	.21E+03	.46E+05	.93E+03	.14E+04	1200	6	4.6E+06	6.7	3.80	2.70	50	4
41706	.11E+03	.23E+02	.21E+03	.43E+03	.00E+00	.54E+04	.21E+03	.17E+03	1200	1	5.2E+05	2.2	.00	.00	0	4
41903	.19E+03	.00E+00	.19E+02	.45E+03	.17E+03	.34E+05	.20E+03	.21E+03	1200	2	3.1E+06	4.1	38.20	.00	100	4
42006	.38E+03	.53E+02	.11E+04	.43E+02	.98E+02	.22E+05	.13E+03	.16E+03	1200	3	2.2E+06	4.1	.78	12.80	50	4
42204	.11E+04	.00E+00	.00E+00	.84E+04	.34E+03	.71E+05	.74E+03	.35E+04	1200	4	7.5E+06	12.0	10.00	.00	50	4
42319	.12E+04	.00E+00	.90E+02	.80E+04	.28E+03	.65E+05	.14E+04	.27E+04	1200	1	6.3E+06	7.3	.00	.00	125	4
42408	.43E+03	.00E+00	.00E+00	.16E+04	.26E+03	.80E+05	.40E+03	.70E+03	1200	2	7.7E+06	1.8	38.20	.00	30	4
42508	.00E+00	.00E+00	.00E+00	.16E+03	.00E+00	.27E+04	.43E+02	.39E+02	1200	1	3.0E+05	1.9	.00	.00	50	4
42714	.00E+00	.00E+00	.00E+00	.00E+00	.20E+03	.58E+05	.00E+00	.00E+00	1200	5	7.7E+06	3.4	10.00	.00	200	4
42819	.00E+00	.00E+00	.00E+00	.00E+00	.27E+03	.73E+05	.10E+04	.00E+00	1200	1	1.3E+07	6.6	.00	.00	70	4
50103	.32E+04	.19E+04	.15E+05	.75E+04	.23E+03	.64E+05	.97E+03	.27E+04	1200	6	5.2E+06	9.6	3.80	2.70	40	4
50119	.34E+03	.87E+02	.57E+03	.90E+03	.25E+02	.61E+04	.60E+02	.35E+03	1200	1	6.4E+05	7.5	.00	.00	60	4
1	.92E+04	.78E+03	.10E+05	.20E+05	.13E+04	.17E+06	.42E+04	.13E+05	1200	2	1.4E+07	2.8	38.20	.00	0	4
50304	.53E+03	.12E+03	.25E+04	.24E+04	.34E+02	.12E+05	.33E+03	.11E+04	1200	1	1.4E+06	2.1	.00	.00	10	4
50404	.15E+05	.19E+05	.11E+06	.11E+04	.00E+00	.38E+05	.14E+04	.83E+03	1200	5	1.6E+05	7.0	10.00	.00	40	4
50420	.71E+03	.24E+03	.18E+04	.81E+03	.00E+00	.78E+04	.12E+03	.40E+03	1200	1	1.2E+06	5.3	.00	.00	20	4
50617	.42E+03	.75E+02	.55E+03	.20E+03	.00E+00	.14E+04	.75E+02	.97E+02	1200	4	9.6E+05	21.0	10.00	.00	25	4
50811	.96E+03	.18E+03	.12E+04	.13E+04	.52E+02	.17E+05	.24E+03	.60E+03	1200	1	1.9E+06	27.6	.00	.00	15	4
51104	.28E+02	.00E+00	.81E+01	.22E+02	.74E+01	.19E+04	.13E+02	.12E+02	1200	2	3.2E+05	4.2	38.20	.00	5	4

Solutions

1. H2O	6. Citrox	11. Oxalic/HNO3
2. HNO3	7. Tartaric/NaOH	12. NH4OH
3. KMnO4/HNO3	8. 4324	13. EDTA/NaOH
4. 4521	9. Oxalic	14. ARR
5. 4502	10. Citric A	15. HF/HNO3

&k2S

G-101 1982 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
1	.00E+00	.30E+03	.54E+04	.13E+05	.00E+00	.30E+05	.12E+07	.69E+04	750	7	8.1E+07	44.2	2.25	7.50	0	1
61126	.00E+00	.11E+04	.81E+04	.67E+04	.00E+00	.40E+05	.11E+07	.38E+04	750	2	7.7E+07	1.1	38.20	.00	55	1
1	.00E+00	.46E+02	.47E+03	.20E+03	.00E+00	.42E+04	.63E+05	.19E+03	750	1	4.2E+06	4.5	.00	.00	0	1
1	.00E+00	.30E+03	.54E+04	.13E+05	.00E+00	.30E+05	.12E+07	.69E+04	750	7	8.1E+07	44.2	2.25	7.50	0	1
61215	.00E+00	.00E+00	.84E+04	.31E+05	.00E+00	.46E+05	.30E+07	.18E+05	750	2	1.9E+08	3.4	38.20	.00	160	1
1	.00E+00	.46E+02	.47E+03	.20E+03	.00E+00	.42E+04	.63E+05	.19E+03	300	1	4.2E+06	4.5	.00	.00	0	1
1	.00E+00	.30E+03	.54E+04	.13E+05	.00E+00	.30E+05	.12E+07	.69E+04	750	7	8.1E+07	44.2	2.25	7.50	0	1
61307	.00E+00	.00E+00	.37E+04	.10E+05	.00E+00	.25E+05	.58E+06	.41E+04	750	2	3.8E+07	160.0	38.20	.00	40	1
1	.00E+00	.30E+03	.54E+04	.13E+05	.00E+00	.30E+05	.12E+07	.69E+04	300	7	8.1E+07	44.2	2.25	7.50	0	1
1	.00E+00	.37E+03	.67E+04	.16E+05	.00E+00	.37E+05	.16E+07	.86E+04	300	2	1.0E+08	54.8	38.20	.00	0	1
61507	.00E+00	.70E+02	.80E+03	.72E+02	.00E+00	.50E+04	.75E+05	.33E+03	300	1	5.3E+06	3.3	.00	.00	5	1
1	.00E+00	.30E+03	.54E+04	.13E+05	.00E+00	.30E+05	.12E+07	.69E+04	300	7	8.1E+07	44.2	2.25	7.50	0	1
1	.00E+00	.37E+03	.67E+04	.16E+05	.00E+00	.37E+05	.16E+07	.86E+04	300	2	1.0E+08	54.8	38.20	.00	0	1
61608	.00E+00	.22E+02	.14E+03	.33E+03	.00E+00	.33E+04	.51E+05	.53E+02	300	1	3.0E+06	5.7	.00	.00	20	1
1	.00E+00	.30E+03	.54E+04	.13E+05	.00E+00	.30E+05	.12E+07	.69E+04	300	3	8.1E+07	44.2	.78	12.80	0	1
1	.00E+00	.30E+03	.54E+04	.13E+05	.00E+00	.30E+05	.12E+07	.69E+04	300	4	8.1E+07	44.2	8.00	.00	0	1
1	.00E+00	.37E+03	.67E+04	.16E+05	.00E+00	.37E+05	.16E+07	.86E+04	300	2	1.0E+08	54.8	38.20	.00	0	1

Solutions

1. H2O
2. HNO3
3. KMnO4/HNO3
4. 4521
5. 4502
6. Citrox
7. Tartaric/NaOH
8. 4324
9. Oxalic
10. Citric A
11. Oxalic/HNO3
12. NH4OH
13. EDTA/NaOH
14. ARR
15. HF/HNO3

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G-106 1982 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
52705	.50E+03	.00E+00	.45E+03	.26E+04	.00E+00	.43E+05	.44E+04	.55E+03	2200	7	6.4E+06	3.2	2.25	7.50	90	2
60406	.10E+03	.36E+02	.28E+03	.89E+03	.32E+02	.10E+05	.91E+03	.22E+03	2200	7	1.0E+06	17.6	2.25	7.50	12	2
60514	.00E+00	.00E+00	.36E+02	.35E+03	.21E+02	.71E+04	.24E+03	.69E+02	2200	7	5.6E+05	7.5	2.25	7.50	0	2
60611	.00E+00	.00E+00	.10E+03	.25E+03	.20E+02	.68E+04	.34E+03	.00E+00	2200	7	5.5E+05	14.2	2.25	7.50	25	2
60712	.00E+00	.16E+02	.19E+03	.94E+02	.97E+01	.34E+04	.79E+02	.28E+02	2200	7	3.2E+05	6.2	2.25	7.50	50	2
61003	.33E+03	.00E+00	.12E+03	.19E+03	.28E+02	.77E+04	.23E+03	.41E+02	2200	2	6.2E+05	2.5	38.20	.00	25	2
61020	.25E+03	.00E+00	.55E+02	.52E+02	.75E+02	.31E+05	.24E+03	.15E+03	1800	3	1.2E+06	3.5	.78	12.80	10	2
61403	.29E+03	.13E+02	.15E+03	.58E+03	.42E+02	.17E+05	.35E+04	.21E+03	2200	4	2.0E+06	11.9	8.00	.00	15	2
61517	.22E+02	.00E+00	.24E+02	.87E+02	.82E+01	.25E+04	.11E+04	.19E+02	2200	2	7.2E+05	3.2	38.20	.00	1	2

Solutions

1. H2O	6. Citrox	11. Oxalic/HNO3
2. HNO3	7. Tartaric/NaOH	12. NH4OH
3. KMnO4/HNO3	8. 4324	13. EDTA/NaOH
4. 4521	9. Oxalic	14. ARR
5. 4502	10. Citric A	15. HF/HNO3

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G-111 1982 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
1	.42E+03	.27E+02	.27E+03	.14E+05	.60E+02	.14E+05	.13E+05	.74E+04	700	1	2.3E+05	.2	.00	.00	0	3
1	.10E+04	.42E+03	.31E+04	.45E+04	.21E+03	.57E+05	.71E+04	.18E+04	1200	5	7.7E+06	4.3	8.00	.00	0	3
1	.42E+03	.27E+02	.27E+03	.14E+05	.60E+02	.14E+05	.13E+05	.74E+04	700	1	2.3E+05	.2	.00	.00	0	3
1	.39E+03	.21E+02	.14E+03	.57E+03	.32E+02	.11E+05	.65E+03	.19E+03	1200	4	1.6E+06	9.7	8.00	.00	0	3
1	.42E+03	.27E+02	.27E+03	.14E+05	.60E+02	.14E+05	.13E+05	.74E+04	700	1	2.3E+05	.2	.00	.00	0	3
51506	.82E+03	.22E+03	.44E+04	.66E+04	.00E+00	.10E+05	.86E+04	.93E+03	700	2	2.1E+06	2.2	38.20	.00	25	3
1	.42E+03	.27E+02	.27E+03	.14E+05	.60E+02	.14E+05	.13E+05	.74E+04	700	1	2.3E+05	.2	.00	.00	0	3
1	.44E+03	.36E+02	.36E+03	.36E+03	.00E+00	.86E+04	.49E+03	.11E+03	1200	3	6.4E+06	.0	.78	12.80	0	3
51806	.23E+03	.00E+00	.20E+03	.39E+05	.12E+03	.25E+05	.20E+05	.20E+05	700	1	1.0E+05	.0	.00	.00	40	3
1	.10E+04	.42E+03	.31E+04	.45E+04	.21E+03	.57E+05	.71E+04	.18E+04	1200	5	7.7E+06	4.3	8.00	.00	0	3
1	.42E+03	.27E+02	.27E+03	.14E+05	.60E+02	.14E+05	.13E+05	.74E+04	700	1	2.3E+05	.2	.00	.00	0	3
1	.39E+03	.21E+02	.14E+03	.57E+03	.32E+02	.11E+05	.65E+03	.19E+03	1200	4	1.6E+06	9.7	8.00	.00	0	3
1	.42E+03	.27E+02	.27E+03	.14E+05	.60E+02	.14E+05	.13E+05	.74E+04	700	1	2.3E+05	.2	.00	.00	0	3
52530	.94E+04	.46E+04	.32E+05	.20E+05	.22E+04	.54E+06	.43E+05	.71E+04	1200	7	7.1E+07	1.7	2.25	7.50	250	3
52705	.00E+00	.00E+00	.38E+03	.22E+04	.20E+03	.61E+05	.73E+04	.00E+00	1200	7	6.4E+06	3.2	2.25	7.50	90	3
60225	.00E+00	.47E+02	.45E+03	.15E+04	.00E+00	.12E+05	.38E+04	.72E+03	1200	7	1.2E+06	1.4	2.25	7.50	30	3
60307	.17E+03	.00E+00	.26E+03	.58E+03	.15E+02	.43E+04	.11E+04	.10E+03	1200	7	1.7E+06	6.3	2.25	7.50	40	3
60403	.23E+03	.12E+03	.49E+03	.50E+03	.98E+01	.34E+04	.11E+04	.13E+03	1200	7	1.2E+06	9.7	2.25	7.50	10	3
60419	.44E+02	.27E+02	.28E+03	.32E+03	.00E+00	.19E+04	.76E+03	.10E+03	1200	7	2.4E+05	7.4	2.25	7.50	22	3
60604	.32E+03	.83E+02	.64E+03	.83E+03	.34E+02	.16E+05	.16E+04	.47E+03	1200	7	1.6E+06	9.2	2.25	7.50	10	3
1	.15E+04	.70E+03	.49E+04	.37E+04	.35E+03	.91E+05	.84E+04	.12E+04	1200	7	1.2E+07	5.6	2.25	7.50	0	3
1	.46E+03	.81E+02	.17E+04	.28E+04	.15E+02	.96E+04	.35E+04	.49E+03	1200	2	9.5E+05	2.3	38.20	.00	10	3
60807	.44E+03	.36E+02	.36E+03	.36E+03	.00E+00	.86E+04	.49E+03	.11E+03	1200	3	6.4E+06	.0	.78	12.80	100	3
60826	.39E+03	.21E+02	.14E+03	.57E+03	.32E+02	.11E+05	.65E+03	.19E+03	1200	4	1.6E+06	9.7	8.00	.00	10	3
1	.42E+03	.27E+02	.27E+03	.14E+05	.60E+02	.14E+05	.13E+05	.74E+04	1200	1	2.3E+05	.2	.00	.00	0	3
60911	.25E+03	.00E+00	.91E+02	.63E+03	.23E+02	.93E+04	.60E+03	.24E+03	1200	2	2.8E+05	2.3	38.20	.00	10	3
1	.42E+03	.27E+02	.27E+03	.14E+05	.60E+02	.14E+05	.13E+05	.74E+04	1200	1	2.3E+05	.2	.00	.00	0	3
1	.46E+03	.81E+02	.17E+04	.28E+04	.15E+02	.96E+04	.35E+04	.49E+03	1200	2	9.5E+05	2.3	38.20	.00	0	3
61127	.53E+03	.43E+02	.31E+03	.72E+02	.25E+02	.81E+04	.96E+04	.69E+02	1200	1	3.1E+05	.3	.00	.00	10	3

Solutions

1. H2O
2. HNO3
3. KMnO4/HNO3
4. 4521
5. 4502
6. Citrox
7. Tartaric/NaOH
8. 4324
9. Oxalic
10. Citric A
11. Oxalic/HNO3
12. NH4OH
13. EDTA/NaOH
14. ARR
15. HF/HNO3

Appendix D

1983 Aluminum Decontamination Data

Appendix D

1983 Aluminum Decontamination Data

The data in this appendix is arranged in two parts. The first part is a long analysis of the data. It consists of 21 tables, each of which look at the information collected by sampling in a unique way. These tables provide many different ways of looking at the data. It is hoped that considerable time will be spent reviewing these tables by those who want more detail concerning the many aspects of decontamination. Many of the figures and tables used in the body of the report came from this section. However, these tables provide in-depth analysis and allow the researcher to identify trends or effects that were not discussed in the report.

The second part of this appendix contains the raw data. This is the unmodified, unmanipulated sample results. In this section, the averages have been included and can be identified by a log number of 1. Actual log numbers are given so that a researcher can obtain original sample results or in some way verify any questions that may arise. The sample results for the isotopes are recorded as dps/mL. Beta results are a gross beta count and are in dpm/mL.

Solutions were tracked and the quantities of chemicals used were recorded. A weight percent was used to calculate chemical quantities. To simplify the tracking of chemical quantities, the weight percent was calculated assuming that a liter of solution weighted one kg. Thus, if 300 grams of chemical A were taken and water was added to make one liter, then this solution would be 30 wt% chemical A. The calculation simply becomes:

$$(300\ g/1000\ mL)(1\ mL/1\ g)(100) = 30\ wt\%$$

This ignores the actual density of the solution. However, the error introduced by this simplifying approach was decided to be acceptable due to other errors, such as measuring quantities of bulk chemicals used and in the volume measurements of the liquids. This seems to be acceptable, because large errors were created by inaccuracies in weighing large quantities of bulk chemicals and in errors in measuring volumes of large tanks.

The tables contained in this appendix are based on averaged data from the 1983 decontamination of First Cycle following Aluminum campaign #38. Below is a summary of the data tables. The raw data is also listed below under "data" and is listed in the order the decontamination occurred.

1983 Aluminum Decontamination Data

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ESTIMATED VALUES BASED ON AVERAGES

DECON INFORMATION ON 1983 Decon

TABLE 1

Individual Isotope Information

	Ci	mg	R/hr
Zr 95	211	10	524
Nb 95	3768	96	17288
Ru103	0	0	0
Ru106	232	69	136
Sb125	378	357	291
Cs134	80	62	284
Cs137	881	10107	2973
Ce144	178	56	16
Total	5729	10757	21512
Beta	3579		

TABLE 2

X/L Isotope Information

	mCi/L	ug/L	mR/hr*L
Zr 95	1.0	.0	2.4
Nb 95	17.0	.4	77.9
Ru103	.0	.0	.0
Ru106	1.0	.3	.6
Sb125	1.7	1.6	1.3
Cs134	.4	.3	1.3
Cs137	4.0	45.6	13.4
Ce144	.8	.3	.1
Total	25.8	48.5	97.0
Beta	16.1	Beta/min/ml= 3.6E+07	

TABLE 3

% Isotope Information

	Ci	mg	R/hr
Zr 95	3.7	.1	2.4
Nb 95	65.8	.9	80.4
Ru103	.0	.0	.0
Ru106	4.1	.6	.6
Sb125	6.6	3.3	1.4
Cs134	1.4	.6	1.3
Cs137	15.4	94.0	13.8
Ce144	3.1	.5	.1

TABLE 4

Solution Information - mCi/L

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	1.01	.28	2.62	2.04	.00	.34	.27	.23	6.79	H2O	79420
	.09	.03	.37	16.05	.00	.93	1.50	2.08	21.04	HNO3	47530
	.28	.11	1.30	1.90	.01	1.01	.37	.26	5.23	KMnO4/HNO3	6650
	.14	.37	4.47	6.88	.00	.50	.34	.50	13.21	4521	16890
	.18	1.01	12.62	1.40	.00	2.43	1.23	.35	19.21	4502	20690
	9.42	1.02	7.17	16.18	.00	1.37	.42	.97	36.55	CITROX	8750
	.04	.45	5.76	72.97	.00	2.16	7.07	1.91	90.37	Tartaric/NaOH	34320
	.01	1.22	15.61	.02	.00	3.21	.03	.00	20.11	4324	2400
	.54	.49	5.68	17.84	.00	.73	2.30	1.08	28.65	Oxalic	2200
	.07	.01	.04	.16	.00	.12	.08	.02	.51	Citric A	3000
Tot	.80	.36	3.97	16.98	.00	1.05	1.70	.95	25.83		221850

TABLE 5

Solution Information - ug/L

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
.32	.22	30.00	.05	.00	.10	.26	.01	30.96	H2O	79420
.03	.03	4.21	.41	.00	.28	1.41	.10	6.46	HNO3	47530
.09	.08	14.93	.05	.00	.30	.35	.01	15.80	KMnO4/HNO3	6650
.05	.28	51.32	.18	.00	.15	.32	.02	52.31	4521	16890
.06	.78	144.80	.04	.00	.72	1.16	.02	147.56	4502	20690
2.96	.79	82.27	.41	.00	.41	.39	.05	87.27	CITROX	8750
.01	.35	66.09	1.86	.00	.64	6.67	.09	75.71	Tartaric/NaOH	34320
.00	.94	179.03	.00	.00	.95	.03	.00	180.96	4324	2400
.17	.38	65.10	.45	.00	.22	2.17	.05	68.53	Oxalic	2200
.02	.01	.44	.00	.00	.04	.08	.00	.59	Citric A	3000

Tot	.25	.28	45.56	.43	.00	.31	1.61	.04	48.49		221850

TABLE 6

Solution Information - mR/hr*L

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.09	.99	8.83	9.35	.00	.20	.21	.58	20.25	H2O	79420
	.01	.12	1.24	73.63	.00	.54	1.15	5.16	81.85	HNO3	47530
	.02	.38	4.39	8.72	.03	.59	.28	.64	15.06	KMnO4/HNO3	6650
	.01	1.29	15.10	31.59	.00	.29	.26	1.24	49.79	4521	16890
	.02	3.58	42.60	6.41	.00	1.42	.94	.86	55.82	4502	20690
	.84	3.63	24.20	74.23	.00	.80	.32	2.39	106.41	CITROX	8750
	.00	1.60	19.44	334.78	.00	1.26	5.44	4.74	367.28	Tartaric/NaOH	34320
	.00	4.33	52.67	.11	.00	1.88	.02	.01	59.02	4324	2400
	.05	1.72	19.15	81.84	.00	.43	1.77	2.68	107.64	Oxalic	2200
	.01	.03	.13	.76	.00	.07	.06	.06	1.11	Citric A	3000
Tot	.07	1.28	13.40	77.93	.00	.61	1.31	2.36	96.97		221850

TABLE 7

Solution Information - curies

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
81	22	208	162	0	27	22	19	540	H2O	79420
4	2	17	763	0	44	71	99	1000	HNO3	47530
2	1	9	13	0	7	2	2	35	KMnO4/HNO3	6650
2	6	76	116	0	8	6	8	223	4521	16890
4	21	261	29	0	50	25	7	398	4502	20690
82	9	63	142	0	12	4	8	320	CITROX	8750
1	16	198	2504	0	74	243	66	3101	Tartaric/NaOH	34320
0	3	37	0	0	8	0	0	48	4324	2400
1	1	12	39	0	2	5	2	63	Oxalic	2200
0	0	0	0	0	0	0	0	2	Citric A	3000

TABLE 8

Solution Information - mg

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
25	17	2383	4	0	8	20	1	2459	H2O	79420

1	1	200	19	0	13	67	5	307	HNO3	47530
1	1	99	0	0	2	2	0	105	KMnO4/HNO3	6650
1	5	867	3	0	2	5	0	884	4521	16890
1	16	2996	1	0	15	24	0	3053	4502	20690
26	7	720	4	0	4	3	0	764	CITROX	8750
0	12	2268	64	0	22	229	3	2598	Tartaric/NaOH	34320
0	2	430	0	0	2	0	0	434	4324	2400
0	1	143	1	0	0	5	0	151	Oxalic	2200
0	0	1	0	0	0	0	0	2	Citric A	3000

TABLE 9

Solution Information - R/hr

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
7	79	701	742	0	16	17	46	1608	H2O	79420
0	6	59	3499	0	26	55	245	3890	HNO3	47530
0	3	29	58	0	4	2	4	100	KMnO4/HNO3	6650
0	22	255	533	0	5	4	21	841	4521	16890
0	74	881	133	0	29	20	18	1155	4502	20690
7	32	212	649	0	7	3	21	931	CITROX	8750
0	55	667	11490	0	43	187	163	12605	Tartaric/NaOH	34320
0	10	126	0	0	5	0	0	142	4324	2400
0	4	42	180	0	1	4	6	237	Oxalic	2200
0	0	0	2	0	0	0	0	3	Citric A	3000

TABLE 10

% Solution Information curies % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
14.9	4.1	38.5	30.0	.0	5.0	4.0	3.4	9.4	H2O	35.8
.4	.2	1.7	76.3	.0	4.4	7.1	9.9	17.5	HNO3	21.4
5.3	2.1	24.9	36.3	.2	19.3	7.0	4.9	.6	KMnO4/HNO3	3.0
1.1	2.8	33.9	52.1	.0	3.8	2.6	3.8	3.9	4521	7.6
.9	5.3	65.7	7.3	.0	12.6	6.4	1.8	6.9	4502	9.3
25.8	2.8	19.6	44.3	.0	3.8	1.1	2.6	5.6	CITROX	3.9
.0	.5	6.4	80.7	.0	2.4	7.8	2.1	54.1	Tartaric/NaOH	15.5
.0	6.1	77.6	.1	.0	16.0	.2	.0	.8	4324	1.1
1.9	1.7	19.8	62.3	.0	2.5	8.0	3.8	1.1	Oxalic	1.0
13.6	1.7	7.6	32.4	.0	24.3	16.0	4.4	.0	Citric A	1.4

TABLE 11

% Solution Information mg % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
1.0	.7	96.9	.2	.0	.3	.8	.0	22.9	H2O	35.8
.4	.4	65.2	6.3	.0	4.3	21.9	1.5	2.9	HNO3	21.4
.6	.5	94.4	.3	.0	1.9	2.2	.1	1.0	KMnO4/HNO3	3.0
.1	.5	98.1	.3	.0	.3	.6	.0	8.2	4521	7.6
.0	.5	98.1	.0	.0	.5	.8	.0	28.4	4502	9.3
3.4	.9	94.3	.5	.0	.5	.5	.1	7.1	CITROX	3.9
.0	.5	87.3	2.5	.0	.8	8.8	.1	24.2	Tartaric/NaOH	15.5
.0	.5	98.9	.0	.0	.5	.0	.0	4.0	4324	1.1
.2	.5	95.0	.7	.0	.3	3.2	.1	1.4	Oxalic	1.0
3.7	1.1	75.1	.7	.0	6.2	13.0	.2	.0	Citric A	1.4

TABLE 12

% Solution Information R/hr % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
.4	4.9	43.6	46.2	.0	1.0	1.0	2.9	7.5	H2O	35.8
.0	.1	1.5	90.0	.0	.7	1.4	6.3	18.1	HNO3	21.4
.2	2.5	29.2	57.9	.2	3.9	1.9	4.2	.5	KMnO4/HNO3	3.0
.0	2.6	30.3	63.4	.0	.6	.5	2.5	3.9	4521	7.6
.0	6.4	76.3	11.5	.0	2.5	1.7	1.5	5.4	4502	9.3
.8	3.4	22.7	69.8	.0	.8	.3	2.3	4.3	CITROX	3.9
.0	.4	5.3	91.2	.0	.3	1.5	1.3	58.6	Tartaric/NaOH	15.5
.0	7.3	89.2	.2	.0	3.2	.0	.0	.7	4324	1.1
.0	1.6	17.8	76.0	.0	.4	1.6	2.5	1.1	Oxalic	1.0
.6	2.8	11.7	67.9	.0	6.5	5.6	5.0	.0	Citric A	1.4

TABLE 13

% Solution Info. curies,mg,R/hr % down columns

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Soln	Total Vol
45.3	27.8	23.6	4.3	46.3	11.6	5.7	8.8	H2O	35.8
2.4	2.0	2.0	20.2	.2	19.0	18.8	46.8	HNO3	21.4
1.0	.9	1.0	.3	52.8	2.9	.6	.8	KMnO4/HNO3	3.0
1.4	7.7	8.6	3.1	.1	3.6	1.5	4.0	4521	7.6
2.1	26.0	29.6	.8	.6	21.6	6.7	3.4	4502	9.3
46.3	11.2	7.1	3.8	.0	5.2	1.0	4.0	CITROX	3.9
.8	19.4	22.4	66.5	.0	31.9	64.2	31.1	Tartaric/NaOH	15.5
.0	3.7	4.3	.0	.0	3.3	.0	.0	4324	1.1
.7	1.3	1.4	1.0	.0	.7	1.3	1.1	Oxalic	1.0
.1	.0	.0	.0	.0	.2	.1	.0	Citric A	1.4

TABLE 14

% Solution Info. curies/tot curies

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	1.4	.4	3.6	2.8	.0	.5	.4	.3	9.4	H2O	35.8
	.1	.0	.3	13.3	.0	.8	1.2	1.7	17.5	HNO3	21.4
	.0	.0	.2	.2	.0	.1	.0	.0	.6	KMnO4/HNO3	3.0
	.0	.1	1.3	2.0	.0	.1	.1	.1	3.9	4521	7.6
	.1	.4	4.6	.5	.0	.9	.4	.1	6.9	4502	9.3
	1.4	.2	1.1	2.5	.0	.2	.1	.1	5.6	CITROX	3.9
	.0	.3	3.5	43.7	.0	1.3	4.2	1.1	54.1	Tartaric/NaOH	15.5
	.0	.1	.7	.0	.0	.1	.0	.0	.8	4324	1.1
	.0	.0	.2	.7	.0	.0	.1	.0	1.1	Oxalic	1.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	Citric A	1.4
Tot	3.1	1.4	15.4	65.8	.0	4.1	6.6	3.7			

TABLE 15

% Solution Info. mg/tot mg

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.2	.2	22.2	.0	.0	.1	.2	.0	22.9	H2O	35.8
	.0	.0	1.9	.2	.0	.1	.6	.0	2.9	HNO3	21.4
	.0	.0	.9	.0	.0	.0	.0	.0	1.0	KMnO4/HNO3	3.0
	.0	.0	8.1	.0	.0	.0	.1	.0	8.2	4521	7.6
	.0	.2	27.9	.0	.0	.1	.2	.0	28.4	4502	9.3
	.2	.1	6.7	.0	.0	.0	.0	.0	7.1	CITROX	3.9
	.0	.1	21.1	.6	.0	.2	2.1	.0	24.2	Tartaric/NaOH	15.5
	.0	.0	4.0	.0	.0	.0	.0	.0	4.0	4324	1.1
	.0	.0	1.3	.0	.0	.0	.0	.0	1.4	Oxalic	1.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	Citric A	1.4
Tot	.5	.6	94.0	.9	.0	.6	3.3	.1			

TABLE 16

% Solution Info. R/hr/tot R

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
.0	.4	3.3	3.5	.0	.1	.1	.2	7.5	H2O	35.8

	.0	.0	.3	16.3	.0	.1	.3	1.1	18.1	HNO3	21.4
	.0	.0	.1	.3	.0	.0	.0	.0	.5	KMnO4/HNO3	3.0
	.0	.1	1.2	2.5	.0	.0	.0	.1	3.9	4521	7.6
	.0	.3	4.1	.6	.0	.1	.1	.1	5.4	4502	9.3
	.0	.1	1.0	3.0	.0	.0	.0	.1	4.3	CITROX	3.9
	.0	.3	3.1	53.4	.0	.2	.9	.8	58.6	Tartaric/NaOH	15.5
	.0	.0	.6	.0	.0	.0	.0	.0	.7	4324	1.1
	.0	.0	.2	.8	.0	.0	.0	.0	1.1	Oxalic	1.0
	.0	.0	.0	.0	.0	.0	.0	.0	.0	Citric A	1.4
Tot	.1	1.3	13.8	80.4	.0	.6	1.4	2.4			

TABLE 17

Solution Summary

	gamma R/hr	gamma mg	UDS g	gamma curie	beta curie	Cost $	Soln	Vol-L
	1608	2459	103	540	262	0	H2O	79420
	3890	307	187	1000	884	4433	HNO3	47530
	100	105	14	35	59	646	KMnO4/HNO3	6650
	841	884	57	223	247	13698	4521	16890
	1155	3053	287	398	237	7965	4502	20690
	931	764	23	320	83	1151	CITROX	8750
	12605	2598	103	3101	1746	3565	Tartaric/NaOH	34320
	142	434	0	48	12	61	4324	2400
	237	151	15	63	45	356	Oxalic	2200
	3	2	0	2	3	644	Citric A	3000
Total	21512	10757	789	5729	3579	32520		221850

TABLE 18

Solution Summary %

gamma R/hr	gamma mg	UDS g	gamma curie	beta curie	Cost $	Soln	Vol-L
7.5	22.9	13.0	9.4	7.3	.0	H2O	35.8
18.1	2.9	23.7	17.5	24.7	13.6	HNO3	21.4
.5	1.0	1.7	.6	1.6	2.0	KMnO4/HNO3	3.0
3.9	8.2	7.2	3.9	6.9	42.1	4521	7.6
5.4	28.4	36.4	6.9	6.6	24.5	4502	9.3
4.3	7.1	2.9	5.6	2.3	3.5	CITROX	3.9
58.6	24.2	13.1	54.1	48.8	11.0	Tartaric/NaOH	15.5
.7	4.0	.0	.8	.3	.2	4324	1.1
1.1	1.4	1.8	1.1	1.2	1.1	Oxalic	1.0
.0	.0	.0	.0	.1	2.0	Citric A	1.4

TABLE 19

Solution Summary x/L

gamma mR/hr*L	gamma ug/L	UDS g/L	gamma mcurie/L	beta mcurie/L	B/L	Cost $/L	Soln	Tot Vol-L
20.2	31.0	1.3	6.8	3.30	3.3	.00	H2O	79420
81.8	6.5	3.9	21.0	18.61	18.6	.09	HNO3	47530
15.1	15.8	2.0	5.2	8.88	8.9	.10	KMnO4/HNO3	6650
49.8	52.3	3.4	13.2	14.65	14.6	.81	4521	16890
55.8	147.6	13.9	19.2	11.47	11.5	.38	4502	20690
106.4	87.3	2.7	36.5	9.48	9.5	.13	CITROX	8750
367.3	75.7	3.0	90.4	50.89	50.9	.10	Tartaric/NaOH	34320
59.0	181.0	.0	20.1	4.83	4.8	.03	4324	2400
107.6	68.5	6.6	28.6	20.27	20.3	.16	Oxalic	2200
1.1	.6	.0	.5	.92	.9	.21	Citric A	3000
97.0	48.5	3.6	25.8	16.13		.15		221850

TABLE 20

Cost Summary x/$

	gamma mR/hr/$	gamma ug/$	UDS g/$	gamma mcurie/$	beta mcurie/$	cost $	Soln	Tot Vol-L
	0	0	0	0	0	0	H2O	79420
	878	69	42	226	199	4433	HNO3	47530
	155	163	21	54	91	646	KMnO4/HNO3	6650
	61	65	4	16	18	13698	4521	16890
	145	383	36	50	30	7965	4502	20690
	809	664	20	278	72	1151	CITROX	8750
	3536	729	29	870	490	3565	Tartaric/NaOH	34320
	2305	7069	0	785	189	61	4324	2400
	664	423	41	177	125	356	Oxalic	2200
	5	3	0	2	4	644	Citric A	3000
Total	662	331	24	176	110	1.00		6.82

TABLE 21

Waste Analysis

Volume of Waste 221850 L 58613 gal

Wt of chemicals w/o HNO3	7244 Kg	15936 lbs
Moles of Na+ ; Molarity	56174 moles	.25 M
Moles of K+ ; Molarity	26241 moles	.12 M
Moles Na+ plus K+ ; Molarity	82415 moles	.37 M
Chemical cost 1982 $	32520 $	

Chemical Analysis (Kg)

	KMnO4	Citric	Oxalic	NH Oxal	Tart A	K+	Na+	Kg	L	# of Flushes
H2O									79420	58
HNO3								15832	47530	37
KMnO4/HNO3	51					12		902	6650	6
4521		71	213	1134				1418	16890	15
4502	346					1014	15	1732	20690	14
Citrox		333	236					569	8750	5
Tart A/NaOH					675		1267	2878	34320	31
4324							11	96	2400	4
Oxalic A			220					220	2200	1
Citric A		279						279	3000	3
Totals	397	682	669	1134	675	1026	1292	7244	221850	174

Approx. pH	.1
Number of flushes	174
Samples taken	143

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F Cell 1983-84 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
120205	.60E+07	.53E+06	.30E+07	.58E+07	.00E+00	.67E+06	.14E+06	.46E+06	500	6	1.2E+08	.0	3.80	2.70	350	1
1	.14E+06	.16E+05	.53E+05	.26E+06	.32E+03	.29E+05	.17E+05	.23E+05	500	1	3.0E+07	.0	.00	.00	0	1
120223	.55E+03	.17E+05	.12E+06	.22E+04	.00E+00	.89E+04	.15E+06	.19E+04	500	5	7.8E+07	.0	10.00	.00	30	1
1	.14E+06	.16E+05	.53E+05	.26E+06	.32E+03	.29E+05	.17E+05	.23E+05	500	1	3.0E+07	.0	.00	.00	0	1
120306	.88E+05	.34E+04	.27E+05	.29E+07	.00E+00	.71E+05	.32E+05	.61E+05	500	6	1.1E+05	.0	3.80	2.70	150	1
120319	.53E+05	.27E+04	.15E+05	.14E+07	.00E+00	.36E+05	.16E+05	.31E+05	500	1	5.9E+07	.0	.00	.00	350	1
120407	.80E+05	.53E+04	.31E+05	.63E+06	.00E+00	.93E+05	.23E+05	.00E+00	500	2	5.0E+07	.0	38.20	.00	10	1
120417	.38E+05	.15E+04	.93E+04	.20E+06	.00E+00	.51E+05	.78E+04	.76E+04	500	3	3.4E+07	.0	.78	12.80	11	1
120517	.15E+05	.66E+03	.54E+04	.10E+05	.00E+00	.50E+05	.11E+04	.88E+03	500	1	2.0E+07	.0	.00	.00	50	1
120523	.20E+05	.10E+04	.68E+04	.16E+06	.00E+00	.26E+05	.50E+04	.47E+04	500	4	2.0E+07	.0	10.00	.00	40	1
120536	.17E+04	.10E+03	.73E+03	.16E+05	.00E+00	.22E+04	.37E+03	.57E+03	500	1	1.6E+07	.0	.00	.00	60	1
120826	.13E+05	.11E+04	.73E+04	.20E+06	.00E+00	.11E+06	.30E+05	.47E+04	500	5	1.7E+07	.0	10.00	.00	35	1
120909	.00E+00	.45E+03	.30E+04	.40E+02	.00E+00	.65E+04	.31E+04	.00E+00	500	1	8.9E+06	.0	.00	.00	5	1
120960	.12E+05	.44E+03	.32E+04	.78E+05	.00E+00	.85E+05	.47E+04	.43E+04	500	2	1.2E+07	.0	38.20	.00	20	1
121216	.54E+04	.28E+03	.15E+04	.52E+05	.00E+00	.28E+05	.27E+04	.31E+04	500	4	5.1E+06	.0	10.00	.00	8	1
121704	.71E+05	.59E+04	.89E+05	.35E+05	.00E+00	.20E+06	.14E+05	.19E+05	400	7	1.9E+06	.0	.23	.75	80	2
121719	.14E+04	.00E+00	.49E+03	.83E+03	.00E+00	.16E+06	.21E+04	.30E+03	400	7	1.7E+07	.0	.23	.75	10000	2
121805	.36E+03	.00E+00	.10E+03	.19E+03	.00E+00	.54E+05	.72E+03	.78E+02	400	7	5.1E+06	.0	.23	.75	15	2
1	.15E+05	.79E+03	.63E+04	.14E+07	.00E+00	.97E+05	.17E+06	.20E+06	400	2	8.5E+07	.0	38.20	.00	0	2
121931	.41E+02	.00E+00	.17E+02	.13E+02	.00E+00	.39E+04	.72E+02	.70E+01	400	3	3.6E+05	.0	.78	12.80	5	2
122047	.14E+04	.23E+02	.16E+03	.74E+04	.00E+00	.70E+04	.97E+03	.00E+00	400	4	9.8E+05	.0	10.00	.00	5	2
122106	.53E+03	.21E+02	.13E+03	.13E+05	.00E+00	.13E+05	.23E+04	.26E+03	400	2	1.5E+06	.0	38.20	.00	2	3
122116	.91E+02	.00E+00	.58E+02	.64E+04	.00E+00	.62E+04	.22E+04	.10E+03	400	7	7.6E+05	.0	.23	.75	2	3
1	.46E+04	.16E+04	.34E+05	.83E+07	.00E+00	.17E+06	.64E+06	.13E+06	400	7	3.3E+08	.0	.23	.75	0	3
1	.46E+04	.16E+04	.34E+05	.83E+07	.00E+00	.17E+06	.64E+06	.13E+06	400	7	3.3E+08	.0	.23	.75	0	3
122206	.28E+03	.00E+00	.12E+03	.79E+02	.00E+00	.31E+05	.48E+03	.00E+00	400	2	3.0E+06	.0	38.20	.00	20	3
122420	.34E+02	.00E+00	.10E+02	.42E+03	.00E+00	.28E+04	.45E+03	.12E+02	800	7	2.0E+06	.0	.23	.75	25	4
122430	.11E+05	.42E+03	.10E+05	.26E+03	.13E+03	.23E+05	.15E+04	.68E+03	800	3	1.7E+07	.0	.78	12.80	60	4
1	.14E+06	.16E+05	.53E+05	.26E+06	.32E+03	.29E+05	.17E+05	.23E+05	800	1	3.0E+07	.0	.00	.00	0	4
122612	.39E+02	.80E+01	.67E+02	.15E+04	.40E+01	.18E+04	.26E+04	.29E+02	800	4	2.3E+06	.0	10.00	.00	5	4
122620	.51E+03	.00E+00	.78E+02	.13E+04	.00E+00	.54E+05	.81E+03	.80E+02	800	2	1.4E+06	.0	38.20	.00	10	4
1	.14E+06	.16E+05	.53E+05	.26E+06	.32E+03	.29E+05	.17E+05	.23E+05	800	1	3.0E+07	.0	.00	.00	0	4
122705	.19E+03	.00E+00	.25E+02	.90E+03	.00E+00	.12E+05	.40E+03	.37E+02	800	7	5.4E+05	.0	.23	.75	5	4
122711	.77E+02	.00E+00	.26E+02	.15E+04	.00E+00	.53E+04	.54E+03	.19E+02	800	7	5.7E+05	.0	.23	.75	2	4
122720	.76E+02	.00E+00	.00E+00	.41E+04	.00E+00	.27E+04	.42E+03	.58E+02	800	2	5.9E+05	.0	38.20	.00	2	4
122722	.82E+02	.00E+00	.14E+02	.58E+03	.00E+00	.14E+04	.12E+03	.25E+02	800	1	5.3E+05	.0	.00	.00	2	4
123109	.25E+05	.22E+04	.10E+05	.12E+07	.00E+00	.77E+05	.17E+06	.10E+06	1200	2	6.4E+07	.0	38.20	.00	150	5
123110	.00E+00	.63E+04	.78E+05	.29E+08	.00E+00	.44E+06	.19E+07	.24E+06	1200	7	1.1E+09	.0	2.25	7.50	1800	5
123114	.00E+00	.00E+00	.71E+05	.15E+08	.00E+00	.29E+06	.15E+07	.44E+06	1200	7	6.3E+08	.0	2.25	7.50	1000	5
10104	.22E+05	.00E+00	.75E+04	.44E+07	.00E+00	.34E+06	.65E+06	.80E+06	1200	2	3.1E+08	.0	38.20	.00	450	5
10109	.22E+05	.12E+04	.62E+04	.29E+06	.23E+04	.14E+06	.58E+05	.37E+05	1200	3	3.5E+07	.0	.78	12.80	200	5
10111	.42E+04	.00E+00	.63E+03	.26E+06	.00E+00	.22E+05	.37E+05	.27E+05	1200	1	1.8E+07	.0	.00	.00	60	5
10112	.00E+00	.00E+00	.00E+00	.21E+07	.00E+00	.24E+05	.83E+05	.18E+06	1200	4	9.1E+07	.0	10.00	.00	150	5
10204	.00E+00	.00E+00	.46E+04	.22E+07	.00E+00	.21E+05	.13E+06	.28E+06	1200	2	9.4E+07	.0	38.20	.00	150	5
10516	.59E+06	.68E+05	.22E+06	.27E+06	.14E+04	.65E+05	.27E+05	.57E+05	1200	1	6.7E+07	.0	.00	.00	200	5

Solutions
1. H2O
2. HNO3
3. KMnO4/HNO3
4. 4521
6. Citrox
7. Tartaric/NaOH
8. 4324
9. Oxalic
11. Oxalic/HNO3
12. NH4OH
13. EDTA/NaOH
14. ARR

5. 4502

10. Citric A

15. HF/HNO3

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J-127 1983-84 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
1	.26E+02	.00E+00	.50E+01	.21E+02	.00E+00	.28E+04	.14E+03	.21E+02	1200	1	1.2E+06	.1	.00	.00	0	1
1	.26E+02	.00E+00	.50E+01	.21E+02	.00E+00	.28E+04	.14E+03	.21E+02	1200	1	1.2E+06	.1	.00	.00	0	1
1	.26E+02	.00E+00	.50E+01	.21E+02	.00E+00	.28E+04	.14E+03	.21E+02	1200	1	1.2E+06	.1	.00	.00	0	1
1	.26E+02	.00E+00	.50E+01	.21E+02	.00E+00	.28E+04	.14E+03	.21E+02	1200	1	1.2E+06	.1	.00	.00	0	1
1	.26E+02	.00E+00	.50E+01	.21E+02	.00E+00	.28E+04	.14E+03	.21E+02	1200	1	1.2E+06	.1	.00	.00	0	1
123103	.53E+03	.78E+03	.10E+05	.27E+03	.00E+00	.86E+04	.75E+03	.98E+02	600	8	4.6E+06	.0	4.00	.00	50	2
10118	.17E+03	.00E+00	.31E+02	.27E+03	.00E+00	.14E+05	.13E+04	.10E+03	650	2	1.2E+07	7.9	18.60	.00	50	3
10205	.53E+03	.78E+03	.10E+05	.27E+03	.00E+00	.86E+04	.75E+03	.98E+02	650	7	1.0E+07	.0	2.25	7.50	350	3
10408	.53E+03	.78E+03	.10E+05	.27E+03	.00E+00	.86E+04	.75E+03	.98E+02	650	7	1.8E+07	.0	2.25	7.50	60	3
10515	.17E+03	.00E+00	.31E+02	.27E+03	.00E+00	.14E+05	.13E+04	.10E+03	650	2	4.7E+06	7.9	18.60	.00	45	3
10715	.26E+02	.00E+00	.50E+01	.21E+02	.00E+00	.28E+04	.14E+03	.21E+02	750	1	2.4E+06	.1	.00	.00	10	4
10904	.15E+04	.31E+04	.40E+05	.20E+03	.00E+00	.65E+04	.45E+03	.11E+03	750	5	4.3E+06	15.3	8.00	.00	100	4
10908	.42E+03	.00E+00	.20E+02	.60E+03	.00E+00	.11E+05	.11E+04	.16E+03	750	4	1.0E+06	.4	5.00	.00	5	4
11005	.17E+03	.00E+00	.31E+02	.27E+03	.00E+00	.14E+05	.13E+04	.10E+03	750	2	1.3E+06	21.6	18.60	.00	10	4
11018	.26E+02	.00E+00	.50E+01	.21E+02	.00E+00	.28E+04	.14E+03	.21E+02	750	1	6.8E+04	.2	.00	.00	5	4

Solutions
1. H2O
2. HNO3
3. KMnO4/HNO3
4. 4521
5. 4502
6. Citrox
7. Tartaric/NaOH
8. 4324
9. Oxalic
10. Citric A
11. Oxalic/HNO3
12. NH4OH
13. EDTA/NaOH
14. ARR
15. HF/HNO3

&k2S

J-128 1983-84 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
1	.00E+00	.00E+00	.10E+01	.30E+01	.00E+00	.81E+03	.43E+02	.00E+00	1200	1	8.8E+05	.0	.00	.00	0	1
1	.00E+00	.00E+00	.10E+01	.30E+01	.00E+00	.81E+03	.43E+02	.00E+00	1200	1	8.8E+05	.0	.00	.00	0	1
1	.00E+00	.00E+00	.10E+01	.30E+01	.00E+00	.81E+03	.43E+02	.00E+00	1200	1	8.8E+05	.0	.00	.00	0	1
1	.00E+00	.00E+00	.10E+01	.30E+01	.00E+00	.81E+03	.43E+02	.00E+00	1200	1	8.8E+05	.0	.00	.00	0	1
1	.00E+00	.00E+00	.10E+01	.30E+01	.00E+00	.81E+03	.43E+02	.00E+00	1200	1	8.8E+05	.0	.00	.00	0	1
123104	.29E+02	.00E+00	.16E+02	.11E+03	.00E+00	.14E+05	.68E+03	.24E+02	600	8	4.3E+06	.0	4.00	.00	50	2
10117	.26E+02	.00E+00	.70E+01	.12E+03	.00E+00	.61E+04	.48E+03	.22E+02	650	2	2.8E+06	1.0	18.60	.00	25	3
10206	.29E+02	.00E+00	.16E+02	.11E+03	.00E+00	.14E+05	.68E+03	.24E+02	650	7	3.7E+07	.0	2.25	7.50	150	3
10409	.29E+02	.00E+00	.16E+02	.11E+03	.00E+00	.14E+05	.68E+03	.24E+02	650	7	1.7E+07	.0	2.25	7.50	40	3
10514	.26E+02	.00E+00	.70E+01	.12E+03	.00E+00	.61E+04	.48E+03	.22E+02	650	2	4.9E+06	1.0	18.60	.00	40	3
10716	.00E+00	.00E+00	.10E+01	.30E+01	.00E+00	.81E+03	.43E+02	.00E+00	750	1	1.5E+06	.0	.00	.00	10	4
10905	.00E+00	.00E+00	.46E+02	.00E+00	.00E+00	.41E+05	.12E+04	.00E+00	750	5	1.7E+06	7.2	8.00	.00	25	4
10909	.90E+02	.00E+00	.80E+01	.33E+03	.00E+00	.78E+04	.10E+04	.73E+02	750	4	7.1E+05	.3	5.00	.00	5	4
11006	.26E+02	.00E+00	.70E+01	.12E+03	.00E+00	.61E+04	.48E+03	.22E+02	750	2	5.2E+05	2.7	18.60	.00	5	4
11019	.00E+00	.00E+00	.10E+01	.30E+01	.00E+00	.81E+03	.43E+02	.00E+00	750	1	2.5E+05	.0	.00	.00	5	4

Solutions

1. H2O	6. Citrox	11. Oxalic/HNO3
2. HNO3	7. Tartaric/NaOH	12. NH4OH
3. KMnO4/HNO3	8. 4324	13. EDTA/NaOH
4. 4521	9. Oxalic	14. ARR
5. 4502	10. Citric A	15. HF/HNO3

&k2S

J-134 1983-84 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
1	.40E+01	.10E+01	.90E+01	.23E+02	.00E+00	.52E+03	.85E+02	.13E+02	1200	1	1.4E+06	.2	.00	.00	0	1
1	.40E+01	.10E+01	.90E+01	.23E+02	.00E+00	.52E+03	.85E+02	.13E+02	1200	1	1.4E+06	.2	.00	.00	0	1
1	.40E+01	.10E+01	.90E+01	.23E+02	.00E+00	.52E+03	.85E+02	.13E+02	1200	1	1.4E+06	.2	.00	.00	0	1
1	.40E+01	.10E+01	.90E+01	.23E+02	.00E+00	.52E+03	.85E+02	.13E+02	1200	1	1.4E+06	.2	.00	.00	0	1
1	.40E+01	.10E+01	.90E+01	.23E+02	.00E+00	.52E+03	.85E+02	.13E+02	1200	1	1.4E+06	.2	.00	.00	0	1
123105	.79E+02	.25E+00	.46E+02	.62E+03	.00E+00	.13E+05	.20E+04	.16E+03	600	8	1.1E+07	.0	4.00	.00	50	2
10116	.11E+03	.00E+00	.22E+02	.95E+03	.00E+00	.88E+04	.20E+04	.28E+03	650	2	2.0E+07	.2	18.60	.00	50	3
10207	.79E+02	.25E+00	.46E+02	.62E+03	.00E+00	.13E+05	.20E+04	.16E+03	650	7	1.9E+07	.0	2.25	7.50	400	3
10410	.79E+02	.25E+00	.46E+02	.62E+03	.00E+00	.13E+05	.20E+04	.16E+03	650	7	1.9E+07	.0	2.25	7.50	40	3
10513	.11E+03	.00E+00	.22E+02	.95E+03	.00E+00	.88E+04	.20E+04	.28E+03	650	2	3.0E+06	.2	18.60	.00	30	3
10717	.40E+01	.10E+01	.90E+01	.23E+02	.00E+00	.52E+03	.85E+02	.13E+02	750	1	2.7E+06	.2	.00	.00	10	4
10906	.00E+00	.00E+00	.12E+03	.00E+00	.00E+00	.33E+05	.32E+04	.00E+00	750	5	2.3E+06	6.2	8.00	.00	25	4
10910	.20E+03	.00E+00	.31E+02	.15E+04	.00E+00	.78E+04	.26E+04	.36E+03	750	4	8.9E+05	.5	5.00	.00	2	4
11007	.11E+03	.00E+00	.22E+02	.95E+03	.00E+00	.88E+04	.20E+04	.28E+03	750	2	9.0E+05	.5	18.60	.00	10	4
11020	.40E+01	.10E+01	.90E+01	.23E+02	.00E+00	.52E+03	.85E+02	.13E+02	750	1	5.7E+04	.4	.00	.00	5	4

Solutions

1. H2O	6. Citrox	11. Oxalic/HNO3
2. HNO3	7. Tartaric/NaOH	12. NH4OH
3. KMnO4/HNO3	8. 4324	13. EDTA/NaOH
4. 4521	9. Oxalic	14. ARR
5. 4502	10. Citric A	15. HF/HNO3

&k2S

J-135 1983-84 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc. #
1	.41E+02	.00E+00	.16E+02	.20E+02	.00E+00	.36E+04	.16E+03	.16E+02	1200	1	1.6E+06	5.4	.00	.00	0	1
1	.41E+02	.00E+00	.16E+02	.20E+02	.00E+00	.36E+04	.16E+03	.16E+02	1200	1	1.6E+06	5.4	.00	.00	0	1
1	.41E+02	.00E+00	.16E+02	.20E+02	.00E+00	.36E+04	.16E+03	.16E+02	1200	1	1.6E+06	5.4	.00	.00	0	1
1	.41E+02	.00E+00	.16E+02	.20E+02	.00E+00	.36E+04	.16E+03	.16E+02	1200	1	1.6E+06	5.4	.00	.00	0	1
1	.41E+02	.00E+00	.16E+02	.20E+02	.00E+00	.36E+04	.16E+03	.16E+02	1200	1	1.6E+06	5.4	.00	.00	0	1
123106	.27E+03	.18E+06	.23E+07	.25E+04	.00E+00	.44E+06	.12E+04	.24E+03	600	8	2.3E+07	.0	4.00	.00	50	2
10115	.31E+03	.00E+00	.12E+03	.79E+03	.00E+00	.32E+05	.19E+04	.49E+03	650	2	9.1E+06	.5	18.60	.00	50	3
10208	.27E+03	.18E+06	.23E+07	.25E+04	.00E+00	.44E+06	.12E+04	.24E+03	650	7	1.7E+07	.0	2.25	7.50	100	3
10411	.27E+03	.18E+06	.23E+07	.25E+04	.00E+00	.44E+06	.12E+04	.24E+03	650	7	4.5E+07	.0	2.25	7.50	95	3
10512	.31E+03	.00E+00	.12E+03	.79E+03	.00E+00	.32E+05	.19E+04	.49E+03	650	2	7.0E+06	.5	18.60	.00	50	3
10718	.41E+02	.00E+00	.16E+02	.20E+02	.00E+00	.36E+04	.16E+03	.16E+02	750	1	2.8E+06	5.4	.00	.00	10	4
10907	.00E+00	.71E+06	.91E+07	.78E+04	.00E+00	.17E+07	.00E+00	.00E+00	750	5	4.5E+07	24.6	8.00	.00	200	4
10911	.74E+03	.00E+00	.51E+02	.13E+04	.00E+00	.23E+05	.27E+04	.47E+03	750	4	2.2E+06	1.0	5.00	.00	20	4
11008	.31E+03	.00E+00	.12E+03	.79E+03	.00E+00	.32E+05	.19E+04	.49E+03	750	2	2.9E+06	1.4	18.60	.00	20	4
11021	.41E+02	.00E+00	.16E+02	.20E+02	.00E+00	.36E+04	.16E+03	.16E+02	750	1	3.1E+05	10.7	.00	.00	8	4

Solutions
1. H2O
2. HNO3
3. KMnO4/HNO3
4. 4521
5. 4502
6. Citrox
7. Tartaric/NaOH
8. 4324
9. Oxalic
10. Citric A
11. Oxalic/HNO3
12. NH4OH
13. EDTA/NaOH
14. ARR
15. HF/HNO3

&k2S

G Cell 1984 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
1	.61E+05	.23E+05	.24E+06	.96E+05	.00E+00	.18E+05	.14E+05	.94E+04	3420	1	7.7E+06	1.2	.00	.00	0	1
1	.61E+05	.23E+05	.24E+06	.96E+05	.00E+00	.18E+05	.14E+05	.94E+04	3420	1	7.7E+06	1.2	.00	.00	0	1
11203	.14E+05	.62E+05	.71E+06	.48E+04	.00E+00	.35E+05	.34E+04	.30E+04	3420	1	3.5E+06	.0	.00	.00	60	1
11305	.00E+00	.68E+05	.86E+06	.67E+07	.00E+00	.97E+05	.88E+06	.18E+06	3420	7	2.7E+08	5.3	2.25	7.50	600	1
11403	.00E+00	.57E+04	.63E+05	.21E+07	.00E+00	.42E+05	.19E+06	.19E+06	3420	2	7.9E+07	2.0	18.60	.00	120	1
11408	.32E+05	.53E+05	.66E+06	.28E+05	.00E+00	.85E+05	.17E+06	.82E+04	3420	5	8.7E+07	2.4	10.00	.00	200	1
11507	.17E+05	.66E+05	.81E+06	.14E+06	.00E+00	.57E+05	.14E+05	.77E+04	3420	4	1.1E+08	9.1	10.00	.00	75	1
11603	.00E+00	.00E+00	.00E+00	.93E+06	.00E+00	.27E+05	.80E+05	.13E+06	3420	2	3.1E+07	4.1	38.20	.00	80	1
11607	.14E+05	.50E+04	.57E+05	.31E+06	.00E+00	.22E+05	.25E+05	.32E+05	3420	1	2.1E+07	.8	.00	.00	60	1
11504	.37E+04	.13E+05	.16E+06	.11E+06	.00E+00	.14E+05	.12E+06	.22E+05	2600	7	2.7E+07	1.5	2.25	7.50	300	2
11703	.00E+00	.00E+00	.00E+00	.57E+06	.00E+00	.10E+05	.12E+05	.27E+05	2600	2	1.5E+07	11.3	38.20	.00	50	2
11711	.00E+00	.16E+03	.85E+03	.10E+05	.00E+00	.10E+05	.20E+05	.64E+03	2600	5	4.9E+06	38.6	10.00	.00	30	2
11725	.40E+06	.51E+05	.33E+06	.13E+05	.00E+00	.37E+05	.37E+05	.82E+04	2600	1	9.9E+06	1.2	.00	.00	60	2
11807	.00E+00	.25E+05	.31E+06	.25E+06	.00E+00	.16E+05	.15E+05	.12E+05	2600	6	4.3E+07	5.0	3.80	2.70	20	2
11903	.00E+00	.00E+00	.00E+00	.44E+06	.00E+00	.70E+04	.14E+05	.36E+05	2600	2	1.7E+07	1.8	38.20	.00	25	2
11911	.00E+00	.29E+03	.32E+04	.18E+06	.00E+00	.39E+04	.66E+04	.91E+04	2600	1	5.0E+06	.8	.00	.00	20	2
12003	.00E+00	.24E+05	.24E+06	.26E+07	.00E+00	.48E+05	.19E+06	.11E+06	1200	7	1.0E+08	8.0	2.25	7.50	400	3
12007	.14E+05	.11E+05	.10E+06	.14E+07	.00E+00	.43E+05	.12E+06	.12E+06	1200	2	5.5E+08	12.9	38.20	.00	100	3
12014	.12E+05	.20E+05	.25E+06	.16E+05	.00E+00	.28E+05	.13E+05	.12E+05	1200	3	4.8E+07	2.8	.78	12.80	25	3
12016	.33E+04	.88E+04	.11E+06	.38E+04	.00E+00	.91E+04	.28E+04	.72E+03	1200	1	1.7E+07	.3	.00	.00	25	3
12104	.00E+00	.00E+00	.00E+00	.85E+06	.00E+00	.62E+04	.24E+05	.42E+05	1200	4	2.1E+07	4.3	10.00	.00	70	3
12109	.38E+04	.26E+03	.69E+03	.42E+06	.00E+00	.16E+05	.29E+05	.18E+05	1200	2	1.2E+07	2.8	38.20	.00	75	3
12114	.00E+00	.61E+02	.22E+03	.19E+06	.00E+00	.64E+04	.16E+05	.12E+05	1200	1	5.6E+06	2.4	.00	.00	25	3
12507	.30E+04	.15E+03	.63E+03	.35E+06	.00E+00	.39E+05	.43E+05	.10E+06	2200	5	2.1E+07	.7	8.00	.00	50	4
1	.61E+05	.23E+05	.24E+06	.96E+05	.00E+00	.18E+05	.14E+05	.94E+04	2200	1	7.7E+06	1.2	.00	.00	0	4
1	.20E+05	.18E+05	.21E+06	.66E+06	.00E+00	.27E+05	.85E+05	.40E+05	2200	9	4.5E+07	6.6	10.00	.00	0	4
12614	.15E+04	.22E+04	.24E+05	.72E+06	.00E+00	.22E+05	.57E+05	.68E+05	2200	2	4.4E+06	15.1	38.20	.00	20	4
12620	.22E+05	.56E+02	.25E+03	.64E+05	.00E+00	.66E+04	.11E+05	.49E+04	2200	1	5.3E+06	1.1	.00	.00	30	4
12703	.20E+04	.00E+00	.18E+03	.45E+05	.00E+00	.82E+04	.17E+05	.21E+04	2200	7	2.6E+06	15.1	2.25	7.50	25	4
12706	.25E+04	.00E+00	.33E+03	.11E+06	.00E+00	.37E+05	.17E+05	.10E+05	2200	2	2.4E+06	7.4	38.20	.00	20	4
12815	.58E+05	.53E+05	.66E+06	.49E+05	.00E+00	.21E+05	.15E+05	.50E+04	2200	1	1.4E+06	4.8	.00	.00	20	4
12904	.00E+00	.81E+04	.10E+06	.13E+07	.00E+00	.43E+05	.20E+06	.64E+05	2600	7	5.5E+07	7.0	2.25	5.70	110	5
12908	.00E+00	.19E+03	.00E+00	.77E+05	.00E+00	.14E+05	.14E+05	.18E+05	2600	2	4.6E+06	3.5	38.20	.00	35	5
13005	.90E+03	.55E+04	.72E+05	.00E+00	.00E+00	.57E+04	.58E+04	.00E+00	2600	5	1.2E+07	42.8	8.00	.00	35	5
11313	.63E+03	.00E+00	.76E+02	.62E+05	.00E+00	.26E+04	.23E+04	.21E+04	2600	6	2.1E+06	.6	3.80	2.70	5	5
13120	.24E+04	.55E+04	.74E+05	.26E+04	.00E+00	.35E+04	.50E+03	.41E+03	2600	2	9.0E+06	3.4	38.20	.00	50	5
20104	.00E+00	00E+00	.00E+00	.68E+03	.00E+00	.25E+03	.11E+03	.64E+02	2600	1	9.4E+04	.5	.00	.00	10	5

Solutions

1. H2O
2. HNO3
3. KMnO4/HNO3
4. 4521
5. 4502
6. Citrox
7. Tartaric/NaOH
8. 4324
9. Oxalic
10. Citric A
11. Oxalic/HNO3
12. NH4OH
13. EDTA/NaOH
14. ARR
15. HF/HNO3

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H Cell 1984 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
20219	.00E+00	.42E+05	.58E+06	.73E+07	.00E+00	.58E+05	.81E+05	.20E+06	200	7	2.0E+07	29.5	2.25	7.50	450	1
20303	.47E+05	.57E+04	.53E+05	.33E+07	.00E+00	.35E+05	.43E+05	.29E+07	120	2	2.8E+08	9.1	18.60	.00	1000	1
20308	.00E+00	.82E+04	.11E+06	.33E+05	.00E+00	.97E+04	.00E+00	.14E+06	120	1	2.4E+07	1.8	.00	.00	180	1
20313	.00E+00	.13E+04	.18E+05	.10E+05	.27E+03	.55E+05	.93E+04	.26E+05	120	5	1.1E+07	13.9	8.00	.00	90	1
20404	.00E+00	.46E+03	.49E+04	.97E+05	.00E+00	.81E+04	.14E+04	.81E+05	120	4	1.1E+07	3.3	5.00	.00	30	1
20413	.00E+00	.00E+00	.30E+05	.48E+06	.00E+00	.13E+05	.00E+00	.22E+06	120	2	8.5E+07	5.1	18.60	.00	130	1
20504	.21E+04	.28E+04	.36E+05	.81E+05	.00E+00	.75E+04	.12E+04	.39E+05	120	1	1.6E+07	2.6	.00	.00	15	1
20908	.00E+00	.00E+00	.00E+00	.39E+06	.00E+00	.49E+05	.97E+05	.70E+05	2550	1	2.3E+07	1.3	.00	.00	80	2
21005	.00E+00	.79E+03	.72E+04	.63E+06	.00E+00	.12E+06	.69E+05	.17E+06	2550	7	4.0E+07	5.6	2.25	7.50	125	2
21207	.35E+03	.27E+02	.19E+02	.54E+05	.00E+00	.18E+05	.87E+04	.18E+05	2550	7	5.3E+06	.0	2.25	7.50	30	2
21307	.00E+00	.00E+00	.00E+00	.93E+05	.00E+00	.10E+06	.73E+04	.54E+05	2550	2	2.2E+07	2.1	38.20	.00	50	2
21406	.63E+03	.31E+03	.40E+04	.85E+04	.00E+00	.14E+05	.11E+04	.80E+04	2550	1	5.2E+06	1.5	.00	.00	28	2
21520	.23E+03	.45E+02	.20E+03	.82E+04	.00E+00	.27E+04	.17E+04	.29E+04	2550	5	1.7E+06	9.5	8.00	.00	15	2
21608	.00E+00	.15E+02	.67E+02	.00E+00	.00E+00	.27E+03	.21E+03	.00E+00	2550	1	3.5E+04	3.7	.00	.00	5	2
21720	.10E+04	.00E+00	.94E+03	.30E+05	.00E+00	.10E+05	.15E+04	.61E+04	2550	6	2.7E+06	3.4	3.80	2.70	20	2
21910	.11E+04	.27E+03	.28E+04	.12E+05	.00E+00	.21E+04	.51E+03	.00E+00	2550	2	1.1E+06	1.3	38.20	.00	10	2
22106	.20E+02	.60E+01	.29E+02	.13E+02	.00E+00	.60E+03	.52E+02	.70E+02	2550	3	2.8E+05	4.0	.78	12.80	20	2
22228	.14E+04	.60E+03	.65E+04	.21E+04	.00E+00	.95E+03	.19E+03	.48E+03	2550	4	1.3E+06	7.3	8.00	.00	1	2
22320	.00E+00	.00E+00	.17E+02	.25E+04	.50E+01	.12E+04	.12E+03	.12E+04	2550	2	3.8E+05	1.4	38.20	.00	2	2
22406	.18E+02	.00E+00	.70E+01	.79E+03	.00E+00	.48E+03	.63E+02	.22E+03	2550	1	1.4E+05	1.0	.00	.00	2	2

Solutions

1. H2O
2. HNO3
3. KMnO4/HNO3
4. 4521
5. 4502
6. Citrox
7. Tartaric/NaOH
8. 4324
9. Oxalic
10. Citric A
11. Oxalic/HNO3
12. NH4OH
13. EDTA/NaOH
14. ARR
15. HF/HNO3

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E Cell 1984 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
41510	.32E+03	.52E+03	.41E+04	.24E+05	.00E+00	.11E+05	.51E+05	.11E+04	1600	5	8.8E+06	.0	6.00	.00	20	1
41521	.36E+04	.15E+03	.11E+04	.83E+05	.00E+00	.33E+04	.95E+04	.24E+04	1600	4	5.7E+06	.0	8.00	.00	30	1
41606	.32E+03	.12E+03	.14E+04	.12E+05	.00E+00	.32E+03	.23E+04	.22E+03	1600	7	8.8E+06	.0	2.25	7.50	150	1
41610	.32E+04	.70E+02	.54E+03	.93E+04	.00E+00	.13E+04	.38E+04	.14E+04	1600	10	3.5E+06	.0	9.30	.00	10	1
41705	.58E+04	.20E+05	.18E+06	.61E+04	.00E+00	.10E+05	.10E+05	.49E+03	1600	5	2.0E+07	.0	6.00	.00	75	1
41713	.54E+04	.20E+03	.16E+04	.13E+05	.00E+00	.15E+04	.57E+04	.86E+03	1600	4	4.1E+06	.0	8.00	.00	20	1
41806	.72E+03	.11E+04	.15E+05	.80E+05	.00E+00	.19E+04	.22E+05	.16E+04	1600	7	4.9E+06	.0	2.25	7.50	150	1
42004	.47E+03	.11E+03	.66E+03	.22E+05	.00E+00	.94E+04	.95E+04	.87E+03	700	7	3.0E+06	.0	2.25	7.50	20	2
42012	.24E+03	.20E+02	.39E+03	.20E+04	.00E+00	.56E+04	.10E+04	.12E+03	700	10	6.1E+05	.0	9.30	.00	8	2
42027	.51E+03	.52E+03	.68E+04	.42E+05	.00E+00	.26E+04	.12E+05	.90E+03	700	7	6.7E+05	.0	2.25	7.50	5	2
42105	.34E+04	.12E+04	.45E+04	.29E+04	.00E+00	.11E+05	.32E+04	.25E+03	700	10	1.5E+05	.0	9.30	.00	50	2
42107	.37E+02	.90E+01	.12E+03	.93E+03	.00E+00	.11E+04	.34E+03	.40E+02	700	1	2.1E+05	.0	.00	.00	5	2

Solutions

1. H2O
2. HNO3
3. KMnO4/HNO3
4. 4521
5. 4502
6. Citrox
7. Tartaric/NaOH
8. 4324
9. Oxalic
10. Citric A
11. Oxalic/HNO3
12. NH4OH
13. EDTA/NaOH
14. ARR
15. HF/HNO3

Appendix E

1984 Rover Decontamination Data

Appendix E

1984 Rover Decontamination Data

The data in this appendix is arranged in two parts. The first part is a long analysis of the data. It consists of 21 tables, each of which look at the information collected by sampling in a unique way. These tables provide many different ways of looking at the data. It is hoped that considerable time will be spent reviewing these tables by those who want more detail concerning the many aspects of decontamination. Many of the figures and tables used in the body of the report came from this section. However, these tables provide in-depth analysis and allow the researcher to identify trends or effects that were not discussed in the report.

The second part of this appendix contains the raw data. This is the unmodified, unmanipulated sample results. In this section, the averages have been included and can be identified by a log number of 1. Actual log numbers are given so that a researcher can obtain original sample results or in some way verify any questions that may arise. The sample results for the isotopes are recorded as dps/mL. Beta results are a gross beta count and are in dpm/mL.

Solutions were tracked and the quantities of chemicals used were recorded. A weight percent was used to calculate chemical quantities. To simplify the tracking of chemical quantities, the weight percent was calculated assuming that a liter of solution weighted one kg. Thus, if 300 grams of chemical A were taken and water was added up to make one liter then this solution would be 30 wt% chemical A. The calculation simply becomes:

$$(300\ g/1000\ mL)(1\ mL/1\ g)(100) = 30\ wt\%$$

This ignores the actual density of the solution. However, the error introduced by this simplifying approach was decided to be acceptable due to other errors, such as measuring quantities of bulk chemicals used and in the volume measurements of the liquids. This seems to be acceptable because large errors were created by inaccuracies in weighing large quantities of bulk chemicals and in errors in measuring volumes of large tanks.

The tables contained in this appendix are based on averaged data from the 1984 decontamination of First Cycle following Rover campaign #39. Below is a summary of the data tables. The raw data is listed below under "data."

1984 Rover Decontamination Data

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ESTIMATED VALUES BASED ON AVERAGES

DECON INFORMATION ON 1984 Decon

TABLE 1

Individual Isotope Information

	Ci	mg	R/hr
Zr 95	0	0	0
Nb 95	0	0	0
Ru103	0	0	0
Ru106	1	0	0
Sb125	4	4	3
Cs134	0	0	0
Cs137	4	46	14
Ce144	0	0	0
Total	9	50	17
Beta	6		

TABLE 2

X/L Isotope Information

	mCi/L	ug/L	mR/hr*L
Zr 95	.0	.0	.0
Nb 95	.0	.0	.0
Ru103	.0	.0	.0
Ru106	.0	.0	.0
Sb125	.1	.1	.1
Cs134	.0	.0	.0
Cs137	.1	1.4	.4
Ce144	.0	.0	.0
Total	.3	1.6	.5
Beta	.2	Beta/min/ml= 4.5E+05	

TABLE 3

% Isotope Information

	Ci	mg	R/hr
Zr 95	.1	.0	.1
Nb 95	.3	.0	.8
Ru103	.0	.0	.0
Ru106	6.9	.4	2.0
Sb125	45.6	7.4	17.6
Cs134	.1	.0	.1
Cs137	46.8	92.2	79.4
Ce144	.3	.0	.0

TABLE 4

Solution Information - mCi/L

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.00	.00	.13	.00	.00	.01	.08	.00	.21	HNO3	10220
	.00	.00	.16	.00	.00	.02	.03	.00	.21	KMnO4/HNO3	4375
	.00	.00	.18	.00	.00	.03	.20	.00	.41	4521	6420
	.00	.00	.08	.00	.00	.04	.23	.00	.35	4502	6420
	.00	.00	.01	.00	.00	.00	.11	.00	.13	CITROX	1902
	.00	.00	.11	.00	.00	.00	.03	.00	.14	Oxalic	2600
Tot	.00	.00	.13	.00	.00	.02	.12	.00	.27		31937

TABLE 5

Solution Information - ug/L

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.00	.00	1.51	.00	.00	.00	.07	.00	1.58	HNO3	10220
	.00	.00	1.82	.00	.00	.00	.03	.00	1.86	KMnO4/HNO3	4375
	.00	.00	2.06	.00	.00	.01	.19	.00	2.25	4521	6420
	.00	.00	.93	.00	.00	.01	.22	.00	1.16	4502	6420
	.00	.00	.11	.00	.00	.00	.11	.00	.22	CITROX	1902
	.00	.00	1.30	.00	.00	.00	.02	.00	1.33	Oxalic	2600
Tot	.00	.00	1.45	.00	.00	.01	.12	.00	1.57		31937

TABLE 6

Solution Information - mR/hr*L

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.00	.00	.44	.01	.00	.00	.06	.00	.51	HNO3	10220
	.00	.00	.54	.01	.00	.01	.02	.00	.58	KMnO4/HNO3	4375
	.00	.00	.60	.01	.00	.02	.15	.00	.78	4521	6420
	.00	.00	.27	.00	.00	.02	.18	.00	.47	4502	6420
	.00	.00	.03	.00	.00	.00	.09	.00	.12	CITROX	1902
	.00	.00	.38	.00	.00	.00	.02	.00	.41	Oxalic	2600
Tot	.00	.00	.43	.00	.00	.01	.09	.00	.54		31937

TABLE 7

Solution Information - curies

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
0	0	1	0	0	0	1	0	2	HNO3	10220
0	0	1	0	0	0	0	0	1	KMnO4/HNO3	4375
0	0	1	0	0	0	1	0	3	4521	6420
0	0	1	0	0	0	1	0	2	4502	6420
0	0	0	0	0	0	0	0	0	CITROX	1902
0	0	0	0	0	0	0	0	0	Oxalic	2600

TABLE 8

Solution Information - mg

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
0	0	15	0	0	0	1	0	16	HNO3	10220
0	0	8	0	0	0	0	0	8	KMnO4/HNO3	4375
0	0	13	0	0	0	1	0	14	4521	6420
0	0	6	0	0	0	1	0	7	4502	6420
0	0	0	0	0	0	0	0	0	CITROX	1902
0	0	3	0	0	0	0	0	3	Oxalic	2600

TABLE 9

Solution Information - R/hr

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol

0	0	5	0	0	0	1	0	5	HNO3	10220
0	0	2	0	0	0	0	0	3	KMnO4/HNO3	4375
0	0	4	0	0	0	1	0	5	4521	6420
0	0	2	0	0	0	1	0	3	4502	6420
0	0	0	0	0	0	0	0	0	CITROX	1902
0	0	1	0	0	0	0	0	1	Oxalic	2600

TABLE 10

% Solution Information curies % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
.1	.0	61.4	.5	.0	2.7	35.1	.2	25.4	HNO3	32.0
1.1	.1	76.3	.6	.0	7.8	13.9	.1	10.6	KMnO4/HNO3	13.7
.5	.1	43.4	.3	.0	7.7	47.9	.1	30.8	4521	20.1
.0	.0	23.3	.0	.0	10.8	65.9	.0	26.0	4502	20.1
.9	.0	8.0	.5	.0	.0	90.7	.0	2.8	CITROX	6.0
.0	.1	78.4	.7	.0	3.4	17.5	.0	4.4	Oxalic	8.1

TABLE 11

% Solution Information mg % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
.0	.0	95.4	.0	.0	.1	4.5	.0	32.3	HNO3	32.0
.0	.0	98.2	.0	.0	.3	1.5	.0	16.2	KMnO4/HNO3	13.7
.0	.0	91.2	.0	.0	.4	8.3	.0	28.9	4521	20.1
.0	.0	80.3	.0	.0	1.0	18.7	.0	14.9	4502	20.1
.2	.0	51.6	.0	.0	.0	48.2	.0	.8	CITROX	6.0
.0	.0	98.1	.0	.0	.1	1.8	.0	6.9	Oxalic	8.1

TABLE 12

% Solution Information R/hr % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
.0	.0	86.8	1.0	.0	.7	11.3	.2	30.5	HNO3	32.0
.0	.2	93.1	1.0	.0	1.7	3.9	.1	14.7	KMnO4/HNO3	13.7
.0	.2	77.1	.7	.0	2.4	19.4	.1	29.4	4521	20.1
.0	.0	57.9	.0	.0	4.7	37.4	.0	17.8	4502	20.1
.1	.0	27.2	2.2	.0	.0	70.5	.0	1.4	CITROX	6.0

.0	.1	93.4	1.1	.0	.7	4.8	.0	6.2	Oxalic	8.1

TABLE 13

% Solution Info. curies,mg,R/hr % down columns

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Soln	Total Vol
8.7	14.0	33.4	40.0	.0	10.0	19.6	47.4	HNO3	32.0
36.0	22.6	17.3	20.0	.0	12.1	3.2	18.6	KMnO4/HNO3	13.7
48.0	59.3	28.6	26.7	.0	34.6	32.4	34.1	4521	20.1
.0	.0	13.0	.0	.0	41.1	37.6	.0	4502	20.1
7.4	.0	.5	4.0	.0	.0	5.5	.0	CITROX	6.0
.0	4.0	7.3	9.2	.0	2.1	1.7	.0	Oxalic	8.1

TABLE 14

% Solution Info. curies/tot curies

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.0	.0	15.6	.1	.0	.7	8.9	.0	25.4	HNO3	32.0
	.1	.0	8.1	.1	.0	.8	1.5	.0	10.6	KMnO4/HNO3	13.7
	.2	.0	13.4	.1	.0	2.4	14.8	.0	30.8	4521	20.1
	.0	.0	6.1	.0	.0	2.8	17.1	.0	26.0	4502	20.1
	.0	.0	.2	.0	.0	.0	2.5	.0	2.8	CITROX	6.0
	.0	.0	3.4	.0	.0	.1	.8	.0	4.4	Oxalic	8.1
Tot	.3	.1	46.8	.3	.0	6.9	45.6	.1			

TABLE 15

% Solution Info. mg/tot mg

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.0	.0	30.8	.0	.0	.0	1.4	.0	32.3	HNO3	32.0
	.0	.0	15.9	.0	.0	.0	.2	.0	16.2	KMnO4/HNO3	13.7
	.0	.0	26.4	.0	.0	.1	2.4	.0	28.9	4521	20.1
	.0	.0	12.0	.0	.0	.1	2.8	.0	14.9	4502	20.1
	.0	.0	.4	.0	.0	.0	.4	.0	.8	CITROX	6.0
	.0	.0	6.8	.0	.0	.0	.1	.0	6.9	Oxalic	8.1
Tot	.0	.0	92.2	.0	.0	.4	7.4	.0			

TABLE 16

% Solution Info. R/hr/tot R

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.0	.0	26.5	.3	.0	.2	3.5	.0	30.5	HNO3	32.0
	.0	.0	13.7	.2	.0	.2	.6	.0	14.7	KMnO4/HNO3	13.7
	.0	.1	22.7	.2	.0	.7	5.7	.0	29.4	4521	20.1
	.0	.0	10.3	.0	.0	.8	6.6	.0	17.8	4502	20.1
	.0	.0	.4	.0	.0	.0	1.0	.0	1.4	CITROX	6.0
	.0	.0	5.8	.1	.0	.0	.3	.0	6.2	Oxalic	8.1
Tot	.0	.1	79.4	.8	.0	2.0	17.6	.1			

TABLE 17

Solution Summary

	gamma R/hr	gamma mg	UDS g	gamma curie	beta curie	Cost $	Soln	Vol-L
	5	16	14	2	2	1093	HNO3	10220
	3	8	9	1	0	370	KMnO4/HNO3	4375
	5	14	9	3	2	4961	4521	6420
	3	7	10	2	2	2363	4502	6420
	0	0	0	0	0	159	CITROX	1902
	1	3	4	0	0	421	Oxalic	2600
Total	17	50	46	9	6	9366		31937

TABLE 18

Solution Summary %

gamma R/hr	gamma mg	UDS g	gamma curie	beta curie	Cost $	Soln	Vol-L
30.5	32.3	29.4	25.4	32.6	11.7	HNO3	32.0
14.7	16.2	19.8	10.6	7.2	3.9	KMnO4/HNO3	13.7
29.4	28.9	20.4	30.8	31.2	53.0	4521	20.1
17.8	14.9	21.4	26.0	24.5	25.2	4502	20.1
1.4	.8	.0	2.8	3.3	1.7	CITROX	6.0
6.2	6.9	9.0	4.4	1.1	4.5	Oxalic	8.1

TABLE 19

Solution Summary x/L

gamma mR/hr*L	gamma ug/L	UDS g/L	gamma mcurie/L	beta mcurie/L	B/L	Cost $/L	Soln	Tot Vol-L
.5	1.6	1.3	.2	.21	.2	.11	HNO3	10220
.6	1.9	2.1	.2	.11	.1	.08	KMnO4/HNO3	4375
.8	2.3	1.5	.4	.31	.3	.77	4521	6420
.5	1.2	1.5	.3	.25	.2	.37	4502	6420
.1	.2	.0	.1	.11	.1	.08	CITROX	1902
.4	1.3	1.6	.1	.03	.0	.16	Oxalic	2600
.5	1.6	1.4	.3	.20		.29		31937

TABLE 20

Cost Summary x/$

	gamma mR/hr/$	gamma ug/$	UDS g/$	gamma mcurie/$	beta mcurie/$	cost $	Soln	Tot Vol-L
	5	15	12	2	2	1093	HNO3	10220
	7	22	25	2	1	370	KMnO4/HNO3	4375
	1	3	2	1	0	4961	4521	6420
	1	3	4	1	1	2363	4502	6420
	1	3	0	2	1	159	CITROX	1902
	3	8	10	1	0	421	Oxalic	2600
Total	2	5	5	1	1	1.00		3.41

TABLE 21

Waste Analysis

Volume of Waste	31937 L	8438 gal
Wt of chemicals w/o HNO3	1395 Kg	3070 lbs
Moles of Na+ ; Molarity	174 moles	.01 M
Moles of K+ ; Molarity	7871 moles	.25 M
Moles Na+ plus K+ ; Molarity	8045 moles	.25 M
Chemical cost 1982 $	9366 $	

Chemical Analysis (Kg)

	KMnO4	Citric	Oxalic	NH Oxal	Tart A	K+	Na+	Kg	L	# of Flushes
HNO3								3904	10220	4
KMnO4/HNO3	29					7		515	4375	2
4521		26	77	410				514	6420	2
4502	103					301	4	514	6420	2
Citrox		46	32					78	1902	1
Oxalic A			260					260	2600	1
Totals	131	72	369	410	0	308	4	1395	31937	12

Approx. pH	-.3
Number of flushes	12
Samples taken	12

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1984 Decon FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
70507	.00E+00	.00E+00	.24E+04	.00E+00	.00E+00	.20E+04	.14E+05	.00E+00	3820	5	7.3E+05	1.7	8.00	.00	5	1
70638	.13E+03	.30E+02	.72E+04	.51E+02	.00E+00	.15E+04	.12E+05	.23E+02	3820	4	1.0E+06	1.1	8.00	.00	8	1
70734	.00E+00	.71E+01	.52E+04	.70E+02	.00E+00	.60E+02	.64E+04	.32E+02	3820	2	8.8E+05	1.6	38.20	.00	2	1
70838	.00E+00	.00E+00	.39E+04	.00E+00	.00E+00	.52E+03	.44E+03	.00E+00	2600	5	2.8E+05	1.3	8.00	.00	4	4
70926	.00E+00	.00E+00	.58E+04	.32E+02	.00E+00	.71E+03	.46E+03	.00E+00	2600	4	2.5E+05	2.0	8.00	.00	5	4
71001	.00E+00	.00E+00	.31E+04	.12E+02	.00E+00	.58E+03	.25E+03	.00E+00	2600	2	2.5E+05	2.0	38.20	.00	1	4
71033	.16E+03	.18E+02	.22E+04	.16E+02	.00E+00	.13E+04	.20E+04	.27E+02	1775	3	5.8E+05	.9	.53	8.65	20	6
71118	.40E+02	.00E+00	.37E+03	.22E+02	.00E+00	.00E+00	.42E+04	.00E+00	1902	6	2.5E+05	.0	2.42	1.70	2	6
71210	.75E+02	.00E+00	.21E+04	.96E+01	.00E+00	.26E+03	.24E+04	.00E+00	1200	2	2.3E+05	.6	38.20	.00	3	6
71313	.34E+02	.45E+01	.84E+04	.69E+02	.00E+00	.13E+03	.44E+03	.00E+00	2600	3	3.3E+03	2.9	.78	12.80	5	5
71406	.00E+00	.30E+01	.42E+04	.37E+02	.00E+00	.18E+03	.94E+03	.00E+00	2600	9	6.2E+04	1.6	10.00	.00	2	5
71413	.00E+00	.00E+00	.74E+04	.41E+02	.00E+00	.57E+02	.17E+03	.00E+00	2600	2	1.5E+05	.6	38.20	.00	5	5

Solutions

1. H2O
2. HNO3
3. KMnO4/HNO3
4. 4521
5. 4502
6. Citrox
7. Tartaric/NaOH
8. 4324
9. Oxalic
10. Citric A
11. Oxalic/HNO3
12. NH4OH
13. EDTA/NaOH
14. ARR
15. HF/HNO3

Appendix F

1986 Aluminum Decontamination Data

Appendix F

1986 Aluminum Decontamination Data

The data in this appendix is arranged in two parts. The first part is a long analysis of the data. It consists of 21 tables, each of which look at the information collected by sampling in a unique way. These tables provide many different ways of looking at the data. It is hoped that considerable time will be spent reviewing these tables by those who want more detail concerning the many aspects of decontamination. Many of the figures and tables used in the body of the report came from this section. However, these tables provide in-depth analysis and allow the researcher to identify trends or effects that were not discussed in the report.

The second part of this appendix contains the raw data. This is the unmodified, unmanipulated sample results. In this section, the averages have been included and can be identified by a log number of 1. Actual log numbers are given so that a researcher can obtain original sample results or in some way verify any questions that may arise. The sample results for the isotopes are recorded as dps/mL. Beta results are a gross beta count and are in dpm/mL.

Solutions were tracked and the quantities of chemicals used were recorded. A weight percent was used to calculate chemical quantities. To simplify the tracking of chemical quantities, the weight percent was calculated assuming a liter of solution weighted one kg. Thus, if 300 grams of chemical A were taken and water was added to make one liter then this solution would be 30 wt% chemical A. The calculation simply becomes:

$$(300\ g/1000\ mL)(1\ mL/1\ g)(100) = 30\ wt\%$$

This ignores the actual density of the solution. However, the error introduced by this simplifying approach was decided to be acceptable due to other errors, such as measuring quantities of bulk chemicals used and in the volume measurements of the liquids. This seems to be acceptable because large errors were created by inaccuracies in weighing large quantities of bulk chemicals and in errors in measuring volumes of large tanks.

The tables contained in this appendix are based on averaged data from the 1986 decontamination of First Cycle following Aluminum campaign #40. Below is a summary of the data tables. The raw data is listed below under "data" and is given in the same sequence as the decontamination occurred.

1986 Aluminum Decontamination Data

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ESTIMATED VALUES BASED ON AVERAGES

DECON INFORMATION ON 1986 Decon

TABLE 1

Individual Isotope Information

	Ci	mg	R/hr
Zr 95	17	1	41
Nb 95	272	7	1248
Ru103	0	0	0
Ru106	88	26	52
Sb125	431	407	332
Cs134	28	21	98
Cs137	219	2515	740
Ce144	8	3	1
Total	1063	2979	2511
Beta	1092		

TABLE 2

X/L Isotope Information

	mCi/L	ug/L	mR/hr*L
Zr 95	.1	.0	.2
Nb 95	1.2	.0	5.6
Ru103	.0	.0	.0
Ru106	.4	.1	.2
Sb125	2.0	1.8	1.5
Cs134	.1	.1	.4
Cs137	1.0	11.4	3.3
Ce144	.0	.0	.0
Total	4.8	13.5	11.4
Beta	4.9	Beta/min/ml= 1.1E+07	

TABLE 3

% Isotope Information

	Ci	mg	R/hr
Zr 95	1.6	.0	1.6
Nb 95	25.6	.2	49.7
Ru103	.0	.0	.0
Ru106	8.3	.9	2.1
Sb125	40.5	13.7	13.2
Cs134	2.6	.7	3.9
Cs137	20.6	84.4	29.5
Ce144	.8	.1	.0

TABLE 4

Solution Information - mCi/L

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.05	.16	1.23	.70	.00	.26	1.35	.04	3.80	H2O	54447
	.01	.10	.83	.40	.00	.29	.81	.03	2.48	HNO3	65658
	.01	.05	.38	.12	.00	.08	.19	.01	.84	KMnO4/HNO3	11416
	.01	.11	.91	.25	.00	.20	1.06	.03	2.57	4521	2251
	.00	.05	.37	.57	.00	.47	2.43	.04	3.94	4502	20824
	.34	.25	1.91	5.84	.00	.65	7.65	.18	16.82	Tartaric/NaOH	2720
	.01	.03	.21	2.04	.00	.41	1.64	.12	4.45	Oxalic	15431
	.15	.31	2.29	7.17	.00	1.57	7.79	.45	19.72	Oxalic/HNO3	16228
	.00	.06	.49	1.19	.00	.95	2.97	.11	5.77	NH4OH	2900
	.02	.11	.83	.23	.00	.07	1.07	.01	2.35	EDTA/NaOH	18757
	.02	.23	2.00	2.16	.00	.62	4.61	.10	9.74	ARR	10394
Tot	.04	.13	.99	1.23	.00	.40	1.95	.08	4.81		221026

TABLE 5

Solution Information - ug/L

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
.02	.12	14.16	.02	.00	.08	1.27	.00	15.67	H2O	54447
.00	.08	9.56	.01	.00	.08	.77	.00	10.50	HNO3	65658
.00	.04	4.36	.00	.00	.02	.18	.00	4.60	KMnO4/HNO3	11416
.00	.08	10.47	.01	.00	.06	1.00	.00	11.63	4521	2251
.00	.04	4.24	.01	.00	.14	2.29	.00	6.73	4502	20824
.11	.19	21.88	.15	.00	.19	7.22	.01	29.74	Tartaric/NaOH	2720
.00	.02	2.36	.05	.00	.12	1.55	.01	4.11	Oxalic	15431
.05	.24	26.22	.18	.00	.46	7.35	.02	34.52	Oxalic/HNO3	16228
.00	.05	5.58	.03	.00	.28	2.81	.01	8.75	NH4OH	2900
.01	.08	9.53	.01	.00	.02	1.01	.00	10.66	EDTA/NaOH	18757

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.01	.18	22.92	.05	.00	.18	4.35	.00	27.70	ARR	10394
Tot	.01	.10	11.38	.03	.00	.12	1.84	.00	13.48		221026

TABLE 6

Solution Information - mR/hr*L

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.00	.56	4.16	3.21	.00	.15	1.04	.10	9.23	H2O	54447
	.00	.36	2.81	1.82	.00	.17	.62	.08	5.87	HNO3	65658
	.00	.17	1.28	.57	.00	.05	.14	.02	2.24	KMnO4/HNO3	11416
	.00	.38	3.08	1.13	.00	.12	.82	.07	5.60	4521	2251
	.00	.17	1.25	2.63	.00	.27	1.87	.11	6.30	4502	20824
	.03	.87	6.44	26.81	.00	.38	5.89	.44	40.86	Tartaric/NaOH	2720
	.00	.10	.69	9.36	.00	.24	1.27	.29	11.95	Oxalic	15431
	.01	1.09	7.71	32.89	.00	.92	5.99	1.11	49.72	Oxalic/HNO3	16228
	.00	.23	1.64	5.46	.00	.55	2.29	.27	10.44	NH4OH	2900
	.00	.37	2.80	1.06	.00	.04	.83	.03	5.14	EDTA/NaOH	18757
	.00	.82	6.74	9.90	.00	.36	3.55	.25	21.63	ARR	10394
Tot	.00	.44	3.35	5.65	.00	.23	1.50	.19	11.36		221026

TABLE 7

Solution Information - curies

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
3	9	67	38	0	14	74	2	207	H2O	54447
1	7	55	26	0	19	53	2	163	HNO3	65658
0	1	4	1	0	1	2	0	10	KMnO4/HNO3	11416
0	0	2	1	0	0	2	0	6	4521	2251
0	1	8	12	0	10	51	1	82	4502	20824
1	1	5	16	0	2	21	0	46	Tartaric/NaOH	2720
0	0	3	31	0	6	25	2	69	Oxalic	15431
2	5	37	116	0	25	126	7	320	Oxalic/HNO3	16228
0	0	1	3	0	3	9	0	17	NH4OH	2900
0	2	16	4	0	1	20	0	44	EDTA/NaOH	18757
0	2	21	22	0	6	48	1	101	ARR	10394

TABLE 8

Solution Information - mg

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
1	7	771	1	0	4	69	0	853	H2O	54447
0	5	628	1	0	6	50	0	690	HNO3	65658
0	0	50	0	0	0	2	0	53	KMnO4/HNO3	11416
0	0	24	0	0	0	2	0	26	4521	2251
0	1	88	0	0	3	48	0	140	4502	20824
0	1	60	0	0	1	20	0	81	Tartaric/NaOH	2720
0	0	36	1	0	2	24	0	63	Oxalic	15431
1	4	425	3	0	8	119	0	560	Oxalic/HNO3	16228
0	0	16	0	0	1	8	0	25	NH4OH	2900
0	2	179	0	0	0	19	0	200	EDTA/NaOH	18757
0	2	238	1	0	2	45	0	288	ARR	10394

TABLE 9

Solution Information - R/hr

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
0	30	227	175	0	8	57	6	502	H2O	54447
0	24	185	120	0	11	41	5	386	HNO3	65658
0	2	15	7	0	1	2	0	26	KMnO4/HNO3	11416
0	1	7	3	0	0	2	0	13	4521	2251
0	4	26	55	0	6	39	2	131	4502	20824
0	2	18	73	0	1	16	1	111	Tartaric/NaOH	2720
0	2	11	144	0	4	20	4	184	Oxalic	15431
0	18	125	534	0	15	97	18	807	Oxalic/HNO3	16228
0	1	5	16	0	2	7	1	30	NH4OH	2900
0	7	53	20	0	1	16	1	96	EDTA/NaOH	18757
0	9	70	103	0	4	37	3	225	ARR	10394

TABLE 10

% Solution Information curies % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
1.4	4.1	32.5	18.4	.0	7.0	35.6	1.1	19.5	H2O	24.6
.6	4.1	33.6	16.0	.0	11.6	32.7	1.4	15.3	HNO3	29.7
.7	5.9	45.5	14.9	.0	9.8	22.3	.9	.9	KMnO4/HNO3	5.2
.3	4.1	35.6	9.6	.0	7.8	41.4	1.2	.5	4521	1.0
.1	1.2	9.4	14.6	.0	11.8	61.8	1.1	7.7	4502	9.4
2.0	1.5	11.3	34.7	.0	3.9	45.5	1.1	4.3	Tartaric/NaOH	1.2
.2	.6	4.6	45.8	.0	9.2	36.9	2.6	6.5	Oxalic	7.0
.8	1.6	11.6	36.4	.0	8.0	39.5	2.3	30.1	Oxalic/HNO3	7.3
.0	1.1	8.4	20.6	.0	16.4	51.5	1.9	1.6	NH4OH	1.3
1.0	4.5	35.3	9.8	.0	3.1	45.7	.5	4.1	EDTA/NaOH	8.5
.2	2.4	20.5	22.2	.0	6.4	47.3	1.0	9.5	ARR	4.7

TABLE 11

% Solution Information mg % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
.1	.8	90.4	.1	.0	.5	8.1	.0	28.6	H2O	24.6
.0	.7	91.0	.1	.0	.8	7.3	.0	23.1	HNO3	29.7
.0	.8	94.7	.1	.0	.5	3.8	.0	1.8	KMnO4/HNO3	5.2
.0	.7	90.1	.1	.0	.5	8.6	.0	.9	4521	1.0
.0	.6	63.0	.2	.0	2.1	34.1	.0	4.7	4502	9.4
.4	.6	73.6	.5	.0	.6	24.3	.0	2.7	Tartaric/NaOH	1.2
.1	.5	57.3	1.3	.0	3.0	37.7	.1	2.1	Oxalic	7.0
.1	.7	76.0	.5	.0	1.3	21.3	.1	18.8	Oxalic/HNO3	7.3
.0	.6	63.8	.3	.0	3.2	32.1	.1	.9	NH4OH	1.3
.1	.8	89.4	.1	.0	.2	9.5	.0	6.7	EDTA/NaOH	8.5
.0	.6	82.8	.2	.0	.7	15.7	.0	9.7	ARR	4.7

TABLE 12

% Solution Information R/hr % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
.1	6.0	45.1	34.7	.0	1.7	11.3	1.1	20.0	H2O	24.6
.0	6.1	47.9	31.1	.0	2.9	10.6	1.4	15.4	HNO3	29.7
.0	7.8	57.3	25.5	.0	2.1	6.4	.8	1.0	KMnO4/HNO3	5.2
.0	6.7	55.0	20.2	.0	2.1	14.6	1.3	.5	4521	1.0
.0	2.7	19.8	41.7	.0	4.3	29.7	1.7	5.2	4502	9.4
.1	2.1	15.7	65.6	.0	.9	14.4	1.1	4.4	Tartaric/NaOH	1.2
.0	.8	5.8	78.3	.0	2.0	10.6	2.4	7.3	Oxalic	7.0
.0	2.2	15.5	66.1	.0	1.8	12.1	2.2	32.1	Oxalic/HNO3	7.3
.0	2.2	15.7	52.2	.0	5.3	21.9	2.6	1.2	NH4OH	1.3
.0	7.3	54.6	20.6	.0	.8	16.1	.6	3.8	EDTA/NaOH	8.5
.0	3.8	31.2	45.8	.0	1.7	16.4	1.2	9.0	ARR	4.7

TABLE 13

% Solution Info. curies,mg,R/hr % down columns

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Soln	Total Vol
36.0	30.8	30.7	14.0	.0	16.3	17.1	13.4	H2O	24.6
11.4	24.1	25.0	9.6	.0	21.3	12.4	13.2	HNO3	29.7

.8	2.0	2.0	.5	.0	1.1	.5	.5		KMnO4/HNO3	5.2
.2	.9	.9	.2	.0	.5	.6	.4		4521	1.0
.8	3.7	3.5	4.4	.0	11.0	11.7	5.4		4502	9.4
11.4	2.4	2.4	5.8	.0	2.0	4.8	2.9		Tartaric/NaOH	1.2
1.7	1.5	1.4	11.6	.0	7.2	5.9	10.8		Oxalic	7.0
30.1	18.0	16.9	42.8	.0	28.8	29.3	43.7		Oxalic/HNO3	7.3
.0	.7	.6	1.3	.0	3.1	2.0	1.9		NH4OH	1.3
5.5	7.2	7.1	1.6	.0	1.6	4.7	1.4		EDTA/NaOH	8.5
2.1	8.7	9.5	8.2	.0	7.3	11.1	6.3		ARR	4.7

TABLE 14

% Solution Info. curies/tot curies

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.3	.8	6.3	3.6	.0	1.4	6.9	.2	19.5	H2O	24.6
	.1	.6	5.1	2.5	.0	1.8	5.0	.2	15.3	HNO3	29.7
	.0	.1	.4	.1	.0	.1	.2	.0	.9	KMnO4/HNO3	5.2
	.0	.0	.2	.1	.0	.0	.2	.0	.5	4521	1.0
	.0	.1	.7	1.1	.0	.9	4.8	.1	7.7	4502	9.4
	.1	.1	.5	1.5	.0	.2	2.0	.0	4.3	Tartaric/NaOH	1.2
	.0	.0	.3	3.0	.0	.6	2.4	.2	6.5	Oxalic	7.0
	.2	.5	3.5	10.9	.0	2.4	11.9	.7	30.1	Oxalic/HNO3	7.3
	.0	.0	.1	.3	.0	.3	.8	.0	1.6	NH4OH	1.3
	.0	.2	1.5	.4	.0	.1	1.9	.0	4.1	EDTA/NaOH	8.5
	.0	.2	2.0	2.1	.0	.6	4.5	.1	9.5	ARR	4.7
Tot	.8	2.6	20.6	25.6	.0	8.3	40.5	1.6			

TABLE 15

% Solution Info. mg/tot mg

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.0	.2	25.9	.0	.0	.1	2.3	.0	28.6	H2O	24.6
	.0	.2	21.1	.0	.0	.2	1.7	.0	23.1	HNO3	29.7
	.0	.0	1.7	.0	.0	.0	.1	.0	1.8	KMnO4/HNO3	5.2
	.0	.0	.8	.0	.0	.0	.1	.0	.9	4521	1.0
	.0	.0	3.0	.0	.0	.1	1.6	.0	4.7	4502	9.4
	.0	.0	2.0	.0	.0	.0	.7	.0	2.7	Tartaric/NaOH	1.2
	.0	.0	1.2	.0	.0	.1	.8	.0	2.1	Oxalic	7.0
	.0	.1	14.3	.1	.0	.3	4.0	.0	18.8	Oxalic/HNO3	7.3
	.0	.0	.5	.0	.0	.0	.3	.0	.9	NH4OH	1.3
	.0	.1	6.0	.0	.0	.0	.6	.0	6.7	EDTA/NaOH	8.5
	.0	.1	8.0	.0	.0	.1	1.5	.0	9.7	ARR	4.7
Tot	.1	.7	84.4	.2	.0	.9	13.7	.0			

TABLE 16

% Solution Info. R/hr/tot R

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.0	1.2	9.0	7.0	.0	.3	2.3	.2	20.0	H2O	24.6
	.0	.9	7.4	4.8	.0	.4	1.6	.2	15.4	HNO3	29.7
	.0	.1	.6	.3	.0	.0	.1	.0	1.0	KMnO4/HNO3	5.2
	.0	.0	.3	.1	.0	.0	.1	.0	.5	4521	1.0
	.0	.1	1.0	2.2	.0	.2	1.6	.1	5.2	4502	9.4
	.0	.1	.7	2.9	.0	.0	.6	.0	4.4	Tartaric/NaOH	1.2
	.0	.1	.4	5.8	.0	.1	.8	.2	7.3	Oxalic	7.0
	.0	.7	5.0	21.3	.0	.6	3.9	.7	32.1	Oxalic/HNO3	7.3
	.0	.0	.2	.6	.0	.1	.3	.0	1.2	NH4OH	1.3
	.0	.3	2.1	.8	.0	.0	.6	.0	3.8	EDTA/NaOH	8.5
	.0	.3	2.8	4.1	.0	.1	1.5	.1	9.0	ARR	4.7
Tot	.0	3.9	29.5	49.7	.0	2.1	13.2	1.6			

TABLE 17

Solution Summary

	gamma R/hr	gamma mg	UDS g	gamma curie	beta curie	Cost $	Soln	Vol-L
	502	853	0	207	214	0	H2O	54447
	386	690	0	163	189	4019	HNO3	65658
	26	53	0	10	10	1109	KMnO4/HNO3	11416
	13	26	0	6	14	870	4521	2251
	131	140	0	82	295	4683	4502	20824
	111	81	0	46	34	258	Tartaric/NaOH	2720
	184	63	0	69	58	2307	Oxalic	15431
	807	560	0	320	143	1397	Oxalic/HNO3	16228
	30	25	0	17	16	106	NH4OH	2900
	96	200	0	44	54	7646	EDTA/NaOH	18757
	225	288	0	101	66	907	ARR	10394
Total	2511	2979	0	1063	1092	23301		221026

TABLE 18

Solution Summary %

gamma R/hr	gamma mg	UDS g	gamma curie	beta curie	Cost $	Soln	Vol-L
20.0	28.6	.0	19.5	19.6	.0	H2O	24.6
15.4	23.1	.0	15.3	17.3	17.2	HNO3	29.7
1.0	1.8	.0	.9	.9	4.8	KMn04/HNO3	5.2
.5	.9	.0	.5	1.3	3.7	4521	1.0
5.2	4.7	.0	7.7	27.0	20.1	4502	9.4
4.4	2.7	.0	4.3	3.1	1.1	Tartaric/NaOH	1.2
7.3	2.1	.0	6.5	5.3	9.9	Oxalic	7.0
32.1	18.8	.0	30.1	13.1	6.0	Oxalic/HNO3	7.3
1.2	.9	.0	1.6	1.4	.5	NH4OH	1.3
3.8	6.7	.0	4.1	4.9	32.8	EDTA/NaOH	8.5
9.0	9.7	.0	9.5	6.0	3.9	ARR	4.7

TABLE 19

Solution Summary x/L

gamma mR/hr*L	gamma ug/L	UDS g/L	gamma mcurie/L	beta mcurie/L	B/L	Cost $/L	Soln	Tot Vol-L
9.2	15.7	.0	3.8	3.93	3.9	.00	H2O	54447
5.9	10.5	.0	2.5	2.88	2.9	.06	HNO3	65658
2.2	4.6	.0	.8	.84	.8	.10	KMn04/HNO3	11416
5.6	11.6	.0	2.6	6.18	6.2	.39	4521	2251
6.3	6.7	.0	3.9	14.14	14.1	.22	4502	20824
40.9	29.7	.0	16.8	12.62	12.6	.09	Tartaric/NaOH	2720
11.9	4.1	.0	4.5	3.78	3.8	.15	Oxalic	15431
49.7	34.5	.0	19.7	8.82	8.8	.09	Oxalic/HNO3	16228
10.4	8.8	.0	5.8	5.41	5.4	.04	NH4OH	2900
5.1	10.7	.0	2.4	2.87	2.9	.41	EDTA/NaOH	18757
21.6	27.7	.0	9.7	6.32	6.3	.09	ARR	10394
11.4	13.5	.0	4.8	4.94		.11		221026

TABLE 20

Cost Summary x/$

gamma mR/hr/$	gamma ug/$	UDS g/$	gamma mcurie/$	beta mcurie/$	cost $	Soln	Tot Vol-L
0	0	0	0	0	0	H2O	54447
96	172	0	40	47	4019	HNO3	65658
23	47	0	9	9	1109	KMn04/HNO3	11416
14	30	0	7	16	870	4521	2251
28	30	0	17	63	4683	4502	20824
431	314	0	178	133	258	Tartaric/NaOH	2720
80	28	0	30	25	2307	Oxalic	15431

	578	401	0	229	102	1397	Oxalic/HNO3 16228
	286	239	0	158	148	106	NH4OH 2900
	13	26	0	6	7	7646	EDTA/NaOH 18757
	248	317	0	112	72	907	ARR 10394
Total	108	128	0	46	47	1.00	9.49

TABLE 21

Waste Analysis

Volume of Waste	221026 L	58395 gal
Wt of chemicals w/o HNO3	5244 Kg	11537 lbs
Moles of Na+ ; Molarity	36261 moles	.16 M
Moles of K+ ; Molarity	15808 moles	.07 M
Moles Na+ plus K+ ; Molarity	52069 moles	.24 M
Chemical cost 1982 $	23301 $	

Chemical Analysis (Kg)

	KMnO4	Citric	Oxalic	NH Oxal	Tart A	K+	Na+	Kg	L	# of Flushes
H2O									54447	32
HNO3								14355	65658	50
KMnO4/HNO3	89					22		1548	11416	5
4521		5	14	72				90	2251	2
4502	204					596	9	1018	20824	11
Tart A/NaOH					61		63	170	2720	2
Oxalic A			1424					1424	15431	6
Oxalic/HNO3			773					1288	16228	11
NH4OH 49								49	2900	1
EDTA/NaOH 231							587	1202	18757	20
ARR							176	428	10394	5
Totals	292	5	2211	72	61	618	834	5244	221026	145

Approx. pH .0

Number of flushes	145
Samples taken	79

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Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
21612	.12E+05	.16E+04	.97E+04	.46E+04	.00E+00	.36E+04	.47E+04	.15E+04	5870	1	8.1E+06	.0	.00	.00	18	17
22003	.14E+04	.21E+03	.14E+03	.29E+04	.00E+00	.20E+04	.38E+04	.42E+03	5780	1	1.1E+06	.0	.00	.00	8	17
22207	.00E+00	.91E+03	.64E+04	.54E+05	.00E+00	.46E+05	.18E+06	.31E+04	4900	5	1.8E+07	.0	5.00	.00	43	17
22408	.00E+00	.38E+03	.27E+04	.16E+06	.00E+00	.31E+05	.10E+06	.96E+04	5800	9	1.4E+07	.0	10.00	.00	60	17
22605	.44E+03	.16E+03	.89E+03	.33E+05	.00E+00	.12E+05	.15E+05	.14E+04	5800	1	3.2E+06	.0	.00	.00	12	17
22803	.00E+00	.24E+04	.18E+05	.44E+05	.00E+00	.35E+05	.11E+06	.41E+04	2900	12	1.2E+07	.0	1.70	.00	1000	38
30102	.00E+00	.45E+03	.45E+04	.11E+06	.00E+00	.80E+04	.10E+06	.51E+04	5800	14	1.2E+06	.0	4.00	.00	3	38
30312	.11E+01	.99E+03	.77E+04	.16E+05	.00E+00	.14E+05	.21E+05	.66E+03	5710	2	1.2E+06	.0	12.80	.00	9	38
30512	.00E+00	.79E+03	.58E+04	.21E+05	.00E+00	.96E+04	.51E+05	.14E+04	4579	5	6.0E+06	.0	5.00	.00	20	38
30808	.00E+00	.56E+03	.33E+04	.11E+06	.00E+00	.13E+05	.11E+06	.59E+04	5640	11	9.9E+06	.0	3.60	3.50	43	38
31002	.00E+00	.15E+04	.14E+05	.21E+05	.00E+00	.36E+05	.14E+05	.11E+04	2315	2	4.1E+06	.0	12.80	.00	95	38
31411	.30E+04	.18E+04	.14E+05	.27E+05	.00E+00	.29E+04	.12E+05	.16E+04	1700	9	9.2E+06	.0	3.00	.00	0	38
1	.12E+04	.74E+03	.51E+04	.43E+05	.00E+00	.12E+05	.50E+05	.25E+04	1400	7	5.4E+06	.0	2.25	4.00	0	38
32215	.00E+00	.44E+02	.27E+03	.42E+04	.00E+00	.21E+04	.71E+04	.57E+03	1400	3	9.3E+05	.0	.78	12.80	0	38
3233	.00E+00	.58E+01	.45E+02	.54E+03	.00E+00	.21E+03	.43E+03	.67E+02	1437	9	7.5E+04	.0	10.00	.00	0	38
3236	.69E+01	.70E+01	.51E+02	.57E+02	.00E+00	.12E+03	.72E+02	.39E+01	1205	2	3.7E+04	.0	12.80	.00	0	38
3283	.12E+03	.25E+02	.35E+03	.53E+03	.00E+00	.51E+03	.18E+04	.32E+02	4200	13	3.2E+05	.0	.04	4.00	0	38
3313	.00E+00	.77E+03	.51E+04	.51E+04	.00E+00	.18E+04	.62E+04	.33E+03	6550	3	1.1E+06	.0	.78	12.80	0	38
4013	.00E+00	.12E+04	.70E+04	.11E+05	.00E+00	.49E+04	.23E+05	.48E+03	3770	9	2.2E+06	.0	10.00	.00	0	38
4026	.00E+00	.10E+04	.64E+04	.18E+05	.00E+00	.50E+04	.31E+05	.61E+03	4050	2	2.6E+06	.0	12.80	.00	0	38
1	.46E+04	.66E+03	.36E+04	.13E+05	.00E+00	.59E+04	.78E+04	.11E+04	4100	1	4.2E+06	.0	.00	.00	0	38

Solutions

1. H2O
2. HNO3
3. KMnO4/HNO3
4. 4521
5. 4502
6. Citrox
7. Tartaric/NaOH
8. 4324
9. Oxalic
10. Citric A
11. Oxalic/HNO3
12. NH4OH
13. EDTA/NaOH
14. ARR
15. HF/HNO3

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Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
31919	.00E+00	.16E+05	.97E+05	.29E+06	.00E+00	.31E+05	.32E+06	.14E+05	1760	1	3.2E+07	.0	.00	.00	0	55
32029	.25E+05	.18E+05	.14E+06	.40E+06	.00E+00	.37E+05	.53E+06	.11E+05	1320	7	5.2E+07	.0	2.25	4.00	0	55
1	.75E+03	.62E+04	.50E+05	.15E+05	.00E+00	.28E+04	.21E+05	.59E+03	1255	2	5.6E+06	.0	12.80	.00	0	55
3228	.00E+00	.11E+02	.94E+02	.15E+03	.00E+00	.25E+02	.21E+03	.11E+02	2370	5	2.5E+07	.0	2.50	.00	0	55
32318	.52E+05	.10E+06	.74E+06	.20E+07	.00E+00	.46E+06	.23E+07	.10E+06	1702	11	2.8E+07	.0	3.60	3.00	0	55
32419	.24E+04	.55E+04	.42E+05	.37E+05	.00E+00	.96E+04	.30E+05	.17E+04	1378	2	3.1E+05	.0	12.80	.00	0	55
1	.57E+02	.10E+05	.76E+05	.59E+05	.00E+00	.70E+04	.73E+05	.27E+04	1300	1	1.1E+07	.0	.00	.00	0	55
3316	.67E+04	.46E+04	.34E+05	.79E+05	.00E+00	.12E+05	.15E+06	.26E+04	1118	13	1.4E+07	.0	.34	4.00	0	55
33121	.19E+04	.42E+04	.34E+05	.81E+04	.00E+00	.14E+05	.15E+05	.00E+00	1205	3	2.6E+06	.0	.79	12.80	0	55
40135	.00E+00	.29E+04	.26E+05	.92E+05	.00E+00	.20E+05	.15E+06	.44E+04	1434	9	1.3E+07	.0	10.00	.00	0	55
40233	.17E+04	.47E+04	.35E+05	.52E+05	.00E+00	.13E+05	.50E+05	.23E+04	1639	2	1.1E+07	.0	12.80	.00	0	55
40326	.00E+00	.23E+04	.17E+05	.15E+05	.00E+00	.52E+04	.15E+05	.00E+00	1366	1	5.7E+06	.0	.00	.00	0	55
1	.75E+03	.62E+04	.50E+05	.15E+05	.00E+00	.28E+04	.21E+05	.59E+03	2000	2	5.6E+06	.0	12.80	.00	0	71
4121	.00E+00	.45E+04	.27E+05	.65E+04	.00E+00	.85E+04	.23E+06	.39E+03	1877	5	1.3E+07	.0	5.00	.00	0	55
41212	.21E+04	.63E+04	.42E+05	.69E+05	.00E+00	.16E+05	.89E+05	.43E+04	1294	11	1.0E+07	.0	3.60	3.00	0	55
41315	.52E+03	.24E+04	.18E+05	.33E+05	.00E+00	.49E+04	.30E+05	.19E+04	1407	2	6.8E+06	.0	12.80	.00	0	55
41419	.43E+03	.25E+04	.16E+05	.15E+05	.00E+00	.38E+04	.13E+05	.93E+03	1290	1	3.1E+06	.0	.00	.00	0	55
1	.75E+03	.62E+04	.50E+05	.15E+05	.00E+00	.28E+04	.21E+05	.59E+03	2000	2	5.6E+06	.0	12.80	.00	0	71
4176	.22E+03	.19E+04	.15E+05	.27E+04	.00E+00	.13E+04	.54E+04	.22E+03	1225	3	2.1E+06	.0	.78	12.80	0	55
4186	.00E+00	.14E+04	.11E+05	.13E+05	.00E+00	.17E+04	.28E+05	.00E+00	1290	9	4.4E+06	.0	10.00	.00	0	55
41910	.00E+00	.30E+04	.24E+05	.18E+05	.00E+00	.11E+04	.29E+05	.19E+03	2010	2	5.2E+06	.0	12.80	.00	0	55
4202	.00E+00	.11E+04	.85E+04	.45E+04	.00E+00	.10E+04	.86E+04	.90E+02	1200	1	2.0E+06	.0	.00	.00	0	55
1	.57E+02	.10E+05	.76E+05	.59E+05	.00E+00	.70E+04	.73E+05	.27E+04	2000	1	1.1E+07	.0	.00	.00	0	71
5216	.00E+00	.12E+04	.98E+04	.24E+05	.00E+00	.17E+04	.89E+05	.00E+00	1694	14	6.3E+06	.0	4.00	.00	0	100
52128	.00E+00	.80E+04	.65E+05	.13E+03	.00E+00	.13E+04	.33E+04	.00E+00	1036	3	6.9E+06	.0	.78	12.60	0	100
5226	.00E+00	.37E+04	.32E+05	.44E+04	.00E+00	.62E+03	.30E+05	.00E+00	1251	4	8.7E+06	.0	4.00	.00	0	100
52219	.00E+00	.11E+04	.90E+04	.18E+03	.00E+00	.22E+03	.11E+04	.00E+00	1020	2	2.4E+06	.0	12.60	.00	0	100
52220	.00E+00	.43E+04	.36E+05	.35E+04	.00E+00	.00E+00	.13E+05	.00E+00	1046	1	6.7E+06	.0	.00	.00	0	100
52313	.00E+00	.27E+04	.22E+05	.00E+00	.00E+00	.00E+00	.20E+04	.00E+00	1024	2	1.8E+06	.0	12.60	.00	0	100
5263	.00E+00	.16E+04	.13E+05	.11E+04	.00E+00	.23E+04	.56E+05	.00E+00	936	5	4.6E+06	.0	5.00	.00	0	100
52625	.00E+00	.00E+00	.10E+05	.00E+00	.00E+00	.00E+00	.59E+04	.00E+00	1154	11	3.3E+06	.0	10.00	3.00	0	100
52625	.00E+00	.00E+00	.10E+05	.00E+00	.00E+00	.00E+00	.59E+04	.00E+00	1154	2	3.3E+06	.0	12.60	.00	0	100
1	.57E+02	.10E+05	.76E+05	.59E+05	.00E+00	.70E+04	.73E+05	.27E+04	1200	1	1.1E+07	.0	.00	.00	0	100
1	.75E+03	.62E+04	.50E+05	.15E+05	.00E+00	.28E+04	.21E+05	.59E+03	600	2	5.6E+06	.0	12.60	.00	0	1
1	.24E+04	.11E+05	.86E+05	.23E+05	.00E+00	.46E+04	.11E+06	.65E+03	600	13	1.2E+07	.0	.00	4.00	0	1
1	.57E+02	.10E+05	.76E+05	.59E+05	.00E+00	.70E+04	.73E+05	.27E+04	600	1	1.1E+07	.0	.00	.00	0	1
1	.00E+00	.16E+04	.10E+05	.22E+04	.00E+00	.29E+04	.77E+05	.12E+03	600	5	1.5E+07	.0	5.00	.00	0	1
60445	.00E+00	.51E+04	.40E+05	.75E+04	.00E+00	.00E+00	.22E+05	.00E+00	600	11	2.6E+06	.0	10.00	3.00	0	1
60445	.00E+00	.51E+04	.40E+05	.75E+04	.00E+00	.00E+00	.22E+05	.00E+00	600	1	2.6E+06	.0	.00	.00	0	1
60445	.00E+00	.51E+04	.40E+05	.75E+04	.00E+00	.00E+00	.22E+05	.00E+00	600	2	2.5E+06	.0	38.20	.00	0	1
60445	.00E+00	.51E+04	.40E+05	.75E+04	.00E+00	.00E+00	.22E+05	.00E+00	600	2	2.6E+06	.0	38.20	.00	0	1
6068	.30E+04	.40E+04	.33E+05	.10E+03	.00E+00	.36E+03	.23E+04	.60E+02	600	2	2.9E+06	.0	38.20	.00	0	1
6068	.30E+04	.40E+04	.33E+05	.10E+03	.00E+00	.37E+03	.23E+04	.60E+02	600	2	2.9E+06	.0	38.20	.00	0	1
6068	.30E+04	.40E+04	.33E+05	.10E+03	.00E+00	.36E+03	.23E+04	.60E+02	1200	13	2.9E+06	.0	.00	4.00	0	100
6069	.11E+04	.17E+04	.15E+05	.89E+02	.00E+00	.00E+00	.32E+04	.00E+00	1200	2	1.5E+06	.0	38.20	.00	0	100
1	.00E+00	.12E+04	.98E+04	.24E+05	.00E+00	.17E+04	.89E+05	.00E+00	1200	14	6.3E+06	.0	5.00	.00	0	100
1	.75E+03	.62E+04	.50E+05	.15E+05	.00E+00	.28E+04	.21E+05	.59E+03	1200	2	5.6E+06	.0	38.20	.00	0	100
1	.24E+04	.11E+05	.86E+05	.23E+05	.00E+00	.46E+04	.11E+06	.65E+03	1469	13	1.2E+07	.0	.00	10.00	0	100
60824	.00E+00	.44E+05	.35E+06	.49E+04	.00E+00	.00E+00	.35E+05	.00E+00	1230	2	2.8E+06	.0	38.20	.00	0	100
60824	.00E+00	.44E+05	.35E+06	.49E+04	.00E+00	.00E+00	.35E+05	.00E+00	1230	1	2.8E+06	.0	.00	.00	0	100
6091	.00E+00	.18E+05	.14E+06	.65E+04	.00E+00	.32E+04	.15E+06	.00E+00	2256	13	1.6E+07	.0	10.00	.00	0	100
60923	.00E+00	.17E+04	.13E+05	.15E+04	.00E+00	.71E+02	.19E+05	.00E+00	1200	2	2.4E+07	.0	38.20	.00	0	100

60923	.00E+00	.17E+04	.13E+05	.15E+04	.00E+00	.71E+02	.19E+05	.00E+00	1200	1	2.4E+07	.0	.00	.00	0	100
61916	.00E+00	.11E+03	.73E+03	.15E+03	.00E+00	.57E+02	.39E+04	.00E+00	1200	5	4.2E+06	.0	8.00	.00	0	1
61916	.00E+00	.11E+03	.73E+03	.15E+03	.00E+00	.57E+02	.39E+04	.00E+00	1200	11	4.2E+06	.0	10.00	3.00	0	1
1	.75E+03	.62E+04	.50E+05	.15E+05	.00E+00	.28E+04	.21E+05	.59E+03	600	2	5.6E+06	.0	38.20	.00	0	1
1	.57E+02	.10E+05	.76E+05	.59E+05	.00E+00	.70E+04	.73E+05	.27E+04	600	1	1.1E+07	.0	.00	.00	0	1

Solutions

1. H2O	6. Citrox	11. Oxalic/HNO3
2. HNO3	7. Tartaric/NaOH	12. NH4OH
3. KMnO4/HNO3	8. 4324	13. EDTA/NaOH
4. 4521	9. Oxalic	14. ARR
5. 4502	10. Citric A	15. HF/HNO3

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Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
1	.47E+03	.83E+04	.71E+05	.12E+05	.00E+00	.17E+05	.82E+05	.10E+04	4720	1	1.2E+07	.0	.00	.00	0	110
1	.47E+03	.83E+04	.71E+05	.12E+05	.00E+00	.17E+05	.82E+05	.10E+04	1859	1	1.2E+07	.0	.00	.00	0	113
62624	.00E+00	.00E+00	.47E+03	.89E+03	.00E+00	.23E+04	.21E+03	.53E+03	2723	13	8.1E+06	.0	.00	4.00	0	113
62614	.10E+04	.19E+04	.15E+05	.50E+04	.00E+00	.23E+05	.15E+05	.15E+04	3955	2	2.0E+07	.0	38.20	.00	0	113
62754	.54E+03	.42E+04	.36E+05	.15E+05	.00E+00	.16E+05	.51E+05	.25E+04	3242	5	1.0E+08	.0	5.00	.00	0	113
62755	.00E+00	.00E+00	.80E+03	.40E+05	.00E+00	.14E+05	.00E+00	.13E+05	1956	11	5.3E+07	.0	3.60	3.00	0	113
62856	.72E+02	.40E+01	.28E+02	.85E+04	.00E+00	.54E+04	.44E+02	.28E+04	3585	2	0.0E+00	.0	18.60	.00	0	113
1	.47E+03	.83E+04	.71E+05	.12E+05	.00E+00	.17E+05	.82E+05	.10E+04	2456	1	1.2E+07	.0	.00	.00	0	113
1	.00E+00	.00E+00	.47E+03	.89E+03	.00E+00	.23E+04	.21E+03	.53E+03	2531	13	4.8E+06	.0	.00	4.00	0	113
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	1515	2	9.0E+06	.0	38.20	.00	0	113
1	.00E+00	.00E+00	.80E+03	.40E+05	.00E+00	.14E+05	.00E+00	.13E+05	2000	11	4.1E+07	.0	3.60	3.00	0	113
70529	.00E+00	.45E+03	.46E+04	.38E+05	.00E+00	.20E+05	.52E+05	.42E+04	4011	2	8.8E+06	.0	18.60	.00	0	113
70530	.00E+00	.00E+00	.13E+04	.10E+04	.00E+00	.75E+03	.00E+00	.33E+03	2000	1	1.9E+06	.0	.00	.00	0	113
7093	.00E+00	.00E+00	.47E+03	.89E+03	.00E+00	.23E+04	.21E+03	.53E+03	2000	13	3.7E+05	.0	.00	13.00	0	113
7092	.97E+03	.74E+03	.63E+04	.25E+04	.00E+00	.42E+04	.99E+04	.70E+03	4639	2	5.5E+05	.0	38.20	.00	0	113
7095	.00E+00	.00E+00	.80E+03	.40E+05	.00E+00	.14E+05	.00E+00	.13E+05	562	11	4.0E+05	.0	3.60	3.00	0	113
7097	.00E+00	.00E+00	.45E+02	.12E+04	.00E+00	.20E+04	.17E+03	.61E+03	3716	2	3.5E+05	.0	18.60	.00	0	113
7096	.00E+00	.00E+00	.80E+02	.20E+04	.00E+00	.34E+04	.22E+03	.10E+04	730	1	8.8E+05	.0	.00	.00	0	113
1	.00E+00	.00E+00	.47E+03	.89E+03	.00E+00	.23E+04	.21E+03	.53E+03	60	13	4.8E+06	.0	.00	4.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	60	2	9.0E+06	.0	38.20	.00	0	1
1	.54E+03	.42E+04	.36E+05	.15E+05	.00E+00	.16E+05	.51E+05	.25E+04	60	5	1.0E+08	.0	5.00	.00	0	1
1	.00E+00	.00E+00	.80E+03	.40E+05	.00E+00	.14E+05	.00E+00	.13E+05	60	11	4.1E+07	.0	3.60	3.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	70	2	9.0E+06	.0	18.60	.00	0	1
1	.47E+03	.83E+04	.71E+05	.12E+05	.00E+00	.17E+05	.82E+05	.10E+04	60	1	1.2E+07	.0	.00	.00	0	1
1	.00E+00	.00E+00	.47E+03	.89E+03	.00E+00	.23E+04	.21E+03	.53E+03	60	13	4.8E+06	.0	.00	4.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	60	2	9.0E+06	.0	38.20	.00	0	1
1	.54E+03	.42E+04	.36E+05	.15E+05	.00E+00	.16E+05	.51E+05	.25E+04	60	5	1.0E+08	.0	5.00	.00	0	1
1	.00E+00	.00E+00	.80E+03	.40E+05	.00E+00	.14E+05	.00E+00	.13E+05	60	11	4.1E+07	.0	3.60	3.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	60	2	9.0E+06	.0	18.60	.00	0	1
1	.00E+00	.00E+00	.47E+03	.89E+03	.00E+00	.23E+04	.21E+03	.53E+03	60	13	4.8E+06	.0	.00	12.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	60	2	9.0E+06	.0	38.20	.00	0	1
1	.00E+00	.00E+00	.47E+03	.89E+03	.00E+00	.23E+04	.21E+03	.53E+03	60	13	4.8E+06	.0	.00	12.00	0	1
1	.00E+00	.00E+00	.47E+03	.89E+03	.00E+00	.23E+04	.21E+03	.53E+03	60	13	4.8E+06	.0	.00	12.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	60	2	9.0E+06	.0	38.20	.00	0	1
1	.00E+00	.00E+00	.47E+03	.89E+03	.00E+00	.23E+04	.21E+03	.53E+03	60	13	4.8E+06	.0	.00	12.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	60	2	9.0E+06	.0	38.20	.00	0	1
1	.00E+00	.00E+00	.47E+03	.89E+03	.00E+00	.23E+04	.21E+03	.53E+03	60	13	4.8E+06	.0	.00	12.00	0	1
1	.47E+03	.83E+04	.71E+05	.12E+05	.00E+00	.17E+05	.82E+05	.10E+04	60	1	1.2E+07	.0	.00	.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	60	2	9.0E+06	.0	38.20	.00	0	1
1	.00E+00	.00E+00	.47E+03	.89E+03	.00E+00	.23E+04	.21E+03	.53E+03	60	13	4.8E+06	.0	.00	12.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	60	2	9.0E+06	.0	38.20	.00	0	1
1	.00E+00	.00E+00	.47E+03	.89E+03	.00E+00	.23E+04	.21E+03	.53E+03	60	13	4.8E+06	.0	.00	12.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	60	2	9.0E+06	.0	.00	38.20	0	1
1	.47E+03	.83E+04	.71E+05	.12E+05	.00E+00	.17E+05	.82E+05	.10E+04	60	1	1.2E+07	.0	.00	.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	60	2	9.0E+06	.0	38.20	.00	0	1
1	.00E+00	.00E+00	.47E+03	.89E+03	.00E+00	.23E+04	.21E+03	.53E+03	60	13	4.8E+06	.0	.00	12.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	60	2	9.0E+06	.0	38.20	.00	0	1
1	.00E+00	.00E+00	.47E+03	.89E+03	.00E+00	.23E+04	.21E+03	.53E+03	60	13	4.8E+06	.0	.00	12.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	60	2	9.0E+06	.0	38.20	.00	0	1
1	.47E+03	.83E+04	.71E+05	.12E+05	.00E+00	.17E+05	.82E+05	.10E+04	60	1	1.2E+07	.0	.00	.00	0	1
1	.47E+03	.83E+04	.71E+05	.12E+05	.00E+00	.17E+05	.82E+05	.10E+04	1000	1	1.2E+07	.0	.00	.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	1000	2	9.0E+06	.0	18.60	.00	0	1

1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	750	2	9.0E+06	.0	18.60	.00	0	1
1	.47E+03	.83E+04	.71E+05	.12E+05	.00E+00	.17E+05	.82E+05	.10E+04	1200	1	1.2E+07	.0	.00	.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	1200	2	9.0E+06	.0	18.60	.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	1200	2	9.0E+06	.0	18.60	.00	0	1
1	.47E+03	.83E+04	.71E+05	.12E+05	.00E+00	.17E+05	.82E+05	.10E+04	1200	1	1.2E+07	.0	.00	.00	0	1
1	.38E+04	.49E+05	.42E+06	.72E+05	.00E+00	.11E+06	.55E+06	.55E+04	1200	14	7.1E+07	.0	4.00	.00	0	1
1	.58E+03	.31E+04	.26E+05	.14E+05	.00E+00	.15E+05	.41E+05	.20E+04	1200	2	9.0E+06	.0	18.60	.00	0	1
1	.54E+03	.42E+04	.36E+05	.15E+05	.00E+00	.16E+05	.51E+05	.25E+04	1000	5	1.0E+08	.0	5.00	.00	0	1
1	.54E+03	.42E+04	.36E+05	.15E+05	.00E+00	.16E+05	.51E+05	.25E+04	1000	4	2.0E+07	.0	4.00	.00	0	1
72320	.38E+04	.49E+05	.42E+06	.72E+05	.00E+00	.11E+06	.55E+06	.55E+04	1000	2	7.1E+07	.0	38.20	.00	0	1
72320	.38E+04	.49E+05	.42E+06	.72E+05	.00E+00	.11E+06	.55E+06	.55E+04	600	1	7.1E+07	.0	.00	.00	0	1
72320	.38E+04	.49E+05	.42E+06	.72E+05	.00E+00	.11E+06	.55E+06	.55E+04	500	14	7.1E+07	.0	4.00	.00	0	1
7243	.00E+00	.71E+04	.59E+05	.84E+04	.00E+00	.85E+04	.43E+05	.87E+02	500	2	8.0E+06	.0	18.60	.00	0	1
7243	.00E+00	.71E+04	.59E+05	.84E+04	.00E+00	.85E+04	.43E+05	.87E+02	500	1	8.0E+06	.0	.00	.00	0	1
7243	.00E+00	.71E+04	.59E+05	.84E+04	.00E+00	.85E+04	.43E+05	.87E+02	1000	1	8.0E+06	.0	.00	.00	0	1

Solutions

1. H2O
2. HNO3
3. KMnO4/HNO3
4. 4521
5. 4502
6. Citrox
7. Tartaric/NaOH
8. 4324
9. Oxalic
10. Citric A
11. Oxalic/HNO3
12. NH4OH
13. EDTA/NaOH
14. ARR
15. HF/HNO3

Appendix G

1989 FDP Decontamination Data

Appendix G

1989 FDP Decontamination Data

The data in this appendix is arranged in two parts. The first part is a long analysis of the data. It consists of 21 tables, each of which look at the information collected by sampling in a unique way. These tables provide many different ways of looking at the data. It is hoped that considerable time will be spent reviewing these tables by those who want more detail concerning the many aspects of decontamination. Many of the figures and tables used in the body of the report came from this section. However, these tables provide in-depth analysis and allow the researcher to identify trends or effects that were not discussed in the report.

The second part of this appendix contains the raw data. This is the unmodified, unmanipulated sample results. In this section the averages have been included and can be identified by a log number of 1. Actual log numbers are given so that a researcher can obtain original sample results or in some way verify any questions that may arise. The sample results for the isotopes are recorded as dps/mL. Beta results are a gross beta count and are in dpm/mL.

Solutions were tracked and the quantities of chemicals used were recorded. A weight percent was used to calculate chemical quantities. To simplify the tracking of chemical quantities, the weight percent was calculated, assuming a liter of solution weighted one kg. Thus, if 300 grams of chemical A were taken and water was added to make one liter then this solution would be 30 wt% chemical A. The calculation simply becomes:

$$(300\ g/1000\ mL)(1\ mL/1\ g)(100) = 30\ wt\%$$

This ignores the actual density of the solution. However, the error introduced by this simplifying approach was decided to be acceptable due to other errors, such as measuring quantities of bulk chemicals used and in the volume measurements of the liquids. This seems to be acceptable, because large errors were created by inaccuracies in weighing large quantities of bulk chemicals and in errors in measuring volumes of large tanks.

The tables contained in this appendix are based on averaged data from the 1989 decontamination of First Cycle following FDP campaign #41 and 42. Below is a summary of the data tables. The raw data is given below and is listed in the same sequence as the decontamination occurred.

1989 FDP Decontamination Data

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ESTIMATED VALUES BASED ON AVERAGES

DECON INFORMATION ON 1989 Decon

TABLE 1

Individual Isotope Information

	Ci	mg	R/hr
Zr 95	0	0	0
Nb 95	1	0	7
Ru103	0	0	0
Ru106	2104	624	1230
Sb125	501	472	385
Cs134	236	182	835
Cs137	1452	16654	4900
Ce144	355	112	32
Total	4649	18044	7388
Beta	9068		

TABLE 2

X/L Isotope Information

	mCi/L	ug/L	mR/hr*L
Zr 95	.0	.0	.0
Nb 95	.0	.0	.0
Ru103	.0	.0	.0
Ru106	6.1	1.8	3.6
Sb125	1.5	1.4	1.1
Cs134	.7	.5	2.4
Cs137	4.2	48.4	14.2
Ce144	1.0	.3	.1
Total	13.5	52.4	21.5
Beta	26.3	Beta/min/ml= 5.8E+07	

TABLE 3

% Isotope Information

	Ci	mg	R/hr
Zr 95	.0	.0	.0
Nb 95	.0	.0	.1
Ru103	.0	.0	.0
Ru106	45.3	3.5	16.6
Sb125	10.8	2.6	5.2
Cs134	5.1	1.0	11.3
Cs137	31.2	92.3	66.3
Ce144	7.6	.6	.4

TABLE 4

Solution Information - mCi/L

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	2.44	1.03	3.33	.01	.00	4.34	.44	.00	11.58	H2O	56566
	.84	.42	2.69	.00	.00	4.78	.65	.00	9.39	HNO3	76137
	1.64	.47	3.76	.00	.00	4.58	.90	.00	11.34	KMnO4/HNO3	11200
	.46	.07	.65	.00	.00	2.30	.46	.00	3.94	4521	1500
	.51	1.18	8.99	.00	.00	11.33	2.56	.00	24.58	4502	54694
	.00	.05	.59	.00	.00	.59	.18	.00	1.42	CITROX	1567
	.47	.81	5.69	.00	.00	6.10	1.00	.00	14.08	Tartaric/NaOH	37214
	.77	.61	3.73	.00	.00	7.09	1.22	.00	13.42	4324	20086
	.12	.31	2.29	.00	.00	1.05	.41	.00	4.17	Oxalic	15700
	1.27	.51	3.60	.01	.00	7.79	3.69	.00	16.86	Oxalic/HNO3	54839
	.11	.02	.21	.00	.00	.44	.32	.00	1.10	HF/HNO3	14820
Tot	1.03	.69	4.22	.00	.00	6.11	1.45	.00	13.50		344323

TABLE 5

Solution Information - ug/L

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
.77	.80	38.15	.00	.00	1.28	.41	.00	41.41	H2O	56566
.27	.33	30.90	.00	.00	1.42	.61	.00	33.52	HNO3	76137
.51	.36	43.08	.00	.00	1.36	.85	.00	46.17	KMnO4/HNO3	11200
.14	.06	7.44	.00	.00	.68	.43	.00	8.76	4521	1500
.16	.92	103.14	.00	.00	3.36	2.41	.00	109.99	4502	54694
.00	.04	6.82	.00	.00	.18	.17	.00	7.21	CITROX	1567
.15	.63	65.26	.00	.00	1.81	.95	.00	68.79	Tartaric/NaOH	37214
.24	.47	42.76	.00	.00	2.10	1.16	.00	46.73	4324	20086
.04	.24	26.28	.00	.00	.31	.38	.00	27.25	Oxalic	15700
.40	.39	41.26	.00	.00	2.31	3.48	.00	47.84	Oxalic/HNO3	54839

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.03	.02	2.39	.00	.00	.13	.30	.00	2.88	HF/HNO3	14820
Tot	.32	.53	48.37	.00	.00	1.81	1.37	.00	52.40		344323

TABLE 6

Solution Information - mR/hr*L

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.22	3.64	11.22	.03	.00	2.53	.34	.00	17.98	H2O	56566
	.08	1.49	9.09	.02	.00	2.79	.50	.00	13.97	HNO3	76137
	.15	1.66	12.67	.00	.00	2.68	.69	.00	17.85	KMnO4/HNO3	11200
	.04	.26	2.19	.00	.00	1.34	.35	.00	4.18	4521	1500
	.05	4.19	30.34	.02	.00	6.62	1.97	.00	43.19	4502	54694
	.00	.18	2.01	.00	.00	.35	.14	.00	2.68	CITROX	1567
	.04	2.86	19.20	.02	.00	3.57	.77	.00	26.46	Tartaric/NaOH	37214
	.07	2.17	12.58	.00	.00	4.14	.94	.00	19.90	4324	20086
	.01	1.08	7.73	.00	.00	.61	.31	.00	9.75	Oxalic	15700
	.11	1.80	12.14	.04	.00	4.55	2.84	.00	21.49	Oxalic/HNO3	54839
	.01	.09	.70	.00	.00	.26	.24	.00	1.30	HF/HNO3	14820
Tot	.09	2.43	14.23	.02	.00	3.57	1.12	.00	21.46		344323

TABLE 7

Solution Information - curies

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
138	58	188	0	0	245	25	0	655	H2O	56566
64	32	205	0	0	364	49	0	715	HNO3	76137
18	5	42	0	0	51	10	0	127	KMnO4/HNO3	11200
1	0	1	0	0	3	1	0	6	4521	1500
28	65	492	0	0	620	140	0	1344	4502	54694
0	0	1	0	0	1	0	0	2	CITROX	1567
18	30	212	0	0	227	37	0	524	Tartaric/NaOH	37214
15	12	75	0	0	142	25	0	270	4324	20086
2	5	36	0	0	16	6	0	66	Oxalic	15700
69	28	197	1	0	427	203	0	925	Oxalic/HNO3	54839
2	0	3	0	0	7	5	0	16	HF/HNO3	14820

TABLE 8

Solution Information - mg

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
43	45	2158	0	0	73	23	0	2342	H2O	56566
20	25	2353	0	0	108	47	0	2552	HNO3	76137
6	4	483	0	0	15	9	0	517	KMnO4/HNO3	11200
0	0	11	0	0	1	1	0	13	4521	1500
9	50	5641	0	0	184	132	0	6016	4502	54694
0	0	11	0	0	0	0	0	11	CITROX	1567
6	23	2429	0	0	67	35	0	2560	Tartaric/NaOH	37214
5	10	859	0	0	42	23	0	939	4324	20086
1	4	413	0	0	5	6	0	428	Oxalic	15700
22	22	2263	0	0	127	191	0	2624	Oxalic/HNO3	54839
0	0	35	0	0	2	4	0	43	HF/HNO3	14820

TABLE 9

Solution Information - R/hr

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
12	206	635	2	0	143	19	0	1017	H2O	56566
6	113	692	1	0	213	38	0	1063	HNO3	76137
2	19	142	0	0	30	8	0	200	KMnO4/HNO3	11200
0	0	3	0	0	2	1	0	6	4521	1500
2	229	1660	1	0	362	108	0	2362	4502	54694
0	0	3	0	0	1	0	0	4	CITROX	1567
2	107	714	1	0	133	29	0	985	Tartaric/NaOH	37214
1	44	253	0	0	83	19	0	400	4324	20086
0	17	121	0	0	10	5	0	153	Oxalic	15700
6	99	666	2	0	250	156	0	1178	Oxalic/HNO3	54839
0	1	10	0	0	4	4	0	19	HF/HNO3	14820

TABLE 10

% Solution Information curies % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
21.1	8.9	28.7	.1	.0	37.5	3.8	.0	14.1	H2O	16.4
9.0	4.5	28.7	.0	.0	50.9	6.9	.0	15.4	HNO3	22.1
14.4	4.1	33.1	.0	.0	40.4	7.9	.0	2.7	KMnO4/HNO3	3.3
11.7	1.9	16.5	.0	.0	58.3	11.7	.0	.1	4521	.4
2.1	4.8	36.6	.0	.0	46.1	10.4	.0	28.9	4502	15.9
.0	3.6	41.8	.0	.0	41.8	12.7	.0	.0	CITROX	.5
3.4	5.7	40.4	.0	.0	43.4	7.1	.0	11.3	Tartaric/NaOH	10.8
5.7	4.6	27.8	.0	.0	52.8	9.1	.0	5.8	4324	5.8
2.9	7.3	54.9	.0	.0	25.1	9.8	.0	1.4	Oxalic	4.6
7.5	3.0	21.3	.1	.0	46.2	21.9	.0	19.9	Oxalic/HNO3	15.9
9.6	2.2	19.0	.0	.0	40.3	28.8	.0	.4	HF/HNO3	4.3

TABLE 11

% Solution Information mg % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
1.9	1.9	92.1	.0	.0	3.1	1.0	.0	13.0	H2O	16.4
.8	1.0	92.2	.0	.0	4.2	1.8	.0	14.1	HNO3	22.1
1.1	.8	93.3	.0	.0	2.9	1.8	.0	2.9	KMnO4/HNO3	3.3
1.6	.6	85.0	.0	.0	7.8	5.0	.0	.1	4521	.4
.1	.8	93.8	.0	.0	3.1	2.2	.0	33.3	4502	15.9
.0	.6	94.6	.0	.0	2.4	2.4	.0	.1	CITROX	.5
.2	.9	94.9	.0	.0	2.6	1.4	.0	14.2	Tartaric/NaOH	10.8
.5	1.0	91.5	.0	.0	4.5	2.5	.0	5.2	4324	5.8
.1	.9	96.4	.0	.0	1.1	1.4	.0	2.4	Oxalic	4.6
.8	.8	86.2	.0	.0	4.8	7.3	.0	14.5	Oxalic/HNO3	15.9
1.2	.7	83.2	.0	.0	4.6	10.4	.0	.2	HF/HNO3	4.3

TABLE 12

% Solution Information R/hr % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
1.2	20.3	62.4	.1	.0	14.1	1.9	.0	13.8	H2O	16.4
.5	10.7	65.1	.1	.0	20.0	3.6	.0	14.4	HNO3	22.1
.8	9.3	71.0	.0	.0	15.0	3.9	.0	2.7	KMnO4/HNO3	3.3
1.0	6.2	52.3	.0	.0	32.1	8.4	.0	.1	4521	.4
.1	9.7	70.3	.0	.0	15.3	4.6	.0	32.0	4502	15.9
.0	6.8	75.0	.0	.0	13.0	5.2	.0	.1	CITROX	.5
.2	10.8	72.6	.1	.0	13.5	2.9	.0	13.3	Tartaric/NaOH	10.8
.3	10.9	63.2	.0	.0	20.8	4.7	.0	5.4	4324	5.8
.1	11.1	79.3	.0	.0	6.3	3.2	.0	2.1	Oxalic	4.6
.5	8.4	56.5	.2	.0	21.2	13.2	.0	15.9	Oxalic/HNO3	15.9
.7	6.7	54.0	.0	.0	19.9	18.7	.0	.3	HF/HNO3	4.3

TABLE 13

% Solution Info. curies,mg,R/hr % down columns

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Soln	Total Vol
38.9	24.7	13.0	22.1	.0	11.7	4.9	.0	H2O	16.4
18.1	13.6	14.1	20.5	.0	17.3	9.9	.0	HNO3	22.1

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
5.2	2.2	2.9	.0	.0	2.4	2.0	.0		KMnO4/HNO3	3.3
.2	.0	.1	.0	.0	.2	.1	.0		4521	.4
7.9	27.5	33.9	13.2	.0	29.5	27.9	.0		4502	15.9
.0	.0	.1	.0	.0	.0	.1	.0		CITROX	.5
5.0	12.8	14.6	9.1	.0	10.8	7.4	.0		Tartaric/NaOH	10.8
4.3	5.2	5.2	.0	.0	6.8	4.9	.0		4324	5.8
.5	2.0	2.5	.0	.0	.8	1.3	.0		Oxalic	4.6
19.5	11.8	13.6	35.0	.0	20.3	40.5	.0		Oxalic/HNO3	15.9
.4	.2	.2	.1	.0	.3	.9	.0		HF/HNO3	4.3

TABLE 14

% Solution Info. curies/tot curies

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	3.0	1.3	4.0	.0	.0	5.3	.5	.0	14.1	H2O	16.4
	1.4	.7	4.4	.0	.0	7.8	1.1	.0	15.4	HNO3	22.1
	.4	.1	.9	.0	.0	1.1	.2	.0	2.7	KMnO4/HNO3	3.3
	.0	.0	.0	.0	.0	.1	.0	.0	.1	4521	.4
	.6	1.4	10.6	.0	.0	13.3	3.0	.0	28.9	4502	15.9
	.0	.0	.0	.0	.0	.0	.0	.0	.0	CITROX	.5
	.4	.6	4.6	.0	.0	4.9	.8	.0	11.3	Tartaric/NaOH	10.8
	.3	.3	1.6	.0	.0	3.1	.5	.0	5.8	4324	5.8
	.0	.1	.8	.0	.0	.4	.1	.0	1.4	Oxalic	4.6
	1.5	.6	4.2	.0	.0	9.2	4.4	.0	19.9	Oxalic/HNO3	15.9
	.0	.0	.1	.0	.0	.1	.1	.0	.4	HF/HNO3	4.3
Tot	7.6	5.1	31.2	.0	.0	45.3	10.8	.0			

TABLE 15

% Solution Info. mg/tot mg

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.2	.2	12.0	.0	.0	.4	.1	.0	13.0	H2O	16.4
	.1	.1	13.0	.0	.0	.6	.3	.0	14.1	HNO3	22.1
	.0	.0	2.7	.0	.0	.1	.1	.0	2.9	KMnO4/HNO3	3.3
	.0	.0	.1	.0	.0	.0	.0	.0	.1	4521	.4
	.0	.3	31.3	.0	.0	1.0	.7	.0	33.3	4502	15.9
	.0	.0	.1	.0	.0	.0	.0	.0	.1	CITROX	.5
	.0	.1	13.5	.0	.0	.4	.2	.0	14.2	Tartaric/NaOH	10.8
	.0	.1	4.8	.0	.0	.2	.1	.0	5.2	4324	5.8
	.0	.0	2.3	.0	.0	.0	.0	.0	2.4	Oxalic	4.6
	.1	.1	12.5	.0	.0	.7	1.1	.0	14.5	Oxalic/HNO3	15.9
	.0	.0	.2	.0	.0	.0	.0	.0	.2	HF/HNO3	4.3
Tot	.6	1.0	92.3	.0	.0	3.5	2.6	.0			

TABLE 16

% Solution Info. R/hr/tot R

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.2	2.8	8.6	.0	.0	1.9	.3	.0	13.8	H2O	16.4
	.1	1.5	9.4	.0	.0	2.9	.5	.0	14.4	HNO3	22.1
	.0	.3	1.9	.0	.0	.4	.1	.0	2.7	KMnO4/HNO3	3.3
	.0	.0	.0	.0	.0	.0	.0	.0	.1	4521	.4
	.0	3.1	22.5	.0	.0	4.9	1.5	.0	32.0	4502	15.9
	.0	.0	.0	.0	.0	.0	.0	.0	.1	CITROX	.5
	.0	1.4	9.7	.0	.0	1.8	.4	.0	13.3	Tartaric/NaOH	10.8
	.0	.6	3.4	.0	.0	1.1	.3	.0	5.4	4324	5.8
	.0	.2	1.6	.0	.0	.1	.1	.0	2.1	Oxalic	4.6
	.1	1.3	9.0	.0	.0	3.4	2.1	.0	15.9	Oxalic/HNO3	15.9
	.0	.0	.1	.0	.0	.1	.0	.0	.3	HF/HNO3	4.3
Tot	.4	11.3	66.3	.1	.0	16.6	5.2	.0			

TABLE 17

Solution Summary

	gamma R/hr	gamma mg	UDS g	gamma curie	beta curie	Cost $	Soln	Vol-L
	1017	2342	0	655	1468	0	H2O	56566
	1063	2552	0	715	1707	5050	HNO3	76137
	200	517	0	127	145	2055	KMnO4/HNO3	11200
	6	13	0	6	13	869	4521	1500
	2362	6016	0	1344	2267	20927	4502	54694
	4	11	0	2	4	182	CITROX	1567
	985	2560	0	524	957	4614	Tartaric/NaOH	37214
	400	939	0	270	553	252	4324	20086
	153	428	0	66	106	1814	Oxalic	15700
	1178	2624	0	925	1791	3157	Oxalic/HNO3	54839
	19	43	0	16	57	641	HF/HNO3	14820
Total	7388	18044	0	4649	9068	39561		344323

TABLE 18

Solution Summary %

gamma R/hr	gamma mg	UDS g	gamma curie	beta curie	Cost $	Soln	Vol-L
13.8	13.0	.0	14.1	16.2	.0	H2O	16.4
14.4	14.1	.0	15.4	18.8	12.8	HNO3	22.1
2.7	2.9	.0	2.7	1.6	5.2	KMnO4/HNO3	3.3
.1	.1	.0	.1	.1	2.2	4521	.4
32.0	33.3	.0	28.9	25.0	52.9	4502	15.9
.1	.1	.0	.0	.0	.5	CITROX	.5
13.3	14.2	.0	11.3	10.6	11.7	Tartaric/NaOH	10.8
5.4	5.2	.0	5.8	6.1	.6	4324	5.8
2.1	2.4	.0	1.4	1.2	4.6	Oxalic	4.6
15.9	14.5	.0	19.9	19.7	8.0	Oxalic/HNO3	15.9
.3	.2	.0	.4	.6	1.6	HF/HNO3	4.3

Solution Summary x/L — TABLE 19

gamma mR/hr*L	gamma ug/L	UDS g/L	gamma mcurie/L	beta mcurie/L	B/L	Cost $/L	Soln	Tot Vol-L
18.0	41.4	.0	11.6	25.96	26.0	.00	H2O	56566
14.0	33.5	.0	9.4	22.42	22.4	.07	HNO3	76137
17.9	46.2	.0	11.3	12.93	12.9	.18	KMnO4/HNO3	11200
4.2	8.8	.0	3.9	8.56	8.6	.58	4521	1500
43.2	110.0	.0	24.6	41.44	41.4	.38	4502	54694
2.7	7.2	.0	1.4	2.70	2.7	.12	CITROX	1567
26.5	68.8	.0	14.1	25.72	25.7	.12	Tartaric/NaOH	37214
19.9	46.7	.0	13.4	27.55	27.6	.01	4324	20086
9.8	27.3	.0	4.2	6.75	6.8	.12	Oxalic	15700
21.5	47.8	.0	16.9	32.68	32.7	.06	Oxalic/HNO3	54839
1.3	2.9	.0	1.1	3.87	3.9	.04	HF/HNO3	14820
21.5	52.4	.0	13.5	26.34		.11		344323

Cost Summary x/$ — TABLE 20

gamma mR/hr/$	gamma ug/$	UDS g/$	gamma mcurie/$	beta mcurie/$	cost $	Soln	Tot Vol-L
0	0	0	0	0	0	H2O	56566
211	505	0	142	338	5050	HNO3	76137
97	252	0	62	70	2055	KMnO4/HNO3	11200
7	15	0	7	15	869	4521	1500
113	287	0	64	108	20927	4502	54694
23	62	0	12	23	182	CITROX	1567
213	555	0	114	207	4614	Tartaric/NaOH	37214

	1583	3717	0	1068	2192	252	4324	20086
	84	236	0	36	58	1814	Oxalic	15700
	373	831	0	293	567	3157	Oxalic/HNO3	54839
	30	67	0	25	90	641	HF/HNO3	14820
Total	187	456	0	118	229	1.00		8.70

TABLE 21

Waste Analysis

Volume of Waste	344323	L	90970	gal
Wt of chemicals w/o HNO3	12161	Kg	26754	lbs
Moles of Na+ ; Molarity	80304	moles	.23	M
Moles of K+ ; Molarity	69518	moles	.20	M
Moles Na+ plus K+ ; Molarity	149822	moles	.44	M
Chemical cost 1982 $	39561	$		

Chemical Analysis (Kg)

	KMnO4	Citric	Oxalic	NH Oxal	Tart A	K+	Na+	Kg	L	# of Flushes
H2O									56566	22
HNO3								18036	76137	35
KMnO4/HNO3	219					54		1403	11200	5
4521		5	14	72				90	1500	1
4502	910					2664	39	4549	54694	18
Citrox		50	41					91	1567	1
Tart A/NaOH					821		1764	3889	37214	16
4324							45	395	20086	6
Oxalic A			1120					1120	15700	4
Oxalic/HNO3			1708					3100	54839	20
HF/HNO3	100							1837	14820	4
Totals	1128	55	2882	72	821	2718	1847	12161	344323	132

Approx. pH .2

Number of flushes	132
Samples taken	122

&k2S

U Cell 1988 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
71824	.38E+04	.31E+04	.20E+05	.00E+00	.00E+00	.24E+05	.37E+04	.00E+00	750	2	3.2E+08	.0	3.10	.00	0	1
71825	.38E+04	.31E+04	.20E+05	.00E+00	.00E+00	.24E+05	.37E+04	.00E+00	750	2	2.6E+07	.0	3.10	.00	0	1
71911	.38E+04	.31E+04	.20E+05	.00E+00	.00E+00	.24E+05	.37E+04	.00E+00	750	2	5.0E+07	.0	3.10	.00	0	1
71939	.38E+04	.31E+04	.20E+05	.00E+00	.00E+00	.24E+05	.37E+04	.00E+00	750	2	3.6E+07	.0	3.10	.00	0	1
72014	.38E+04	.31E+04	.20E+05	.00E+00	.00E+00	.24E+05	.37E+04	.00E+00	750	2	6.5E+06	.0	3.10	.00	0	1
72034	.38E+04	.31E+04	.20E+05	.00E+00	.00E+00	.24E+05	.37E+04	.00E+00	750	2	1.6E+07	.0	3.10	.00	0	1
72115	.38E+04	.31E+04	.20E+05	.00E+00	.00E+00	.24E+05	.37E+04	.00E+00	750	2	4.4E+06	.0	3.10	.00	0	1
72124	.38E+04	.31E+04	.20E+05	.00E+00	.00E+00	.24E+05	.37E+04	.00E+00	750	2	3.5E+06	.0	3.10	.00	0	1
72128	.38E+04	.31E+04	.20E+05	.00E+00	.00E+00	.24E+05	.37E+04	.00E+00	750	2	7.1E+06	.0	3.10	.00	0	1
72532	.62E+03	.97E+03	.52E+04	.00E+00	.00E+00	.46E+04	.80E+03	.00E+00	1500	1	1.3E+06	.0	.00	.00	0	1
7284	.28E+04	.99E+04	.69E+05	.28E+03	.00E+00	.66E+05	.94E+04	.00E+00	1750	7	1.4E+07	.0	2.25	8.00	0	139
72915	.49E+04	.94E+04	.58E+05	.00E+00	.00E+00	.46E+05	.77E+04	.00E+00	1750	1	1.3E+07	.0	.00	.00	0	139
7305	.38E+04	.31E+04	.20E+05	.00E+00	.00E+00	.24E+05	.37E+04	.00E+00	1750	2	1.4E+08	.0	37.80	.00	0	139
7311	.38E+03	.13E+03	.12E+04	.00E+00	.00E+00	.27E+04	.76E+03	.00E+00	1750	1	1.6E+06	.0	.00	.00	0	139
8011	.39E+04	.79E+04	.56E+05	.00E+00	.00E+00	.41E+05	.77E+04	.00E+00	1750	5	1.6E+07	.0	6.00	.00	0	139
80121	.23E+03	.20E+03	.21E+04	.00E+00	.00E+00	.94E+04	.16E+04	.00E+00	1750	1	6.0E+05	.0	.00	.00	0	139
8022	.98E+04	.87E+02	.38E+03	.56E+02	.00E+00	.40E+04	.18E+04	.00E+00	1750	11	4.7E+06	.0	3.60	3.10	0	139
8031	.60E+02	.13E+02	.13E+03	.00E+00	.00E+00	.65E+03	.16E+03	.00E+00	1750	1	1.1E+05	.0	.00	.00	0	139
1	.30E+04	.36E+04	.24E+05	.38E+02	.00E+00	.22E+05	.38E+04	.00E+00	1500	15	3.1E+07	.0	.20	15.80	0	0
1	.38E+04	.31E+04	.20E+05	.00E+00	.00E+00	.24E+05	.37E+04	.00E+00	1500	2	7.0E+07	.0	12.60	.00	0	0

Solutions

1. H2O
2. HNO3
3. KMnO4/HNO3
4. 4521
5. 4502
6. Citrox
7. Tartaric/NaOH
8. 4324
9. Oxalic
10. Citric A
11. Oxalic/HNO3
12. NH4OH
13. EDTA/NaOH
14. ARR
15. HF/HNO3

&k2S

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Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
72315	.12E+06	.21E+05	.10E+06	.36E+04	.00E+00	.66E+06	.60E+05	.00E+00	3000	1	1.4E+08	.0	.00	.00	0	132
7248	.41E+06	.17E+06	.46E+06	.00E+00	.00E+00	.12E+06	.18E+05	.00E+00	3000	1	2.8E+08	.0	.00	.00	0	132
7274	.17E+05	.49E+04	.27E+05	.00E+00	.00E+00	.10E+06	.85E+04	.00E+00	3000	1	2.7E+07	.0	.00	.00	0	132
7276	.41E+06	.17E+06	.46E+06	.00E+00	.00E+00	.12E+06	.18E+05	.00E+00	6000	1	1.2E+08	.0	.00	.00	0	132
80222	.12E+06	.67E+05	.27E+06	.20E+04	.00E+00	.49E+06	.56E+05	.00E+00	5618	2	9.8E+07	.0	18.90	.00	0	132
8079	.13E+05	.24E+05	.11E+06	.00E+00	.00E+00	.61E+05	.68E+04	.00E+00	5618	1	2.8E+07	.0	.00	.00	0	132
81212	.37E+05	.28E+05	.13E+06	.00E+00	.00E+00	.36E+06	.37E+05	.00E+00	6371	8	6.2E+07	.0	2.00	.00	0	132
81820	.12E+05	.11E+06	.74E+06	.60E+03	.00E+00	.63E+05	.18E+06	.00E+00	5944	5	1.4E+08	.0	8.00	.00	0	132
82219	.13E+06	.51E+05	.29E+06	.28E+04	.00E+00	.44E+06	.80E+06	.00E+00	5917	11	1.9E+08	.0	3.60	3.20	0	132
8283	.19E+05	.90E+05	.53E+06	.00E+00	.00E+00	.13E+06	.54E+05	.00E+00	5772	7	6.5E+07	.0	2.25	6.00	0	132
9035	.35E+05	.51E+05	.27E+06	.00E+00	.00E+00	.16E+06	.81E+04	.00E+00	5170	2	1.0E+07	.0	37.80	.00	0	132
90820	.14E+05	.15E+05	.75E+05	.00E+00	.00E+00	.60E+05	.27E+04	.00E+00	5420	1	1.4E+07	.0	.00	.00	0	132
91220	.37E+04	.43E+04	.24E+05	.00E+00	.00E+00	.43E+05	.57E+04	.00E+00	5815	8	8.7E+06	.0	2.00	.00	0	132
91513	.00E+00	.50E+04	.28E+05	.00E+00	.00E+00	.21E+05	.75E+04	.00E+00	5484	11	7.2E+06	.0	3.60	3.20	0	132
91810	.85E+04	.30E+05	.20E+06	.30E+03	.00E+00	.20E+06	.22E+05	.00E+00	5726	7	3.6E+07	.0	2.25	6.00	0	132
9214	.13E+06	.55E+05	.18E+06	.32E+03	.00E+00	.23E+06	.23E+05	.00E+00	1040	1	7.8E+06	.0	.00	.00	0	132
9236	.77E+05	.18E+05	.15E+06	.00E+00	.00E+00	.22E+06	.38E+05	.00E+00	7000	3	3.4E+07	.0	.80	12.60	0	132
100216	.38E+04	.20E+05	.14E+06	.00E+00	.00E+00	.41E+05	.21E+05	.00E+00	5400	9	2.0E+07	.0	4.50	.00	0	132
1	.13E+06	.55E+05	.18E+06	.32E+03	.00E+00	.23E+06	.23E+05	.00E+00	3000	1	8.4E+07	.0	.00	.00	0	132
92121	.18E+06	.23E+06	.16E+07	.00E+00	.00E+00	.15E+07	.36E+06	.00E+00	400	8	4.7E+08	.0	.20	.00	0	118
92121	.18E+06	.23E+06	.16E+07	.00E+00	.00E+00	.15E+07	.36E+06	.00E+00	600	5	4.7E+08	.0	8.00	.00	0	118
92121	.18E+06	.23E+06	.16E+07	.00E+00	.00E+00	.15E+07	.36E+06	.00E+00	600	11	4.7E+08	.0	3.60	3.15	0	118
92625	.77E+05	.38E+05	.28E+06	.00E+00	.00E+00	.20E+06	.59E+05	.00E+00	1000	3	4.6E+07	.0	8.00	12.60	0	306
92625	.77E+05	.38E+05	.28E+06	.00E+00	.00E+00	.20E+06	.59E+05	.00E+00	1000	11	4.6E+07	.0	3.60	3.15	0	306
92625	.77E+05	.38E+05	.28E+06	.00E+00	.00E+00	.20E+06	.59E+05	.00E+00	800	3	4.6E+07	.0	8.00	12.60	0	306
92625	.77E+05	.38E+05	.28E+06	.00E+00	.00E+00	.20E+06	.59E+05	.00E+00	800	11	4.6E+07	.0	3.60	3.15	0	306
9295	.14E+05	.98E+04	.65E+05	.00E+00	.00E+00	.44E+05	.80E+04	.00E+00	1000	7	1.5E+07	.0	.90	10.00	0	306
9295	.14E+05	.98E+04	.65E+05	.00E+00	.00E+00	.44E+05	.80E+04	.00E+00	800	2	1.5E+07	.0	37.80	.00	0	306
92917	.91E+04	.22E+05	.13E+06	.00E+00	.00E+00	.57E+05	.12E+05	.00E+00	1000	7	2.6E+07	.0	.90	10.00	0	306
92917	.91E+04	.22E+05	.13E+06	.00E+00	.00E+00	.57E+05	.12E+05	.00E+00	1000	2	2.6E+07	.0	37.80	.00	0	306
92918	.91E+03	.24E+04	.18E+05	.00E+00	.00E+00	.13E+05	.27E+04	.00E+00	1900	1	4.8E+06	.0	.00	.00	0	306
1	.28E+05	.23E+05	.14E+06	.00E+00	.00E+00	.26E+06	.45E+05	.00E+00	2500	8	6.1E+07	.0	2.00	.00	0	188
10059	.00E+00	.18E+06	.14E+07	.00E+00	.00E+00	.30E+07	.43E+06	.00E+00	2600	5	4.2E+08	.0	8.00	.00	0	188
10066	.11E+06	.30E+05	.27E+06	.00E+00	.00E+00	.58E+06	.12E+06	.00E+00	2210	11	1.4E+08	.0	3.64	3.15	0	188
10081	.12E+06	.66E+05	.56E+06	.98E+03	.00E+00	.90E+06	.19E+06	.00E+00	2800	7	2.7E+08	.0	2.20	6.00	0	188
10089	.26E+06	.59E+05	.54E+06	.00E+00	.00E+00	.10E+07	.13E+06	.00E+00	2600	2	3.3E+08	.0	37.80	.00	0	188
10095	.65E+04	.18E+05	.15E+06	.00E+00	.00E+00	.71E+04	.62E+04	.00E+00	2500	5	4.1E+07	.0	5.70	.00	0	188
10115	.38E+05	.83E+04	.75E+05	.82E+03	.00E+00	.21E+06	.80E+05	.00E+00	2500	11	4.0E+07	.0	3.60	3.15	0	188
101215	.20E+05	.35E+05	.29E+06	.00E+00	.00E+00	.62E+06	.52E+05	.00E+00	2870	7	8.1E+07	.0	2.25	8.00	0	188
10136	.17E+05	.93E+04	.84E+05	.00E+00	.00E+00	.20E+06	.19E+05	.00E+00	2453	2	4.7E+07	.0	37.80	.00	0	188
101410	.54E+05	.36E+05	.29E+06	.00E+00	.00E+00	.41E+06	.13E+06	.00E+00	2500	8	1.4E+08	.0	2.00	.00	0	193
10153	.14E+05	.48E+04	.35E+05	.00E+00	.00E+00	.18E+06	.24E+05	.00E+00	2500	8	3.7E+07	.0	2.00	.00	0	193
10173	.10E+06	.23E+05	.22E+06	.68E+03	.00E+00	.17E+07	.19E+06	.00E+00	3000	5	1.8E+08	.0	8.00	.00	0	193
10184	.10E+06	.19E+05	.14E+06	.00E+00	.00E+00	.16E+07	.17E+06	.00E+00	3000	11	2.3E+08	.0	4.00	3.15	0	193
101813	.86E+05	.17E+05	.14E+06	.00E+00	.00E+00	.13E+07	.12E+06	.00E+00	3000	2	2.2E+08	.0	37.80	.00	0	193
10194	.85E+05	.15E+05	.11E+06	.00E+00	.00E+00	.12E+07	.11E+06	.00E+00	3000	1	1.9E+08	.0	.00	.00	0	193
10203	.15E+05	.20E+05	.20E+06	.00E+00	.00E+00	.62E+06	.43E+05	.00E+00	2700	7	1.5E+08	.0	2.25	8.00	0	188
102019	.91E+04	.77E+04	.75E+05	.00E+00	.00E+00	.10E+06	.70E+04	.00E+00	2700	2	1.7E+07	.0	37.80	.00	0	188
102113	.00E+00	.28E+04	.27E+05	.00E+00	.00E+00	.85E+05	.91E+04	.00E+00	2500	1	1.7E+07	.0	.00	.00	0	188
1	.19E+05	.32E+05	.23E+06	.13E+03	.00E+00	.24E+06	.40E+05	.00E+00	500	7	6.2E+07	.0	2.25	6.00	0	306
1	.41E+05	.20E+05	.13E+06	.20E+03	.00E+00	.23E+06	.30E+05	.00E+00	500	2	5.4E+07	.0	37.80	.00	0	306
1	.13E+06	.55E+05	.18E+06	.32E+03	.00E+00	.23E+06	.23E+05	.00E+00	500	1	8.4E+07	.0	.00	.00	0	306

102310	.00E+00	.49E+04	.30E+05	.00E+00	.00E+00	.19E+05	.15E+04	.00E+00	500	7	4.2E+06	.0	2.25	6.00	0	306
102310	.00E+00	.49E+04	.30E+05	.00E+00	.00E+00	.19E+05	.15E+04	.00E+00	500	2	4.2E+06	.0	37.80	.00	0	306
102310	.00E+00	.49E+04	.30E+05	.00E+00	.00E+00	.19E+05	.15E+04	.00E+00	500	1	4.2E+06	.0	.00	.00	0	306
102416	.48E+06	.20E+06	.16E+07	.00E+00	.00E+00	.21E+07	.61E+06	.00E+00	600	5	8.4E+08	.0	8.00	.00	0	197
102416	.48E+06	.20E+06	.16E+07	.00E+00	.00E+00	.21E+07	.61E+06	.00E+00	600	11	8.4E+08	.0	3.60	3.15	0	197
102416	.48E+06	.20E+06	.16E+07	.00E+00	.00E+00	.21E+07	.61E+06	.00E+00	600	2	8.4E+08	.0	18.90	.00	0	197
1	.27E+05	.58E+05	.43E+06	.19E+03	.00E+00	.56E+06	.12E+06	.00E+00	5000	5	1.2E+08	.0	8.00	.00	0	207
1	.45E+04	.11E+05	.85E+05	.00E+00	.00E+00	.39E+05	.15E+05	.00E+00	5000	9	1.5E+07	.0	8.00	.00	0	207
11071	.37E+04	.13E+04	.10E+05	.00E+00	.00E+00	.24E+05	.23E+04	.00E+00	5000	2	3.8E+06	.0	18.90	.00	0	207
1	.27E+05	.58E+05	.43E+06	.19E+03	.00E+00	.56E+06	.12E+06	.00E+00	4000	5	1.2E+08	.0	9.00	.00	0	212
110714	.00E+00	.13E+05	.13E+06	.00E+00	.00E+00	.17E+05	.23E+05	.00E+00	4000	2	1.2E+07	.0	18.90	.00	0	212
110716	.00E+00	.92E+04	.86E+05	.00E+00	.00E+00	.12E+05	.17E+05	.00E+00	3000	5	8.8E+06	.0	16.00	.00	0	188
110823	.17E+05	.30E+04	.28E+05	.00E+00	.00E+00	.69E+05	.16E+05	.00E+00	3000	11	1.7E+07	.0	4.00	3.15	0	188
110910	.46E+04	.19E+04	.19E+05	.00E+00	.00E+00	.27E+05	.70E+04	.00E+00	3000	2	6.9E+06	.0	18.90	.00	0	188
11111	.00E+00	.23E+05	.64E+05	.00E+00	.00E+00	.14E+05	.35E+04	.00E+00	2000	5	7.4E+06	.0	10.00	.00	0	207
11111	.00E+00	.23E+05	.64E+05	.00E+00	.00E+00	.14E+05	.35E+04	.00E+00	2000	11	7.4E+06	.0	4.00	3.15	0	207
11123	.38E+04	.25E+04	.23E+05	.00E+00	.00E+00	.32E+05	.75E+04	.00E+00	3000	7	7.2E+06	.0	2.25	12.00	0	0
111318	.24E+04	.18E+04	.16E+05	.00E+00	.00E+00	.14E+05	.26E+04	.00E+00	3000	2	4.2E+06	.0	37.80	.00	0	0
111214	.00E+00	.34E+01	.30E+05	.00E+00	.00E+00	.12E+05	.13E+05	.00E+00	4000	7	3.9E+06	.0	2.25	12.00	0	0
11141	.89E+04	.24E+04	.22E+05	.00E+00	.00E+00	.43E+05	.73E+04	.00E+00	4000	2	1.0E+07	.0	37.80	.00	0	0
11155	.37E+04	.16E+04	.66E+04	.00E+00	.00E+00	.91E+04	.18E+04	.00E+00	2000	7	3.2E+06	.0	2.25	12.00	0	0
11155	.37E+04	.16E+04	.66E+04	.00E+00	.00E+00	.91E+04	.18E+04	.00E+00	2000	2	3.2E+06	.0	37.80	.00	0	0
111519	.56E+03	.22E+04	.17E+05	.00E+00	.00E+00	.59E+04	.41E+03	.00E+00	600	7	1.9E+06	.0	2.25	12.00	0	0
111519	.56E+03	.22E+04	.17E+05	.00E+00	.00E+00	.59E+04	.41E+03	.00E+00	600	2	1.9E+06	.0	37.80	.00	0	0
11176	.68E+04	.41E+04	.45E+05	.00E+00	.00E+00	.54E+05	.14E+05	.00E+00	3000	9	1.5E+07	.0	9.00	.00	0	0
111910	.33E+04	.97E+03	.66E+04	.00E+00	.00E+00	.13E+05	.26E+04	.00E+00	2300	9	3.2E+06	.0	9.00	.00	0	0
111911	.00E+00	.28E+05	.28E+06	.00E+00	.00E+00	.29E+06	.52E+05	.00E+00	2200	5	4.7E+07	.0	12.00	.00	0	0
112012	.17E+05	.27E+04	.24E+05	.00E+00	.00E+00	.85E+05	.17E+05	.00E+00	1500	4	1.9E+07	.0	6.00	.00	0	0
11215	.23E+04	.00E+00	.23E+04	.00E+00	.00E+00	.73E+04	.89E+03	.00E+00	1500	2	1.9E+06	.0	25.20	.00	0	0
112147	.00E+00	.00E+00	.14E+04	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	1200	3	3.8E+05	.0	.80	3.15	0	0
112520	.56E+05	.25E+05	.16E+06	.52E+03	.00E+00	.34E+06	.18E+06	.00E+00	1200	11	5.8E+05	.0	4.00	3.15	0	0
112010	.00E+00	.96E+02	.70E+03	.00E+00	.00E+00	.82E+03	.00E+00	.00E+00	1400	7	3.1E+05	.0	2.25	8.00	0	0
112136	.00E+00	.00E+00	.37E+03	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	1300	2	2.0E+05	.0	25.20	.00	0	0
112228	.00E+00	.95E+02	.73E+03	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	1200	3	2.3E+05	.0	.80	3.15	0	0
112410	.00E+00	.00E+00	.13E+04	.00E+00	.00E+00	.28E+04	.33E+03	.00E+00	1200	11	6.3E+05	.0	4.00	3.15	0	0
112918	.00E+00	.96E+04	.60E+05	.00E+00	.00E+00	.12E+05	.84E+04	.00E+00	6700	5	4.0E+06	.0	6.50	.00	0	0
12045	.61E+03	.31E+04	.18E+05	.00E+00	.00E+00	.22E+05	.73E+04	.00E+00	7500	11	5.4E+06	.0	1.44	1.26	0	0
120520	.00E+00	.36E+03	.27E+04	.00E+00	.00E+00	.22E+04	.16E+05	.00E+00	4100	15	1.2E+06	.0	.73	11.50	0	0
120618	.00E+00	.42E+03	.27E+04	.00E+00	.00E+00	.63E+03	.96E+04	.00E+00	5100	15	3.6E+06	.0	.78	12.40	0	0
120830	.00E+00	.25E+03	.19E+04	.00E+00	.00E+00	.18E+04	.16E+04	.00E+00	6500	2	5.7E+05	.0	6.30	.00	0	0

Solutions

1. H2O
2. HNO3
3. KMnO4/HNO3
4. 4521
5. 4502
6. Citrox
7. Tartaric/NaOH
8. 4324
9. Oxalic
10. Citric A
11. Oxalic/HNO3
12. NH4OH
13. EDTA/NaOH
14. ARR
15. HF/HNO3

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H Cell 1989 FILE AS READ IN

Log #	Ce144 dps/ml	Cs134 dps	Cs137 dps	Nb 95 dps	Ru103 dps	Ru106 dps	Sb125 dps	Zr 95 dps	Vol-L L	Soln	Beta dpm/ml	uds g/L	% ch 1 % wt	% ch 2 % wt	mR/hr mR/hr	Proc #
5113	.00E+00	.12E+05	.11E+06	.00E+00	.00E+00	.53E+05	.33E+05	.00E+00	4244	5	4.0E+07	.0	7.10	.00	0	68
5138	.56E+05	.18E+05	.18E+06	.00E+00	.00E+00	.42E+06	.95E+05	.00E+00	4606	11	8.7E+07	.0	2.50	1.70	0	68
5154	.00E+00	.24E+05	.28E+06	.00E+00	.00E+00	.36E+06	.84E+05	.00E+00	3652	5	4.9E+07	.0	8.20	.00	0	68
5175	.37E+05	.70E+04	.73E+05	.00E+00	.00E+00	.22E+06	.47E+05	.00E+00	4090	11	5.3E+07	.0	2.50	2.00	0	68
51815	.13E+05	.11E+04	.13E+05	.00E+00	.00E+00	.48E+05	.13E+05	.00E+00	4120	15	1.4E+07	.0	.67	9.60	0	73
5196	.31E+04	.26E+03	.29E+04	.00E+00	.00E+00	.11E+05	.29E+04	.00E+00	4120	2	3.3E+06	.0	7.60	.00	0	73
51912	.14E+04	.69E+03	.74E+04	.00E+00	.00E+00	.76E+04	.19E+04	.00E+00	3400	1	1.9E+06	.0	.00	.00	0	73
5224	.00E+00	.52E+04	.62E+05	.00E+00	.00E+00	.18E+04	.91E+04	.00E+00	4686	5	7.5E+06	.0	6.40	.00	0	83
52411	.15E+05	.20E+04	.25E+05	.00E+00	.00E+00	.57E+05	.18E+05	.00E+00	5150	11	2.1E+07	.0	2.00	1.50	0	83
5267	.11E+05	.35E+04	.41E+05	.00E+00	.00E+00	.63E+05	.16E+05	.00E+00	4976	2	1.3E+07	.0	19.00	.00	0	83
52811	.00E+00	.19E+04	.22E+05	.00E+00	.00E+00	.22E+05	.67E+04	.00E+00	1567	6	6.0E+06	.0	3.20	2.60	0	96
5301	.19E+04	.17E+04	.19E+05	.00E+00	.00E+00	.15E+05	.54E+04	.00E+00	1596	7	3.7E+06	.0	3.00	6.30	0	96
53017	.00E+00	.24E+03	.25E+04	.00E+00	.00E+00	.45E+04	.13E+04	.00E+00	3956	1	1.0E+06	.0	.00	.00	0	96
60113	.00E+00	.16E+04	.19E+05	.00E+00	.00E+00	.18E+05	.49E+04	.00E+00	1018	5	1.1E+07	.0	12.00	.00	0	96
6035	.00E+00	.00E+00	.37E+03	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	1032	11	3.3E+05	.0	5.00	3.20	0	96
6035	.00E+00	.00E+00	.41E+02	.00E+00	.00E+00	.00E+00	.00E+00	.00E+00	1032	1	3.9E+04	.0	.00	.00	0	96
60517	.16E+04	.22E+03	.29E+04	.00E+00	.00E+00	.74E+04	.37E+04	.00E+00	1200	2	1.7E+06	.0	37.80	.00	0	101
6064	.53E+03	.23E+04	.27E+05	.00E+00	.00E+00	.15E+05	.35E+04	.00E+00	1200	5	3.8E+06	.0	10.00	.00	0	101
60715	.13E+04	.18E+03	.23E+04	.00E+00	.00E+00	.59E+04	.30E+04	.00E+00	1200	11	1.5E+06	.0	5.00	3.15	0	101
60715	.32E+03	.44E+02	.58E+03	.00E+00	.00E+00	.15E+04	.75E+03	.00E+00	1200	1	3.7E+05	.0	.00	.00	0	101

Solutions

1. H2O
2. HNO3
3. KMnO4/HNO3
4. 4521
5. 4502
6. Citrox
7. Tartaric/NaOH
8. 4324
9. Oxalic
10. Citric A
11. Oxalic/HNO3
12. NH4OH
13. EDTA/NaOH
14. ARR
15. HF/HNO3

Appendix H

1982 to 1990 Decontamination Data Summary

Appendix H

1982 to 1990 Decontamination Data Summary

The data in this appendix is arranged in two parts. The first part is a long analysis of the data. It consists of 21 tables, each of which look at the information collected by sampling in a unique way. These tables provide many different ways of looking at the data. It is hoped that considerable time will be spent reviewing these tables by those who want more detail concerning the many aspects of decontamination. Many of the figures and tables used in the body of the report came from this section. However, these tables provide in depth analysis and allow the researcher to identify trends or effects that were not discussed in the report.

The second part of this appendix contains the raw data. This is the unmodified, unmanipulated sample results. In this section, the averages have been included and can be identified by a log number of 1. Actual log numbers are given so that a researcher can obtain original sample results or in some way verify any questions that may arise. The sample results for the isotopes are recorded as dps/mL. Beta results are a gross beta count and are in dpm/mL.

Solutions were tracked and the quantities of chemicals used was recorded. A weight percent was used to calculate chemical quantities. To simplify the tracking of chemical quantities, the weight percent was calculated assuming a liter of solution weighted one kg. Thus, if 300 grams of chemical A were taken and water was added to make one liter then this solution would be 30 wt% chemical A. The calculation simply becomes:

$$(300\ g/1000\ mL)(1\ mL/1\ g)(100) = 30\ wt\%$$

This ignores the actual density of the solution. However, the error introduced by this simplifying approach was decided to be acceptable due to other errors, such as measuring quantities of bulk chemicals used and in the volume measurements of the liquids. This seems to be acceptable, because large errors were created by inaccuracies in weighing large quantities of bulk chemicals and in errors in measuring volumes of large tanks.

The tables contained in this appendix are based on averaged data from 1982 through 1990 decontaminations of First Cycle following campaigns #37 through 42. Below is a summary of the data tables. Data for this section came from the raw data in the previous appendices.

1982 to 1990 Decontamination Data Summary

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ESTIMATED VALUES BASED ON AVERAGES

DECON INFORMATION ON 1982-1989 Decons

TABLE 1

Individual Isotope Information

	Ci	mg	R/hr
Zr 95	256	12	635
Nb 95	4092	104	18772
Ru103	5	0	13
Ru106	3101	919	1813
Sb125	1626	1534	1252
Cs134	347	268	1228
Cs137	2585	29651	8723
Ce144	555	174	49
Total	12566	32663	32485
Beta	26769		

TABLE 2

X/L Isotope Information

	mCi/L	ug/L	mR/hr*L
Zr 95	.3	.0	.6
Nb 95	4.0	.1	18.5
Ru103	.0	.0	.0
Ru106	3.1	.9	1.8
Sb125	1.6	1.5	1.2
Cs134	.3	.3	1.2
Cs137	2.5	29.2	8.6
Ce144	.5	.2	.0
Total	12.4	32.2	32.0
Beta	26.4	Beta/min/ml= 5.9E+07	

TABLE 3

% Isotope Information

	Ci	mg	R/hr
Zr 95	2.0	.0	2.0
Nb 95	32.6	.3	57.8
Ru103	.0	.0	.0
Ru106	24.7	2.8	5.6
Sb125	12.9	4.7	3.9
Cs134	2.8	.8	3.8
Cs137	20.6	90.8	26.9
Ce144	4.4	.5	.2

TABLE 4

Solution Information - mCi/L

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.89	.36	1.86	.82	.00	1.31	.51	.09	5.84	H2O	250383
	.30	.17	1.17	3.32	.00	2.16	1.29	.45	8.86	HNO3	241995
	.49	.12	1.16	.52	.06	8.52	1.74	.22	12.83	KMnO4/HNO3	53741
	.08	.13	1.60	2.61	.01	1.67	.41	.29	6.80	4521	49961
	.28	.76	6.70	.36	.00	6.06	1.90	.07	16.14	4502	114628
	3.81	.46	3.22	6.53	.00	1.07	.20	.40	15.71	CITROX	21819
	.20	.45	4.06	24.61	.00	3.38	3.70	.65	37.06	Tartaric/NaOH	102504
	.68	.68	5.00	.00	.00	6.68	1.10	.00	14.13	4324	22486
	.09	.18	1.45	1.97	.00	.68	1.03	.12	5.50	Oxalic	35931
	.07	.01	.04	.16	.00	.12	.08	.02	.51	Citric A	3000
	1.01	.46	3.30	1.64	.00	6.37	4.63	.10	17.51	Oxalic/HNO3	71067
	.00	.06	.49	1.19	.00	.95	2.97	.11	5.77	NH4OH	2900
	.02	.11	.83	.23	.00	.07	1.07	.01	2.35	EDTA/NaOH	18757
	.02	.23	2.00	2.16	.00	.62	4.61	.10	9.74	ARR	10394
	.11	.02	.21	.00	.00	.44	.32	.00	1.10	HF/HNO3	14820
Tot	.55	.34	2.55	4.03	.00	3.06	1.60	.25	12.39		1014386

TABLE 5

Solution Information - ug/L

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
.28	.28	21.30	.02	.00	.39	.48	.00	22.75	H2O	250383
.09	.13	13.45	.08	.00	.64	1.21	.02	15.63	HNO3	241995
.15	.09	13.33	.01	.00	2.53	1.64	.01	17.77	KMnO4/HNO3	53741
.03	.10	18.36	.07	.00	.50	.38	.01	19.45	4521	49961
.09	.59	76.80	.01	.00	1.79	1.79	.00	81.08	4502	114628
1.20	.36	36.99	.17	.00	.32	.19	.02	39.24	CITROX	21819

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.06	.35	46.59	.63	.00	1.00	3.49	.03	52.15	Tartaric/NaOH	102504
	.22	.52	57.30	.00	.00	1.98	1.04	.00	61.05	4324	22486
	.03	.14	16.58	.05	.00	.20	.97	.01	17.97	Oxalic	35931
	.02	.01	.44	.00	.00	.04	.08	.00	.59	Citric A	3000
	.32	.36	37.82	.04	.00	1.89	4.37	.00	44.80	Oxalic/HNO3	71067
	.00	.05	5.58	.03	.00	.28	2.81	.01	8.75	NH4OH	2900
	.01	.08	9.53	.01	.00	.02	1.01	.00	10.66	EDTA/NaOH	18757
	.01	.18	22.92	.05	.00	.18	4.35	.00	27.70	ARR	10394
	.03	.02	2.39	.00	.00	.13	.30	.00	2.88	HF/HNO3	14820
Tot	.17	.26	29.23	.10	.00	.91	1.51	.01	32.20		1014386

TABLE 6

Solution Information - mR/hr*L

	Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
	.08	1.26	6.27	3.78	.00	.76	.39	.23	12.78	H2O	250383
	.03	.60	3.96	15.21	.01	1.26	.99	1.12	23.18	HNO3	241995
	.04	.43	3.92	2.38	.16	4.98	1.34	.54	13.79	KMnO4/HNO3	53741
	.01	.46	5.40	11.98	.02	.98	.31	.71	19.88	4521	49961
	.03	2.71	22.59	1.66	.00	3.54	1.46	.18	32.17	4502	114628
	.34	1.65	10.88	29.94	.00	.63	.15	1.00	44.59	CITROX	21819
	.02	1.61	13.71	112.91	.00	1.98	2.85	1.62	134.69	Tartaric/NaOH	102504
	.06	2.40	16.86	.01	.00	3.90	.84	.00	24.08	4324	22486
	.01	.62	4.88	9.03	.00	.40	.79	.29	16.01	Oxalic	35931
	.01	.03	.13	.76	.00	.07	.06	.06	1.11	Citric A	3000
	.09	1.64	11.13	7.54	.00	3.72	3.56	.25	27.93	Oxalic/HNO3	71067
	.00	.23	1.64	5.46	.00	.55	2.29	.27	10.44	NH4OH	2900
	.00	.37	2.80	1.06	.00	.04	.83	.03	5.14	EDTA/NaOH	18757
	.00	.82	6.74	9.90	.00	.36	3.55	.25	21.63	ARR	10394
	.01	.09	.70	.00	.00	.26	.24	.00	1.30	HF/HNO3	14820
Tot	.05	1.21	8.60	18.51	.01	1.79	1.23	.63	32.02		1014386

TABLE 7

Solution Information - curies

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
222	89	465	206	0	327	127	24	1461	H2O	250383
73	41	284	802	1	523	312	109	2144	HNO3	241995
26	7	62	28	3	458	94	12	690	KMnO4/HNO3	53741
4	7	80	130	0	83	20	14	340	4521	49961
32	88	768	41	0	694	218	8	1850	4502	114628
83	10	70	142	0	23	4	9	343	CITROX	21819
20	47	416	2523	0	347	379	67	3799	Tartaric/NaOH	102504
15	15	112	0	0	150	25	0	318	4324	22486

3	6	52	71	0	24	37	4	198	Oxalic	35931
0	0	0	0	0	0	0	0	2	Citric A	3000
72	33	234	117	0	452	329	7	1245	Oxalic/HNO3	71067
0	0	1	3	0	3	9	0	17	NH4OH	2900
0	2	16	4	0	1	20	0	44	EDTA/NaOH	18757
0	2	21	22	0	6	48	1	101	ARR	10394
2	0	3	0	0	7	5	0	16	HF/HNO3	14820

TABLE 8

Solution Information - mg

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
70	69	5334	5	0	97	120	1	5697	H2O	250383
23	32	3255	20	0	155	294	5	3783	HNO3	241995
8	5	717	1	0	136	88	1	955	KMnO4/HNO3	53741
1	5	917	3	0	25	19	1	972	4521	49961
10	68	8803	1	0	206	206	0	9294	4502	114628
26	8	807	4	0	7	4	0	856	CITROX	21819
6	36	4776	64	0	103	358	3	5346	Tartaric/NaOH	102504
5	12	1288	0	0	44	23	0	1373	4324	22486
1	5	596	2	0	7	35	0	646	Oxalic	35931
0	0	1	0	0	0	0	0	2	Citric A	3000
23	25	2688	3	0	134	310	0	3184	Oxalic/HNO3	71067
0	0	16	0	0	1	8	0	25	NH4OH	2900
0	2	179	0	0	0	19	0	200	EDTA/NaOH	18757
0	2	238	1	0	2	45	0	288	ARR	10394
0	0	35	0	0	2	4	0	43	HF/HNO3	14820

TABLE 9

Solution Information - R/hr

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
20	316	1569	945	1	191	98	59	3199	H2O	250383
7	145	957	3682	2	306	240	271	5608	HNO3	241995
2	23	211	128	9	268	72	29	741	KMnO4/HNO3	53741
0	23	270	598	1	49	16	36	993	4521	49961
3	310	2590	190	0	406	168	21	3688	4502	114628
7	36	237	653	0	14	3	22	973	CITROX	21819
2	165	1405	11574	0	203	292	166	13807	Tartaric/NaOH	102504
1	54	379	0	0	88	19	0	541	4324	22486
0	22	175	325	0	14	28	10	575	Oxalic	35931
0	0	0	2	0	0	0	0	3	Citric A	3000
6	116	791	536	0	265	253	18	1985	Oxalic/HNO3	71067
0	1	5	16	0	2	7	1	30	NH4OH	2900
0	7	53	20	0	1	16	1	96	EDTA/NaOH	18757
0	9	70	103	0	4	37	3	225	ARR	10394

0	1	10	0	0	4	4	0	19	HF/HNO3	14820

TABLE 10

% Solution Information curies % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
15.2	6.1	31.8	14.1	.0	22.4	8.7	1.6	11.6	H2O	24.7
3.4	1.9	13.2	37.4	.0	24.4	14.5	5.1	17.1	HNO3	23.9
3.8	.9	9.1	4.0	.5	66.4	13.6	1.7	5.5	KMnO4/HNO3	5.3
1.2	1.9	23.5	38.4	.1	24.6	6.0	4.2	2.7	4521	4.9
1.8	4.7	41.5	2.2	.0	37.5	11.8	.4	14.7	4502	11.3
24.3	3.0	20.5	41.5	.0	6.8	1.3	2.6	2.7	CITROX	2.2
.5	1.2	11.0	66.4	.0	9.1	10.0	1.8	30.2	Tartaric/NaOH	10.1
4.8	4.8	35.3	.0	.0	47.2	7.8	.0	2.5	4324	2.2
1.6	3.2	26.3	35.8	.0	12.3	18.7	2.1	1.6	Oxalic	3.5
13.6	1.7	7.6	32.4	.0	24.3	16.0	4.4	.0	Citric A	.3
5.8	2.6	18.8	9.4	.0	36.4	26.4	.6	9.9	Oxalic/HNO3	7.0
.0	1.1	8.4	20.6	.0	16.4	51.5	1.9	.1	NH4OH	.3
1.0	4.5	35.3	9.8	.0	3.1	45.7	.5	.4	EDTA/NaOH	1.8
2	2.4	20.5	22.2	.0	6.4	47.3	1.0	.8	ARR	1.0
9.6	2.2	19.0	.0	.0	40.3	28.8	.0	.1	HF/HNO3	1.5

TABLE 11

% Solution Information mg % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
1.2	1.2	93.6	.1	.0	1.7	2.1	.0	17.4	H2O	24.7
.6	.8	86.0	.5	.0	4.1	7.8	.1	11.6	HNO3	23.9
.9	.5	75.0	.1	.0	14.2	9.2	.1	2.9	KMnO4/HNO3	5.3
.1	.5	94.4	.3	.0	2.5	2.0	.1	3.0	4521	4.9
.1	.7	94.7	.0	.0	2.2	2.2	.0	28.5	4502	11.3
3.1	.9	94.3	.4	.0	.8	.5	.0	2.6	CITROX	2.2
.1	.7	89.3	1.2	.0	1.9	6.7	.1	16.4	Tartaric/NaOH	10.1
.4	.9	93.9	.0	.0	3.2	1.7	.0	4.2	4324	2.2
.2	.8	92.3	.3	.0	1.1	5.4	.0	2.0	Oxalic	3.5
3.7	1.1	75.1	.7	.0	6.2	13.0	.2	.0	Citric A	.3
.7	.8	84.4	.1	.0	4.2	9.7	.0	9.7	Oxalic/HNO3	7.0
.0	.6	63.8	.3	.0	3.2	32.1	.1	.1	NH4OH	.3
.1	.8	89.4	.1	.0	.2	9.5	.0	.6	EDTA/NaOH	1.8
.0	.6	82.8	.2	.0	.7	15.7	.0	.9	ARR	1.0
1.2	.7	83.2	.0	.0	4.6	10.4	.0	.1	HF/HNO3	1.5

TABLE 12

% Solution Information R/hr % -->

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
.6	9.9	49.1	29.6	.0	6.0	3.1	1.8	9.8	H2O	24.7
.1	2.6	17.1	65.6	.0	5.4	4.3	4.8	17.3	HNO3	23.9
.3	3.1	28.4	17.2	1.2	36.1	9.7	3.9	2.3	KMnO4/HNO3	5.3
.0	2.3	27.2	60.3	.1	4.9	1.6	3.6	3.1	4521	4.9
.1	8.4	70.2	5.2	.0	11.0	4.5	.6	11.4	4502	11.3
.8	3.7	24.4	67.1	.0	1.4	.3	2.2	3.0	CITROX	2.2
.0	1.2	10.2	83.8	.0	1.5	2.1	1.2	42.5	Tartaric/NaOH	10.1
.3	10.0	70.0	.0	.0	16.2	3.5	.0	1.7	4324	2.2
.1	3.9	30.5	56.4	.0	2.5	4.9	1.8	1.8	Oxalic	3.5
.6	2.8	11.7	67.9	.0	6.5	5.6	5.0	.0	Citric A	.3
.3	5.9	39.8	27.0	.0	13.3	12.7	.9	6.1	Oxalic/HNO3	7.0
.0	2.2	15.7	52.2	.0	5.3	21.9	2.6	.1	NH4OH	.3
.0	7.3	54.6	20.6	.0	.8	16.1	.6	.3	EDTA/NaOH	1.8
.0	3.8	31.2	45.8	.0	1.7	16.4	1.2	.7	ARR	1.0
.7	6.7	54.0	.0	.0	19.9	18.7	.0	.1	HF/HNO3	1.5

TABLE 13

% Solution Info. curies,mg,R/hr % down columns

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Soln	Total Vol
40.1	25.8	18.0	5.0	4.9	10.6	7.8	9.2	H2O	24.7
13.2	11.8	11.0	19.6	13.8	16.9	19.2	42.7	HNO3	23.9
4.7	1.9	2.4	.7	67.9	14.8	5.8	4.5	KMnO4/HNO3	5.3
.8	1.9	3.1	3.2	8.6	2.7	1.3	5.6	4521	4.9
5.8	25.3	29.7	1.0	.9	22.4	13.4	3.2	4502	11.3
15.0	2.9	2.7	3.5	.9	.8	.3	3.4	CITROX	2.2
3.7	13.4	16.1	61.7	2.9	11.2	23.3	26.1	Tartaric/NaOH	10.1
2.8	4.4	4.3	.0	.0	4.8	1.5	.0	4324	2.2
.6	1.8	2.0	1.7	.0	.8	2.3	1.6	Oxalic	3.5
.0	.0	.0	.0	.0	.0	.0	.0	Citric A	.3
13.0	9.5	9.1	2.9	.0	14.6	20.2	2.8	Oxalic/HNO3	7.0
.0	.1	.1	.1	.0	.1	.5	.1	NH4OH	.3
.1	.6	.6	.1	.0	.0	1.2	.1	EDTA/NaOH	1.8
.0	.7	.8	.5	.0	.2	2.9	.4	ARR	1.0
.3	.1	.1	.0	.0	.2	.3	.0	HF/HNO3	1.5

TABLE 14

% Solution Info. curies/tot curies

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol

1.8	.7	3.7	1.6	.0	2.6	1.0	.2	11.6	H2O	24.7
.6	.3	2.3	6.4	.0	4.2	2.5	.9	17.1	HNO3	23.9
.2	.1	.5	.2	.0	3.6	.7	.1	5.5	KMnO4/HNO3	5.3
.0	.1	.6	1.0	.0	.7	.2	.1	2.7	4521	4.9
.3	.7	6.1	.3	.0	5.5	1.7	.1	14.7	4502	11.3
.7	.1	.6	1.1	.0	.2	.0	.1	2.7	CITROX	2.2
.2	.4	3.3	20.1	.0	2.8	3.0	.5	30.2	Tartaric/NaOH	10.1
.1	.1	.9	.0	.0	1.2	.2	.0	2.5	4324	2.2
.0	.1	.4	.6	.0	.2	.3	.0	1.6	Oxalic	3.5
.0	.0	.0	.0	.0	.0	.0	.0	.0	Citric A	.3
.6	.3	1.9	.9	.0	3.6	2.6	.1	9.9	Oxalic/HNO3	7.0
.0	.0	.0	.0	.0	.0	.1	.0	.1	NH4OH	.3
.0	.0	.1	.0	.0	.0	.2	.0	.4	EDTA/NaOH	1.8
.0	.0	.2	.2	.0	.1	.4	.0	.8	ARR	1.0
.0	.0	.0	.0	.0	.1	.0	.0	.1	HF/HNO3	1.5
Tot 4.4	2.8	20.6	32.6	.0	24.7	12.9	2.0			

TABLE 15

% Solution Info. mg/tot mg

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
.2	.2	16.3	.0	.0	.3	.4	.0	17.4	H2O	24.7
.1	.1	10.0	.1	.0	.5	.9	.0	11.6	HNO3	23.9
.0	.0	2.2	.0	.0	.4	.3	.0	2.9	KMnO4/HNO3	5.3
.0	.0	2.8	.0	.0	.1	.1	.0	3.0	4521	4.9
.0	2	27.0	.0	.0	.6	.6	.0	28.5	4502	11.3
.1	.0	2.5	.0	.0	.0	.0	.0	2.6	CITROX	2.2
.0	.1	14.6	.2	.0	.3	1.1	.0	16.4	Tartaric/NaOH	10.1
.0	.0	3.9	.0	.0	.1	.1	.0	4.2	4324	2.2
.0	.0	1.8	.0	.0	.0	.1	.0	2.0	Oxalic	3.5
.0	.0	.0	.0	.0	.0	.0	.0	.0	Citric A	.3
.1	.1	8.2	.0	.0	.4	.9	.0	9.7	Oxalic/HNO3	7.0
.0	.0	.0	.0	.0	.0	.0	.0	.1	NH4OH	.3
.0	.0	.5	.0	.0	.0	.1	.0	.6	EDTA/NaOH	1.8
.0	.0	.7	.0	.0	.0	.1	.0	.9	ARR	1.0
.0	.0	.1	.0	.0	.0	.0	.0	.1	HF/HNO3	1.5
Tot .5	.8	90.8	.3	.0	2.8	4.7	.0			

TABLE 16

% Solution Info. R/hr/tot R

Ce144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Total	Soln	Total Vol
.1	1.0	4.8	2.9	.0	.6	.3	.2	9.8	H2O	24.7

	.0	.4	2.9	11.3	.0	.9	.7	.8	17.3	HNO3	23.9
	.0	.1	.6	.4	.0	.8	.2	.1	2.3	KMnO4/HNO3	5.3
	.0	.1	.8	1.8	.0	.2	.0	.1	3.1	4521	4.9
	.0	1.0	8.0	.6	.0	1.2	.5	.1	11.4	4502	11.3
	.0	.1	.7	2.0	.0	.0	.0	.1	3.0	CITROX	2.2
	.0	.5	4.3	35.6	.0	.6	.9	.5	42.5	Tartaric/NaOH	10.1
	.0	.2	1.2	.0	.0	.3	.1	.0	1.7	4324	2.2
	.0	.1	.5	1.0	.0	.0	.1	.0	1.8	Oxalic	3.5
	.0	.0	.0	.0	.0	.0	.0	.0	.0	Citric A	.3
	.0	.4	2.4	1.7	.0	.8	.8	.1	6.1	Oxalic/HNO3	7.0
	.0	.0	.0	.0	.0	.0	.0	.0	.1	NH4OH	.3
	.0	.0	.2	.1	.0	.0	.0	.0	.3	EDTA/NaOH	1.8
	.0	.0	.2	.3	.0	.0	.1	.0	.7	ARR	1.0
	.0	.0	.0	.0	.0	.0	.0	.0	.1	HF/HNO3	1.5
Tot	.2	3.8	26.9	57.8	.0	5.6	3.9	2.0			

TABLE 17

Solution Summary

	gamma R/hr	gamma mg	UDS g	gamma curie	beta curie	Cost $	Soln	Vol-L
	3199	5697	274	1461	2097	0	H2O	250383
	5608	3783	466	2144	3084	19136	HNO3	241995
	741	955	85	690	12368	6132	KMnO4/HNO3	53741
	993	972	285	340	464	41341	4521	49961
	3688	9294	365	1850	2834	41237	4502	114628
	973	856	160	343	118	2754	CITROX	21819
	13807	5346	380	3799	2901	11824	Tartaric/NaOH	102504
	541	1373	0	318	565	314	4324	22486
	575	646	19	198	209	4899	Oxalic	35931
	3	2	0	2	3	644	Citric A	3000
	1985	3184	0	1245	1934	4553	Oxalic/HNO3	71067
	30	25	0	17	16	106	NH4OH	2900
	96	200	0	44	54	7646	EDTA/NaOH	18757
	225	288	0	101	66	907	ARR	10394
	19	43	0	16	57	641	HF/HNO3	14820
Total	32485	32663	2033	12566	26769	142135		1014386

TABLE 18

Solution Summary %

gamma R/hr	gamma mg	UDS g	gamma curie	beta curie	Cost $	Soln	Vol-L
9.8	17.4	13.5	11.6	7.8	.0	H2O	24.7

17.3	11.6	22.9	17.1	11.5	13.5	HNO3	23.9
2.3	2.9	4.2	5.5	46.2	4.3	KMnO4/HNO3	5.3
3.1	3.0	14.0	2.7	1.7	29.1	4521	4.9
11.4	28.5	17.9	14.7	10.6	29.0	4502	11.3
3.0	2.6	7.9	2.7	.4	1.9	CITROX	2.2
42.5	16.4	18.7	30.2	10.8	8.3	Tartaric/NaOH	10.1
1.7	4.2	.0	2.5	2.1	.2	4324	2.2
1.8	2.0	.9	1.6	.8	3.4	Oxalic	3.5
.0	.0	.0	.0	.0	.5	Citric A	.3
6.1	9.7	.0	9.9	7.2	3.2	Oxalic/HNO3	7.0
.1	.1	.0	.1	.1	.1	NH4OH	.3
.3	.6	.0	.4	.2	5.4	EDTA/NaOH	1.8
.7	.9	.0	.8	.2	.6	ARR	1.0
.1	.1	.0	.1	.2	.5	HF/HNO3	1.5

TABLE 19

Solution Summary x/L

gamma mR/hr*L	gamma ug/L	UDS g/L	gamma mcurie/L	beta mcurie/L	B/L	Cost $/L	Soln	Tot Vol-L
12.8	22.8	1.1	5.8	8.38	8.4	.00	H2O	250383
23.2	15.6	1.9	8.9	12.75	12.7	.08	HNO3	241995
13.8	17.8	1.6	12.8	230.14	230.1	.11	KMnO4/HNO3	53741
19.9	19.4	5.7	6.8	9.29	9.3	.83	4521	49961
32.2	81.1	3.2	16.1	24.72	24.7	.36	4502	114628
44.6	39.2	7.3	15.7	5.40	5.4	.13	CITROX	21819
134.7	52.2	3.7	37.1	28.30	28.3	.12	Tartaric/NaOH	102504
24.1	61.1	.0	14.1	25.13	25.1	.01	4324	22486
16.0	18.0	.5	5.5	5.82	5.8	.14	Oxalic	35931
1.1	.6	.0	.5	.92	.9	.21	Citric A	3000
27.9	44.8	.0	17.5	27.21	27.2	.06	Oxalic/HNO3	71067
10.4	8.8	.0	5.8	5.41	5.4	.04	NH4OH	2900
5.1	10.7	.0	2.4	2.87	2.9	.41	EDTA/NaOH	18757
21.6	27.7	.0	9.7	6.32	6.3	.09	ARR	10394
1.3	2.9	.0	1.1	3.87	3.9	.04	HF/HNO3	14820
32.0	32.2	2.0	12.4	26.39		.14		1014386

TABLE 20

Cost Summary x/$

gamma mR/hr/$	gamma ug/$	UDS g/$	gamma mcurie/$	beta mcurie/$	cost $	Soln	Tot Vol-L
0	0	0	0	0	0	H2O	250383
293	198	24	112	161	19136	HNO3	241995
121	156	14	112	2017	6132	KMnO4/HNO3	53741

	24	24	7	8	11	41341	4521	49961
	89	225	9	45	69	41237	4502	114628
	353	311	58	124	43	2754	CITROX	21819
	1168	452	32	321	245	11824	Tartaric/NaOH	102504
	1724	4373	0	1012	1800	314	4324	22486
	117	132	4	40	43	4899	Oxalic	35931
	5	3	0	2	4	644	Citric A	3000
	436	699	0	273	425	4553	Oxalic/HNO3	71067
	286	239	0	158	148	106	NH4OH	2900
	13	26	0	6	7	7646	EDTA/NaOH	18757
	248	317	0	112	72	907	ARR	10394
	30	67	0	25	90	641	HF/HNO3	14820
Total	229	230	14	88	188	1.00		7.14

TABLE 21

Waste Analysis

Volume of Waste	1014386 L	268002 gal
Wt of chemicals w/o HNO3	32899 Kg	72378 lbs
Moles of Na+ ; Molarity	226348 moles	.22 M
Moles of K+ ; Molarity	137692 moles	.14 M
Moles Na+ plus K+ ; Molarity	364040 moles	.36 M
Chemical cost 1982 $	142135 $	

Chemical Analysis (Kg)

	KMnO4	Citric	Oxalic	NH Oxal	Tart A	K+	Na+	Kg	L	# of Flushes
H2O									250383	169
HNO3								68343	241995	164
KMnO4/HNO3	546					134		7100	53741	35
4521		214	642	3423				4280	49961	39
4502	1793					5250	76	8965	114628	55
Citrox		793	569					1362	21819	15
Tart A/NaOH					2193		4312	9692	102504	71
4324							55	491	22486	10
Oxalic A			3024					3024	35931	12
Citric A		279						279	3000	3
Oxalic/HNO3			2481					4388	71067	31

NH4OH	49								49	2900	1
EDTA/NaOH	231							587	1202	18757	20
ARR								176	428	10394	5
HF/HNO3	100								1837	14820	4
Totals		2338	1286	6716	3423	2193	5384	5206	32899	1014386	634

Approx. pH	.1
Number of flushes	634
Samples taken	468

Appendix I

Computer Programs Used in Data Analysis

Appendix I

Computer Programs Used in Data Analysis

The computer codes used in data acquisition and data analysis are provided in this appendix. The codes were written in Fortran and are quite basic. The code is old and used Fortran IV. It is provided here for both documentation purposes and also a resource for those interested in further exploration of the data.

The program ZTOTAL was used for this report. This program provided the 21 tables of data contained in the appendices. A list of the other programs and a brief description is listed below.

Program	Function
ZCONV	Documents radionuclide specific conversion data
ZNM	Nuclide conversion data for use in computer programs
ZADD	Allows sample data to be added to a data file
ZAVER	Averages data in a data file
ZFLUSH	Provides a hard copy of the results of each flush
ZP	A large program with extensive data analysis and graphs
ZRD	Provides a hard copy of a data file
ZSUMEA	Provides a summary of the analysis on each solution
ZTOTAL	Provides multiple analyses of radionuclides and solutions

ZCONV ZCONV

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L ALL

    Isotope  R/hr/dps   mg/dps     t1/2         gamma E   QB      %gamma
    H   3    ----       2.79E-12   12.33    y    ---      .019    ---
    K  40    2.53E-11   3.86E-03   1.277E+9 y    1.461    1.312   10.67
    Mn 54    1.35E-10   3.49E-12   312      d    .835     .697    100.
    Co 60    4.06E-10   2.39E-11   5.271    y    1.332    2.824   100.
                                                 1.173            100.
    Kr 85    3.58E-13   6.86E-11   10.7     y    0.514    .687    0.43
    Sr 90    ----       1.96E-10   28.8     y    ---      .546    ---
    Y  90    ----       4.97E-14   64.1     h             2.284
    Nb 95    1.24E-10   6.88E-13   35       d    .766     .926    99.82
    Zr 95    6.70E-11   1.26E-12   64       d    .757     1.123   54.6
    Ru103    6.96E-11   8.53E-13   40       d    .497     2.35    86.4
    Rh106    Ru106      Ru106      130      m    .512     3.541   19
    Ru106    1.58E-11   8.01E-12   1        y    ---      .039    ---
    Cd113                          9 E 15   y
    Sb125    2.08E-11   2.55E-11   2.7      y    .428     .767    30
    I 129    4.86E-13   1.54E-04   1.58E07  y    .040     .150    7.5
    Cs134    9.57E-11   2.09E-11   2.062    y    .605     2.058   97.6
    Cs137    9.12E-11   3.10E-10   30       y    .662     1.173   85
    Ce141    1.14E-11   9.48E-13   32.5     d    .145     .58     48.4
    Ce144    2.41E-12   8.49E-12   285      d    .134     .318    11.1
    Pr144    ----       3.58E-16   17.3     m    ---      3.00    ---
    Eu154    7.33E-11   9.89E-11   8.5      y    1.274    1.978   35.5
    Eu155    3.91E-12   5.74E-11   4.9      y    .105     .246    23

   ug/dps
   =  dps (atm/dps) (mole/6.023E23 atm) (x g/mole) (1E6 ug/g) (t1/2 /ln2)
           = (2.40E-18) (MW) (t1/2)
                              dps = (N)(k) = ln(2)/ t1/2
                               N = dps/k     k=ln(2)/t1/2
                              lnN1/lnN2=k(t2-t1)
   (R/hr)(dps) at 1 ft (gamma)
   = 6(Ci)(E)(n)  this is a good approximation      Ci= 3.7E10 dps
            = 6 (x dps/3.7E 10dps) (E) (n/100)      E = MeV/decay gamma
            = (1.62E-12) (E) (%)                    n = % gamma/decay

   Isotope   R/(hxCi)   mass/Ci        Ci/g        RQ  Ci   RQ  mass
   H    3     ---       103.    ug     9,673       100      10.3   mg
   K   40     .94       143.    Kg     7.00 E-6    1        143    kg
   Mn  54     5.0       129.    ug     7,752       10       1.29   mg
   Co  60     15.0      884.    ug     1,131       10       8.84   mg
   Kr  85     0.0132    2.54    mg     393         1000     2.54   g
   Sr  90     ---       7.25    mg     138         0.1      0.73   mg
   Y   90     ---       1.84    ug     543,248     10       18.4   ug
   Nb  95     4.59      25.5    ug     39,278      10       0.25   mg
   Zr  95     2.48      46.6    ug     21,480      10       0.47   mg
   Ru 103     2.58      31.6    ug     31,700      10       0.32   mg
   Ru 106     .58       296.    ug     3,375       1        0.30   mg
   Cd 113     ---       2.85 E12 g     3.51 E-13   0.1      285 E6 kg
   Sb 125     .77       944.    ug     1,060       10       9.44   mg
   I  129     .018      5680.   g      1.76 E-4    0.001    5.68   g
   Cs 134     3.54      773.    ug     1,295       1        0.77   mg
   Cs 137     3.37      11.5    mg     87          1        11.5   mg
   Ce 141     .42       35.1    ug     28,500      10       0.35   mg
   Ce 144     .09       314.    ug     3,182       1        0.31   mg
   Pr 144     ---       13.2    ng     7.55 E+7    1000     13.2   ug
   Eu 154     2.71      3.66    mg     273         10       36.6   mg
   Eu 155     .14       2.12    mg     471         10       21.2   mg
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T ZNM
/L ALL
2.41E- 9    8.49E- 9     0.00     0.0
9.57E- 8    2.09E- 8     0.28     0.0
9.12E- 8    3.10E- 7     7.86     0.28
1.24E- 7    6.88E-10     9.66     0.0
6.96E- 8    8.53E-10     4.60     0.0
1.58E- 8    8.01E- 9     2.31     1.62
2.08E- 8    2.55E- 8     2.93     0.72
6.70E- 8    1.26E- 9     0.64     0.0
0.0         0.0          1.62     0.0
0.0         0.0          2.31     0.0
0.0         0.0          1.62     0.28
0.0         0.0          2.15     0.0
0.0         0.0         30.06     0.72
0.0         0.0          2.12     0.0
0.0         0.0          1.54     0.28
C  First column is mR/hr*dps at 1 ft (30.5cm)
C  Second column is microgram/dps.
C  Order of nuclides is:
C     1. Ce144    3. Cs137    5. Ru103    7. Sb125
C     2. Cs134    4. Nb 95    6. Ru106    8. Zr 95
C  Third column is $/Kg.
C  Fourth column is the second chemical, if present.
C  Order of chimicals is:
C     1. H2O            6. Citrox           11. Oxalic/HNO3
C     2. HNO3           7. Tartaric/NaOH    12. NH4OH
C     3. KMnO4/HNO3     8. 4324             13. EDTA/NaOH
C     4  4521           9. Oxalic           14. ARR
C     5. 4502          10. Citric A         15. HF/HNO3
C
C  For more information see file ZCONV
```

```
T ZADD
/L ALL
 $CONTROL USLINIT,INIT,NOSOURCE
 C  Text is ZADD
        DIMENSION RAWDATA(300,17)
        REAL NUM
        CHARACTER LB*8(17),ANS
        DATA LB/"Log #","Ce144","Cs134","Cs137","Nb 95","Ru103",
       * "Ru106","Sb125","Zr 95","Vol-L","Soln #","Beta","uds g/l",
       * "% chem 1","% chem 2","mR/hr","Proc #"/,Y/"Y"/,N/"N"/
 C
 C
        CALL CHANGE
 C
 99     DISPLAY "Do you want to run the program  Y/N  "
         ANS="Y"
         ACCEPT ANS
          IF (ANS.EQ."N") STOP
          IF (ANS.NE."Y") GOTO 99
 C
 13       DO 1 I=1,300
               DO 2 J=1,17
                  RAWDATA(I,J)=0
 2             CONTINUE
 1        CONTINUE
          DO 3 I=1,300
             READ (9@I,100,END=4,ERR=16) (RAWDATA(I,J),J=1,17)
 3        CONTINUE
 16     DISPLAY "Reading error"
        STOP
 4      K=I
        DISPLAY "This flush number",K
 5      DISPLAY "Modify old data  N/Y "
        ANS="N"
        ACCEPT ANS
         IF (ANS.EQ."Y") GOTO 21
         IF (ANS.NE."N") GOTO 5
 6       DO 7 J=1,17,1
              IF (J.EQ.2) WRITE (6,601)
              IF (J.EQ.11) WRITE (6,602)
            DISPLAY J,LB(J)
            ACCEPT RAWDATA(K,J)
 7       CONTINUE
 601   FORMAT (T18,"dps/ml",/)
 602   FORMAT (T8,"1. H2O",T32,"6. Citrox (citric/oxalic)",T59,
      & "11. Oxalic/HNO3",/,T8,"2. HNO3",T32,"7. Tartaric/NaOH",T59,
      & "12. NH4OH",/,T8,"3. KMnO4/HNO3",T32,"8. 4324",T59,
      & "13. EDTA/NaOH",/,T8,"4. 4521 (Citrox+NH4)",T32,"9. Oxalic",
      & T59,"14. ARR",/,T8,"5. 4502 (KMnO4/NaOH)",T31,"10. Citric",
      & T59,"15. HF/HNO3",/)
 8       DO 9 J=1,17
            DISPLAY J,LB(J),RAWDATA(K,J)
 9       CONTINUE
 10    DISPLAY "Is the data correct  Y/N "
       ANS="Y"
       ACCEPT ANS
         IF (ANS.EQ."Y") GOTO 11
         IF (ANS.EQ."N") GOTO 12
           DISPLAY "Answer Y or N"
         GOTO 10
```

```
12    DISPLAY "Which number do you want changed"
      ACCEPT J
        RAWDATA(K,J)=0
      DISPLAY "Enter the correct data"
      ACCEPT NUM
        RAWDATA(K,J)=NUM
      GOTO 8
11    WRITE (9@K,100) (RAWDATA(K,J),J=1,17)
15    DISPLAY "Is there any more data Y/N"
      ANS="Y"
      ACCEPT ANS
        IF (ANS.EQ."Y") GOTO 13
        IF (ANS.EQ."N") GOTO 14
        DISPLAY "Answer Y or N"
        GOTO 15
21    DISPLAY "What flush number"
        ACCEPT K
        GOTO 8
100   FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
     * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,1X,E7.2,1X,F5.1,1X,F5.2,1X,
     * F5.2,1X,I6,1X,I3)
14    STOP
      END
C
C
      SUBROUTINE CHANGE
      DIMENSION TEMP(300,17)
      CHARACTER*70 EQFILE,PRGE,BLD,FILE*10,ANS*1
      INTEGER N
5     DISPLAY "Creating a new data file  (N/Y)"
      ANS="N"
      ACCEPT ANS
       IF (ANS.EQ."Y") GOTO 6
       IF (ANS.NE."N") GOTO 5
6     DISPLAY "Name of file "
      ACCEPT FILE
C
      EQFILE[1:11]="FILE FTN09= "
      EQFILE[12:10]=FILE
      EQFILE[22:4]=",OLD"
      EQFILE[26:1]=%15C
        PRGE[1:6]="PURGE "
        PRGE[7:10]=FILE
        PRGE[17:1]=%15C
      BLD[1:6]="BUILD "
      BLD[7:10]=FILE
      BLD[17:16]=";REC=80,,F,ASCII"
      BLD[33:1]=%15C
        IF (ANS.EQ."Y") GOTO 40
C
      CALL COMMAND (EQFILE,I1,I2)
        DO 10 I=1,300
           READ (9@I,100,END=15,ERR=20) (TEMP(I,J),J=1,17)
10      CONTINUE
20     DISPLAY "Reading error"
       STOP
15     K=I-1
      CALL UNITCONTROL(9,8)
      CALL COMMAND (PRGE,I1,I2)
      CALL COMMAND (BLD,I1,I2)
```

```
      CALL COMMAND (EQFILE,I1,I2)
      IF (K.EQ.0) GOTO 31
        DO 30 I=1,K
          WRITE(9@I,100) (TEMP(I,J),J=1,17)
30      CONTINUE
31    CALL UNITCONTROL(9,8)
      GOTO 99
C
40    CALL COMMAND (BLD,I1,I2)
      CALL COMMAND (EQFILE,I1,I2)
C
100   FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
     * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,1X,E7.2,1X,F5.1,1X,F5.2,1X,
     * F5.2,1X,I6,1X,I3)
99    RETURN
      END
```

```
T ZAVER
/L ALL
$CONTROL USLINIT,INIT,NOSOURCE
C
C  NAME PROGRAM  SHORT FORM (ZAVER)
C  FTN01=[FILE TO BE READ INTO]
C  FTN09=[FILE WHERE ORIGINAL DATA FROM]
C
      DIMENSION RAWDATA(790,17)
C
      CHARACTER ANS
       CALL DATAFILE
C
        DO 804 I=1,790
           READ (9@I,800,END=805) (RAWDATA(I,J),J=1,17)
804     CONTINUE
805   K2=I-1
      II=K2
      DISPLAY "Flushes",K2
2     DISPLAY "Do you want to run the program  Y/N  "
       ANS="Y"
       ACCEPT ANS
         IF (ANS.EQ."N") GOTO 99
         IF (ANS.NE."Y") GOTO 2
      CALL SUB5 (II,RAWDATA,RAWDATA)
      DO 6 I=1,II
         WRITE (1,800) (RAWDATA(I,J),J=1,17)
6     CONTINUE
C
110   FORMAT (/,T20,A10,1X,"FILE AS READ IN",//," ",T4,A6,T11,A6,
     *T19,A6,T27,A6,T35,A6,T43,A6,T51,A6,T59,A6,T67,A6,T74,A6,T80,A6,
     * T86,A6,T94,A6,T99,A6,T106,A6,T115,A6,/," ",T11,"dps/ml",T20,
     * "dps",T28,"dps",T36,"dps",T44,"dps",T52,"dps",T60,"dps",T68,
     * "dps",T76,"L",T85,"dpm/ml",T94,"g/L",T100,"% wt",T107,"% wt",
     * T116,"mR/hr",/)
800   FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
     * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,1X,E7.2,1X,F5.1,1X,F5.2,1X,
     * F5.2,1X,I6,1X,I3)
99    STOP
      END
C
C
      SUBROUTINE SUB5 (I2,RD,Z)
      DIMENSION RD(790,15),RDSLN(15,13),RDT(13),AVSLRD(15,13),
     * AVRD(13),COUNT(15),Z(790,15),T(790),KN(15),VOL(15),
     * VOLSNG(15)
C
C*********************************************************************
C                                                                    *
C       T(I)       is the sum of the gamma for a flush               *
C       K          is the solution number                            *
C       COUNT(K)   is the # of flushes of soln k w log #             *
C       N          is the # of flushes w/o gamma scan                *
C       KN(K)      is the # of flushes of soln k w/o gamma           *
C       COUNTTOT   is the total # of flushes with log #'s            *
C       VOL(K)     is the volume of soln K w log #s                  *
C       VOLT       is the total volume of sampled flushes            *
C       VOLSNG(K)  is the volume of sampled soln k w/o gamma         *
C       VOLSNGT    is the total vol of sampled flushes w/o gamma     *
C       VOLNST     is the total vol of flushes w/o log #s            *
```

```
C                                                                      *
C***********************************************************************
C
      COUNTTOT=0
      VOLT=0
      VOLNST=0
      VOLSNGT=0
      N=0
        DO 1 I=1,I2
           T(I)=0
1       CONTINUE
        DO 2 I=1,I2
           DO 3 J=2,9
              T(I)=T(I)+RD(I,J)
3          CONTINUE
2       CONTINUE
        DO 4 I=1,15
           COUNT(I)=0
           KN(I)=0
           VOL(I)=0
           VOLSNG(I)=0
             DO 5 J=1,13
                RDSLN(I,J)=0
                AVSLRD(I,J)=0
5            CONTINUE
4       CONTINUE
        DO 6 I=1,13
           RDT(I)=0
           AVRD(I)=0
6       CONTINUE
        DO 7 I=1,I2
           IF (RD(I,1).EQ.0) VOLNST=VOLNST+RD(I,10)
           IF (RD(I,1).EQ.0) GOTO 7
           K=RD(I,11)
           COUNT(K)=COUNT(K)+1
           COUNTTOT=COUNTTOT+1
           VOL(K)=VOL(K)+RD(I,10)
           VOLT=VOLT+RD(I,10)
             IF(T(I).EQ.0) GOTO 8
           GOTO 9
8                N=N+1
                 KN(K)=KN(K)+1
                 VOLSNG(K)=VOLSNG(K)+RD(I,10)
                 VOLSNGT=VOLSNGT+RD(I,10)
9             DO 10 J=2,9
                 RDSLN(K,J)=RDSLN(K,J)+RD(I,J)*RD(I,10)
                 RDT(J)=RDT(J)+RD(I,J)*RD(I,10)
10            CONTINUE
              DO 11 J=12,13
                 RDSLN(K,J)=RDSLN(K,J)+RD(I,J)*RD(I,10)
                 RDT(J)=RDT(J)+RD(I,J)*RD(I,10)
11            CONTINUE
7       CONTINUE
        DO 12 K=1,15
           IF (COUNT(K).EQ.0) GOTO 12
           IF (COUNT(K).EQ.KN(K)) GOTO 15
C              (If there is no soln k .or. # flshs of soln k= #
C               flshs of soln k w/o gamma) goto 12
           IF (KN(K).GT.0) GOTO 13
C              (If # flshs of soln K w/o g .GT.0) goto 13
```

```
C              Only solns with gamma results go to nest step
             DO 14 J=2,9
                AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
 14          CONTINUE
           GOTO 15
C               13 is ave of sons k w some flshs w/o gamma
C               Vol(K)-Volsng(K)= vol of soln K w gamma
 13          DO 16 J=2,9
                AVSLRD(K,J)=RDSLN(K,J)/(VOL(K)-VOLSNG(K))
 16          CONTINUE
 15          DO 17 J=12,13
                AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
 17          CONTINUE
 12    CONTINUE
             DO 18 J=2,9
                AVRD(J)=RDT(J)/(VOLT-VOLSNGT)
 18          CONTINUE
             DO 19 J=12,13
                AVRD(J)=RDT(J)/VOLT
 19          CONTINUE
       DO 20 I=1,I2,1
          IF (RD(I,1).GT.0 .AND. T(I).GT.0) GOTO 20
C           Solns w log # and w gammas skip to 20
          IF (RD(I,1).GT.0) GOTO 21
           RD(I,1)=1
 21        K=RD(I,11)
C             Working with flushes w/o log #s or no gammas
          IF (COUNT(K).EQ.0) GOTO 22
          IF (COUNT(K).EQ.KN(K)) GOTO 23
            DO 24 J=12,13
               IF (RD(I,J) .GT. 0) GOTO 24
               RD(I,J)=AVSLRD(K,J)
 24         CONTINUE
            DO 25 J=2,9
               RD(I,J)=AVSLRD(K,J)
 25         CONTINUE
         GOTO 20
C              If soln k has no samples then the ave of all is used
 22         DO 26 J=12,13
               RD(I,J)=AVRD(J)
 26         CONTINUE
 23         DO 27 J=2,9
               RD(I,J)=AVRD(J)
 27         CONTINUE
        IF (COUNT(K).EQ.0 .AND. COUNT(K).EQ.KN(K) ) GOTO 20
        IF (RD(I,1).EQ.1 .AND. COUNT(K).EQ.KN(K)) GOTO 30
        GOTO 20
C            For a flush w/o sample, where there are other solns
C              with beta but with no gamma, use soln ave for beta
 30       DO 31 J=12,13
             RD(I,J)=AVSLRD(K,J)
 31       CONTINUE
 20    CONTINUE
       DO 28 I=1,I2
          DO 29 J=1,15
             Z(I,J)=RD(I,J)
 29       CONTINUE
 28    CONTINUE
 99    RETURN
       END
```

```
C
C
      SUBROUTINE DATAFILE
      CHARACTER*40 FILE9,FILE1,PRG,BLD,NAME*10,A*10
C
      DISPLAY " File name to be accessed"
      ACCEPT A
      DISPLAY " File name for averaged data"
      ACCEPT NAME
C
      FILE9[1:11]="FILE FTN09="
      FILE9[12:10]=A
      FILE9[22:4]=",OLD"
      FILE9[26:1]=%15C
        FILE1[1:11]="FILE FTN01="
        FILE1[12:10]=NAME
        FILE1[22:4]=",OLD"
        FILE1[26:1]=%15C
      PRG[1:6]="PURGE "
      PRG[7:10]=NAME
      PRG[17:1]=%15C
        BLD[1:6]="BUILD "
        BLD[7:10]=NAME
        BLD[17:16]=";REC=80,,F,ASCII"
        BLD[33:1]=%15C
C
      CALL COMMAND (FILE9,I1,I2)
      CALL COMMAND (FILE1,I1,I2)
      CALL COMMAND (PRG,I1,I2)
      CALL COMMAND (BLD,I1,I2)
      RETURN
      END
```

```
T ZFLUSH
/L ALL
      $CONTROL USLINIT,INIT,NOSOURCE
      $INTEGER*4
      C
      C  NAME PROGRAM  SHORT FORM (ZFLUSH)
      C      FILE FTN03=ZNM,OLD
      C      FILE FTN09=(FILE TO BE ACCESSED),OLD
      C      FILE FTN01;DEV=LP;CCTL
      C
             DIMENSION RAWDATA(250,17),CNVRSNDT(15,4),DPSFLSH(250),
           * REA(250,8),RFLSH(250),RISO(8),DPSISO(8),BCFL(250),PROCT(5)
      C
            REAL mgISO(8),mgFLSH(250),mgEA(250,8),mCURFLSH(250),mCURISO(8),
           * mCUREA(250,8),Z,TOTmC,TOTmg,TOTB,TOTR,TOTV
      C
            INTEGER C
      C
            CHARACTER ISO*6(8),SOLN*13(15),ANS,LABEL*6(17),FILE*30,ANSPROC
      C
            DATA ISO/"Ce144","Cs134","Cs137","Nb 95","Ru103",
           * "Ru106","Sb125","Zr 95"/
      C
            DATA SOLN/"H2O","HNO3","KMn04/HNO3","4521","4502","CITROX",
           * "Tartaric/NaOH","4324","Oxalic","Citric A","Oxalic/HNO3",
           * "NH4OH","EDTA/NaOH","ARR","HF/HNO3"/
      C
      C
            CALL DATAFILE
      C
      C
            I=16
            DISPLAY  "Print size  16,12,10"
            ACCEPT I
              IF (I.EQ.16) WRITE (1,101)
              IF (I.EQ.12) WRITE (1,102)
              IF (I.EQ.10) WRITE (1,103)
            103         FORMAT  ("")
            102         FORMAT  ("")
      101       FORMAT ("")
      C
      C
            DISPLAY " Report name"
            ACCEPT FILE
            CALL SUB4 (LABEL,RAWDATA,II)
            C=0
      C
      1     DISPLAY " How many flushes  ", II
             ACCEPT II
      C
            DISPLAY "Procedure totals  Y/N"
             ANSPROC="Y"
             ACCEPT ANSPROC
      C
      2     DISPLAY "Do you want to run the program  Y/N  "
             ANS="Y"
             ACCEPT ANS
              IF (ANS.EQ."N") GOTO 99
              IF (ANS.NE."Y") GOTO 2
      C
```

```
3     DISPLAY "Estimates only  N/Y "
       ANS="N"
       ACCEPT ANS
        IF (ANS.EQ."N") GOTO 7
        IF (ANS.NE."Y") GOTO 3
         GOTO 51
C
7     EST = 2
C
10    DISPLAY "Include averaged data  Y/N"
       ANS="Y"
       ACCEPT ANS
        IF (ANS.EQ."N") GOTO 4
        IF (ANS.NE."Y") GOTO 10
         EST=3
C
4       DO 5 I=1,II,1
           DPSFLSH(I)= 0
           RFLSH(I)= 0
           BCFL(I)= 0
           mgFLSH(I)= 0
           mCURFLSH(I)= 0
             DO 6 J=1,8,1
                mCUREA(I,J)=0
                REA(I,J)=0
                mgEA(I,J)=0
6            CONTINUE
5       CONTINUE
        DO 8 I=1,8
           RISO(I)=0
           DPSISO(I)=0
           mgISO(I)=0
           mCURISO(I)=0
8       CONTINUE
        TOTmC=0
        TOTR=0
        TOTmg=0
        TOTV=0
        TOTB=0
        DO 9 I=1,15
            DO 12 J=1,4
               CNVRSNDT(I,J)=0
12          CONTINUE
9       CONTINUE
C
        DO 13 I=1,15
           READ (3@I,100,END=14) (CNVRSNDT(I,J), J=1,4,1)
13      CONTINUE
C
14      DO 15 J=2,9
            DO 16 I=1,II,1
               LOGN=RAWDATA(I,1)
                IF (LOGN.EQ.0) GOTO 16
                IF (LOGN.EQ.1 .AND. EST.LE.2) GOTO 16
               DPSISO(J-1)=DPSISO(J-1)+RAWDATA(I,J)*RAWDATA(I,10)
     *           *1000
               REA(I,J-1)=RAWDATA(I,J)*RAWDATA(I,10)*1000*CNVRSN
     *           DT(J-1,1)
               mgEA(I,J-1)=RAWDATA(I,J)*RAWDATA(I,10)*CNVRSNDT(J-1,2)
               mCUREA(I,J-1)=(RAWDATA(I,J)*RAWDATA(I,10)*1000)/3.7E7
```

```
16          CONTINUE
15      CONTINUE
        DO 17 I=1,II
           TOTV=TOTV+RAWDATA(I,10)
            LOGN=RAWDATA(I,1)
             IF (LOGN.EQ.0) GOTO 17
             IF (LOGN.EQ.1 .AND. EST.LE.2) GOTO 17
             DO 18 J=2,9,1
                DPSFLSH(I)=DPSFLSH(I)+RAWDATA(I,J)*RAWDATA(I,10)*1000
                RFLSH(I)=RFLSH(I)+REA(I,J-1)
                mgFLSH(I)=mgFLSH(I)+mgEA(I,J-1)
18           CONTINUE
          BCFL(I)=(RAWDATA(I,12)*RAWDATA(I,10)*1000/(60*3.7E07))
          mCURFLSH(I)=DPSFLSH(I)/3.7E7
          TOTmC=TOTmC+mCURFLSH(I)
          TOTR=TOTR+RFLSH(I)
17     CONTINUE
       DO 20 I=1,II
            IF (RAWDATA(I,1).EQ.0) GOTO 20
            IF (RAWDATA(I,1).EQ.1 .AND. EST.LE.2) GOTO 20
         mgFLSH(I)=1000*mgFLSH(I)
         TOTmg=TOTmg+mgFLSH(I)
         TOTB=TOTB+BCFL(I)
20     CONTINUE
C
      WRITE (1,948) FILE
      WRITE (1,949)
948   FORMAT (T5,A20,/)
949   FORMAT (T5,"Log #",T19,"Ci",T30,"Ci",T42,"mg",T52,
     & "R/hr",T62,"mCi/L",T73,"mCi/L",T84,"mR/L",T95,"VOL",T104,
     & "Prcd#",T111,"Soln",/,T17,"gamma",T29,"beta",T39,"isotopes",
     & T51,"gamma",T62,"gamma",T73,"beta",T83,"gamma",T96,
     & "L",/)
      K =1000
      END=0
      PRNUM=RAWDATA(1,17)
      DO 950 I=1,II
         IF (PRNUM.NE.RAWDATA(I,17)) GOTO 952
954      FV=RAWDATA(I,10)
         J=RAWDATA(I,11)
         PROCT(1)=PROCT(1)+mCURFLSH(I)
         PROCT(2)=PROCT(2)+BCFL(I)
         PROCT(3)=PROCT(3)+mgFLSH(I)
         PROCT(4)=PROCT(4)+RFLSH(I)
         PROCT(5)=PROCT(5)+FV
      WRITE (1,951) RAWDATA(I,1),mCURFLSH(I)/K,BCFL(I)/K,
     & mgFLSH(I)/K,RFLSH(I)/K,mCURFLSH(I)/FV,BCFL(I)/FV,
     & RFLSH(I)/FV,RAWDATA(I,10),RAWDATA(I,17),SOLN(J)
       IF (I.EQ.II) END=1
       IF (I.EQ.II) GOTO 952
       GOTO 950
C952          WRITE (1,953)
952          IF (ANSPROC.EQ."N") GOTO 958
             WRITE (1,956) (PROCT(IJ)/K,IJ=1,4),PROCT(1)/PROCT(5),
     &        PROCT(2)/PROCT(5),PROCT(4)/PROCT(5),PROCT(5),PRNUM
958          WRITE (1,953)
             IF (I.EQ.II .AND. END.EQ.0) GOTO 959
             IF (I.EQ.II) WRITE (1,956) TOTmC/K,TOTB/K,TOTmg/K,
     &         TOTR/K,TOTmC/TOTV,TOTB/TOTV,TOTR/TOTV,TOTV
             IF (I.EQ.II) GOTO 950
```

```
959          PRNUM=RAWDATA(I,17)
              DO 957 J=1,5
                PROCT(J)=0
957           CONTINUE
            GOTO 954
950   CONTINUE
951   FORMAT (T4,I6,T14,F8.1,T25,F8.1,T36,F8.1,T47,F8.1,T58,F8.1,
     & T69,F8.1,T80,F8.1,T91,I8,T104,I3,T111,A13)
953   FORMAT (T4,120("-"),)
956   FORMAT (T4,"Total",T12,I8,T23,I8,T34,I8,T45,I8,T58,F8.1,T69,
     & F8.1,T80,F8.1,T91,I8,T104,I3)
      GOTO 99
C
51    CALL SUB5 (II,RAWDATA,RAWDATA)
      EST=5
      GOTO 4
C
100   FORMAT (E9.3,E12.3,F10.2,F10.2)
99    STOP
      END
C
C
      SUBROUTINE SUB4 (LB,RAWDATA,K2)
      REAL NUM
      DIMENSION RAWDATA(250,17)
1       DO 2 I=1,250
             DO 3 J=1,17
                 RAWDATA(I,J)=0
3            CONTINUE
2       CONTINUE
        DO 4 I=1,250
           READ (9@I,100,END=5) (RAWDATA(I,J),J=1,17)
4       CONTINUE
5      K=I
        K2=K-1
       IF(K2.EQ.250)DISPLAY"! Data exceeded capacity, only 250 read !"
      &
100    FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
      * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,1X,E7.2,1X,F5.1,1X,F5.2,1X,
      * F5.2,1X,I6,1X,I3)
99     RETURN
       END
C
C
       SUBROUTINE SUB5 (I2,RD,Z)
       DIMENSION RD(250,15),RDSLN(15,13),RDT(13),AVSLRD(15,13),
      * AVRD(13),COUNT(15),Z(250,15),T(250),KN(15),VOL(15),
      * VOLSNG(15)
C
C*********************************************************************
C                                                                    *
C       T(I)      is the sum of the gamma for a flush                *
C       K         is the solution number                             *
C       COUNT(K)  is the # of flushes of soln k w log #              *
C       N         is the # of flushes w/o gamma scan                 *
C       KN(K)     is the # of flushes of soln k w/o gamma            *
C       COUNTTOT  is the total # of flushes with log #'s             *
C       VOL(K)    is the volume of soln K w log #s                   *
C       VOLT      is the total volume of sampled flushes             *
C       VOLSNG(K) is the volume of sampled soln k w/o gamma          *
```

```
C        VOLSNGT   is the total vol of sampled flushes w/o gamma  *
C        VOLNST    is the total vol of flushes w/o log #s         *
C                                                                 *
C*******************************************************************
C
      COUNTTOT=0
      VOLT=0
      VOLNST=0
      VOLSNGT=0
      N=0
        DO 1 I=1,I2
           T(I)=0
1       CONTINUE
        DO 2 I=1,I2
           DO 3 J=2,9
              T(I)=T(I)+RD(I,J)
3          CONTINUE
2       CONTINUE
        DO 4 I=1,15
           COUNT(I)=0
           KN(I)=0
           VOL(I)=0
           VOLSNG(I)=0
             DO 5 J=1,13
                RDSLN(I,J)=0
                AVSLRD(I,J)=0
5            CONTINUE
4       CONTINUE
        DO 6 I=1,13
           RDT(I)=0
           AVRD(I)=0
6       CONTINUE
        DO 7 I=1,I2
           IF (RD(I,1).EQ.0) VOLNST=VOLNST+RD(I,10)
           IF (RD(I,1).EQ.0) GOTO 7
           K=RD(I,11)
           COUNT(K)=COUNT(K)+1
           COUNTTOT=COUNTTOT+1
           VOL(K)=VOL(K)+RD(I,10)
           VOLT=VOLT+RD(I,10)
             IF(T(I).EQ.0) GOTO 8
           GOTO 9
8                N=N+1
                 KN(K)=KN(K)+1
                 VOLSNG(K)=VOLSNG(K)+RD(I,10)
                 VOLSNGT=VOLSNGT+RD(I,10)
9             DO 10 J=2,9
                 RDSLN(K,J)=RDSLN(K,J)+RD(I,J)*RD(I,10)
                 RDT(J)=RDT(J)+RD(I,J)*RD(I,10)
10            CONTINUE
              DO 11 J=12,13
                 RDSLN(K,J)=RDSLN(K,J)+RD(I,J)*RD(I,10)
                 RDT(J)=RDT(J)+RD(I,J)*RD(I,10)
11            CONTINUE
7       CONTINUE
        DO 12 K=1,15
           IF (COUNT(K).EQ.0) GOTO 12
           IF (COUNT(K).EQ.KN(K)) GOTO 15
C              (If there is no soln k .or. # flshs of soln k= #
C               flshs of soln k w/o gamma) goto 12
```

```
            IF (KN(K).GT.0) GOTO 13
C                (If # flshs of soln K w/o g .GT.0) goto 13
C                 Only solns with gamma results go to nest step
               DO 14 J=2,9
                  AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
   14          CONTINUE
             GOTO 15
C                 13 is ave of sons k w some flshs w/o gamma
C                 Vol(K)-Volsng(K)= vol of soln K w gamma
   13          DO 16 J=2,9
                  AVSLRD(K,J)=RDSLN(K,J)/(VOL(K)-VOLSNG(K))
   16          CONTINUE
   15          DO 17 J=12,13
                  AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
   17          CONTINUE
   12     CONTINUE
               DO 18 J=2,9
                  AVRD(J)=RDT(J)/(VOLT-VOLSNGT)
   18          CONTINUE
               DO 19 J=12,13
                  AVRD(J)=RDT(J)/VOLT
   19          CONTINUE
          DO 20 I=1,I2,1
             IF (RD(I,1).GT.0 .AND. T(I).GT.0) GOTO 20
C              Solns w log # and w gammas skip to 20
             IF (RD(I,1).GT.0) GOTO 21
              RD(I,1)=1
   21         K=RD(I,11)
C               Working with flushes w/o log #s or no gammas
             IF (COUNT(K).EQ.0) GOTO 22
             IF (COUNT(K).EQ.KN(K)) GOTO 23
               DO 24 J=12,13
                  IF (RD(I,J) .GT. 0) GOTO 24
                  RD(I,J)=AVSLRD(K,J)
   24          CONTINUE
               DO 25 J=2,9
                  RD(I,J)=AVSLRD(K,J)
   25          CONTINUE
             GOTO 20
C                 If soln k has no samples then the ave of all is used
   22          DO 26 J=12,13
                  RD(I,J)=AVRD(J)
   26          CONTINUE
   23          DO 27 J=2,9
                  RD(I,J)=AVRD(J)
   27          CONTINUE
            IF (COUNT(K).EQ.0 .AND. COUNT(K).EQ.KN(K) ) GOTO 20
            IF (RD(I,1).EQ.1 .AND. COUNT(K).EQ.KN(K)) GOTO 30
            GOTO 20
C                For a flush w/o sample, where there are other solns
C                  with beta but with no gamma, use soln ave for beta
   30        DO 31 J=12,13
                RD(I,J)=AVSLRD(K,J)
   31        CONTINUE
   20     CONTINUE
          DO 28 I=1,I2
             DO 29 J=1,15
                Z(I,J)=RD(I,J)
   29        CONTINUE
   28     CONTINUE
```

```
 99   RETURN
      END
C
C
C
      SUBROUTINE DATAFILE
      CHARACTER*30 NAME,DATA3,PRNT,STRTSP,A*10,DEVN*5
C
      DISPLAY " File name to be accessed"
      ACCEPT A
      DISPLAY "Printer dev number  (local=144,lp=6;default=144)"
      DEVN="144"
      ACCEPT DEVN
C
      NAME[1:11]="FILE FTN09="
      NAME[12:10]=A
      NAME[22:4]=",OLD"
      NAME[26:1]=%15C
       DATA3[1:18]="FILE FTN03=ZNM,OLD"
       DATA3[19:1]=%15C
      PRNT[1:18]="FILE FTN01=LP;DEV="
      PRNT[19:4]=DEVN
      PRNT[23:1]=%15C
       STRTSP[1:14]="STARTSPOOL 144"
       STRTSP[15:1]=%15C
C
      CALL COMMAND (NAME,I1,I2)
      CALL COMMAND (DATA3,I1,I2)
      CALL COMMAND (PRNT,I1,I2)
      CALL COMMAND (STRTSP,I1,I2)
      RETURN
      END
```

```
T ZP
/L ALL
      $CONTROL USLINIT,INIT,NOSOURCE
      C
      C  NAME PROGRAM  SHORT FORM (ZP)
      C     FILE FTN03=ZNM,OLD
      C     FILE FTN09=(FILE TO BE ACCESSED),OLD
      C     FILE FTN01;DEV=LP;CCTL
      C
           DIMENSION RAWDATA(100,17),CNVRSNDT(15,4),DPSFLSH(100),
          * REA(100,8),RFLSH(100),RISO(8),DPSISO(8),BCFL(100),
          * SLNmC(15,8),SLNmg(15,8),SLNREA(15,8),SLNBCT(15),
          * SLNmCT(15),SLNmgT(15),SLNREAT(15),SLNTV(15),
          * COSTFL(100),COSTSLN(15),
          * UDSGFL(100),UDSGSLN(15),
          * PmCISFL(100,8),PmgISFL(100,8),PRISFL(100,8),
          * PmCISFLT(100),PmgISFLT(100),PRISFLT(100),PUDSFLT(100),
          * PBCFLT(100),PCOSTFLT(100),PVOLFLT(100),PmgFLT(100),PRFLT(100),
          * PmCIST(8),PmgIST(8),PRIST(8),
          * PmCSLN(15,8),PRSLN(15,8),PmgSLN(15,8),
          * PmCSLNT(15),PmgSLNT(15),PRSLNT(15),PUDSSLNT(15),PBCSLNT(15),
          * PCOSTSLNT(15),PVOLSLNT(15),
          * PTmCIS(100,8),PTmgIS(100,8),PTmRIS(100,8),PJSL(15,8),
          * PTmgSL(15,8),PTmRSL(15,8),PTmCSL(15,8),PJ(100,8),Pr(12)
      C
          REAL mgISO(8),mgFLSH(100),mgEA(100,8),mCURFLSH(100),mCURISO(8),
          * mCUREA(100,8),TOTmC,TOTmg,TOTR,KgSLN(15,2),KgT(15),KgFL(100,2),
          * Z,MPEW,MCALC
      C   REAL MOLEK,PEWCALNa,PEWCOST,NaWASTE,NaKWASTE
      C
          DOUBLE PRECISION LOGN,MOLEK,NaWASTE,NaKWASTE
          INTEGER C
      C
          CHARACTER ISO*6(8),SOLN*13(15),ANS,LABEL*6(17),FILE*20,ANSPROC
      C
          DATA ISO/"Ce144","Cs134","Cs137","Nb 95","Ru103",
          * "Ru106","Sb125","Zr 95"/
      C
          DATA SOLN/"H2O","HNO3","KMnO4/HNO3","4521","4502","CITROX",
          * "Tartaric/NaOH","4324","Oxalic","Citric A","Oxalic/HNO3",
          * "NH4OH","NaOH/EDTA","ARR","HF/HNO3"/
      C
          DATA LABEL/"Log #","Ce144","Cs134","Cs137","Nb 95","Ru103",
          * "Ru106","Sb125","Zr 95","Vol-L","Soln","Beta","uds",
          * "% ch 1","% ch 2","mR/hr","Proc"/,Y/"Y"/,N/"N"/
      C
      C
          CALL DATAFILE
      C
      C
          I=16
          DISPLAY  "Print size  16,12,10"
          ACCEPT I
            IF (I.EQ.16) WRITE (1,101)
            IF (I.EQ.12) WRITE (1,102)
            IF (I.EQ.10) WRITE (1,103)
      103         FORMAT ("")
      102         FORMAT ("")
      101         FORMAT ("")
      C
```

```
C
      DISPLAY " Report name"
      ACCEPT FILE
      CALL SUB4 (LABEL,RAWDATA,II)
      EST =0
      C=0
C
1     DISPLAY " How many flushes  ", II
       ACCEPT II
        K2=II
C
      DISPLAY "Procedure totals  N/Y"
       ANSPROC="N"
       ACCEPT ANSPROC
C
98    DISPLAY "Do you want to run the program  Y/N  "
       ANS="Y"
       ACCEPT ANS
        IF (ANS.EQ."N") STOP
        IF (ANS.NE."Y") GOTO 98
C
2     DISPLAY "Estimates only Y/N"
       ANS="Y"
       ACCEPT ANS
        IF (ANS.EQ."Y") GOTO 51
        IF (ANS.NE."N") GOTO 2
         EST=2
C
3     DISPLAY "Include averaged data  Y/N"
       ANS="Y"
       ACCEPT ANS
        IF (ANS.EQ."N") GOTO 75
        IF (ANS.NE."Y") GOTO 3
         EST=3
C
75       DISPLAY "1. All went to PEW"
         DISPLAY "2. All went to Tankfarm"
         DISPLAY "3. Mixed, PEW & Tankfarm"
         DISPLAY "4. Calc. all the above Processes"
         DISPLAY "Waste Processing   default = 4 "
           A=4
           ACCEPT A
           IF (A.EQ.1 .OR. A.EQ.2 .OR. A.EQ.3) GOTO 4
           IF (A.NE.4) GOTO 75
C
C
4       DO 5 I=1,II,1
           DPSFLSH(I)= 0
           RFLSH(I)= 0
           BCFL(I)= 0
           COSTFL(I)= 0
           PRISFLT(I)=0
           PmgISFLT(I)=0
           mgFLSH(I)= 0
           mCURFLSH(I)= 0
           UDSGFL(I)= 0
           PmCISFLT(I)=0
           PmgFLT(I)=0
           PRFLT(I)=0
           PUDSFLT(I)=0
```

```
         PBCFLT(I)=0
         PCOSTFLT(I)=0
         PVOLFLT(I)=0
           DO 6 J=1,8,1
              mCUREA(I,J)=0
              REA(I,J)=0
              mgEA(I,J)=0
              PmCISFL(I,J)=0
              PmgISFL(I,J)=0
              PRISFL(I,J)=0
              PTmCIS(I,J)=0
              PTmgIS(I,J)=0
              PTmRIS(I,J)=0
              PJ(I,J)=0
 6         CONTINUE
           DO 7 J=1,2
              KgFL(I,J)=0
 7         CONTINUE
 5     CONTINUE
       DO 8 I=1,8
          RISO(I)=0
          DPSISO(I)=0
          mgISO(I)=0
          mCURISO(I)=0
          PmCIST(I)=0
          PmgIST(I)=0
          PRIST(I)=0
 8     CONTINUE
       DO 9 I=1,15
          SLNBCT(I)=0
          SLNmCT(I)=0
          SLNmgT(I)=0
          SLNREAT(I)=0
          SLNTV(I)=0
          COSTSLN(I)=0
          KgT(I)=0
          UDSGSLN(I)=0
          PmCSLNT(I)=0
          PmgSLNT(I)=0
          PRSLNT(I)=0
          PUDSSLNT(I)=0
          PBCSLNT(I)=0
          PCOSTSLNT(I)=0
          PVOLSLNT(I)=0
           DO 10 J=1,8
              SLNmC(I,J)=0
              SLNmg(I,J)=0
              SLNREA(I,J)=0
              PmCSLN(I,J)=0
              PRSLN(I,J)=0
              PmgSLN(I,J)=0
              PJSL(I,J)=0
              PTmCSL(I,J)=0
              PTmgSL(I,J)=0
              PTmRSL(I,J)=0
 10       CONTINUE
          DO 11 J=1,2
              KgSLN(I,J)=0
 11       CONTINUE
          DO 12 J=1,4
```

```
                 CNVRSNDT(I,J)=0
   12          CONTINUE
   9        CONTINUE
         TOTmC=0
         TOTR=0
         TOTmg=0
         TOTV=0
         TOTV2=0
         TOTB=0
         TOTCOST=0
         TOTCKg=0
         UDSGT=0
         NWS=0
C        TOTV= THE VOL OF SAMPLED FLUSHES
C        TOTV2= THE TOTAL VOL
C
            DO 13 I=1,15
               READ (3@I,100,END=14) (CNVRSNDT(I,J), J=1,4,1)
   13       CONTINUE
C
   14       DO 15 J=2,9
                DO 16 I=1,II,1
                   LOGN=RAWDATA(I,1)
                   IF (RAWDATA(I,1).EQ.0) GOTO 16
                   IF (LOGN.EQ.1 .AND. EST.LE.2) GOTO 16
                   DPSISO(J-1)=DPSISO(J-1)+RAWDATA(I,J)*RAWDATA(I,10)
     *               *1000
                   REA(I,J-1)=RAWDATA(I,J)*RAWDATA(I,10)*1000*CNVRSN
     *               DT(J-1,1)
                   mgEA(I,J-1)=RAWDATA(I,J)*RAWDATA(I,10)*CNVRSNDT(J-1,2)
                   mCUREA(I,J-1)=(RAWDATA(I,J)*RAWDATA(I,10)*1000)/3.7E7
   16            CONTINUE
   15       CONTINUE
            DO 17 I=1,II
               TOTV2=TOTV2+RAWDATA(I,10)
               IF (RAWDATA(I,1).EQ.0) GOTO 17
                 DO 18 J=2,9,1
                    DPSFLSH(I)=DPSFLSH(I)+RAWDATA(I,J)*RAWDATA(I,10)*1000
                    RFLSH(I)=RFLSH(I)+REA(I,J-1)
                    mgFLSH(I)=mgFLSH(I)+mgEA(I,J-1)
   18            CONTINUE
               BCFL(I)=(RAWDATA(I,12)*RAWDATA(I,10)*1000/(60*3.7E07))
               mCURFLSH(I)=DPSFLSH(I)/3.7E7
               TOTmC=TOTmC+mCURFLSH(I)
               TOTR=TOTR+RFLSH(I)
               TOTV=TOTV+RAWDATA(I,10)
   17       CONTINUE
            DO 19 I=1,8
               mCURISO(I)=DPSISO(I)/3.7E7
               RISO(I)=DPSISO(I)*CNVRSNDT(I,1)
               mgISO(I)=DPSISO(I)*CNVRSNDT(I,2)
   19       CONTINUE
            DO 20 I=1,II
                 IF (RAWDATA(I,1).EQ.0) GOTO 20
               TOTB=TOTB+BCFL(I)
               mgFLSH(I)=1000*mgFLSH(I)
               TOTmg=TOTmg+mgFLSH(I)
                 DO 21 J=1,8,1
                    mgEA(I,J)=1000*mgEA(I,J)
   21            CONTINUE
```

```
 20     CONTINUE
        DO 22 I=1,II
            LOGN=RAWDATA(I,1)
            IF (LOGN.GT.1) NWS=NWS+1
            IF (LOGN.EQ.1 .AND. EST.LE.2) RAWDATA(I,12)=0
C           IF (LOGN.EQ.0) GOTO 22
          K= RAWDATA(I,11)
          UDSGFL(I)= RAWDATA(I,10)*RAWDATA(I,13)
          UDSGSLN(K)= UDSGSLN(K)+UDSGFL(I)
          UDSGT= UDSGT+UDSGFL(I)
          SLNTV(K)= SLNTV(K)+RAWDATA(I,10)
          SLNBCT(K)= SLNBCT(K)+BCFL(I)
          KgFL(I,1)= RAWDATA(I,10)*RAWDATA(I,14)/100
          COSTFL(I)= KgFL(I,1)*CNVRSNDT(K,3)
          KgSLN(K,1)= KgSLN(K,1)+KgFL(I,1)
          COSTSLN(K)= KgSLN(K,1)*CNVRSNDT(K,3)
            IF (K.EQ.3 .OR. K.EQ.6 .OR. K.EQ.7) GOTO 23
            IF (K.EQ.11 .OR. K.EQ.13 .OR. K.EQ.15) GOTO 23
          GOTO 24
 23         KgFL(I,2)= RAWDATA(I,10)*RAWDATA(I,15)/100
            COSTFL(I)= COSTFL(I)+KgFL(I,2)*CNVRSNDT(K,4)
            KgSLN(K,2)= KgSLN(K,2)+KgFL(I,2)
            COSTSLN(K)= COSTSLN(K)+KgSLN(K,2)*CNVRSNDT(K,4)
 24           DO 25 J=1,8
                SLNmC(K,J)= SLNmC(K,J)+mCUREA(I,J)
                SLNmg(K,J)= SLNmg(K,J)+mgEA(I,J)
                SLNREA(K,J)= SLNREA(K,J)+REA(I,J)
                PmCIST(J)= mCURISO(J)*100/TOTmC
                PmgIST(J)= mgISO(J)*100/TOTmg
                PRIST(J)= RISO(J)*100/TOTR
                PTmCIS(I,J)=mCUREA(I,J)*100/TOTmC
                PTmgIS(I,J)=mgEA(I,J)*100/TOTmg
                PTmRIS(I,J)=REA(I,J)*100/TOTR
                 IF (mCURISO(J).EQ.0) GOTO 26
                   PJ(I,J)=mCUREA(I,J)*100/mCURISO(J)
 28              IF (mCURFLSH(I).EQ.0) GOTO 27
                   PmCISFL(I,J)= mCUREA(I,J)*100/mCURFLSH(I)
                   PmgISFL(I,J)= mgEA(I,J)*100/mgFLSH(I)
                   PRISFL(I,J)= REA(I,J)*100/RFLSH(I)
                 GOTO 25
 26                PJ(I,J)=0
                 GOTO 28
 27                PmCISFL(I,J)=0
                   PRISFL(I,J)=0
                   PmgISFL(I,J)=0
 25           CONTINUE
          PBCFLT(I)= BCFL(I)*100/TOTB
          PVOLFLT(I)= RAWDATA(I,10)*100/TOTV
          TOTCOST= TOTCOST+COSTFL(I)
          PmCISFLT(I)= mCURFLSH(I)*100/TOTmC
          PmgFLT(I)= mgFLSH(I)*100/TOTmg
          PRFLT(I)= RFLSH(I)*100/TOTR
 22     CONTINUE
        DO 29 I=1,II
            IF (RAWDATA(I,1).EQ.0) GOTO 29
          PCOSTFLT(I)= COSTFL(I)*100/TOTCOST
            IF (UDSGT .EQ.0) GOTO 29
          PUDSFLT(I)= UDSGFL(I)*100/UDSGT
 29     CONTINUE
        DO 30 I=1,15
```

```
            DO 31 J=1,8
              SLNmCT(I)=SLNmCT(I)+SLNmC(I,J)
              SLNmgT(I)=SLNmgT(I)+SLNmg(I,J)
              SLNREAT(I)=SLNREAT(I)+SLNREA(I,J)
31          CONTINUE
30      CONTINUE
        DO 32 I=1,15
            V=SLNTV(I)
              IF (V.EQ.0) GOTO 32
            PBCSLNT(I)= SLNBCT(I)*100/TOTB
            PCOSTSLNT(I)= COSTSLN(I)*100/TOTCOST
            PVOLSLNT(I)= SLNTV(I)*100/TOTV
            PmCSLNT(I)= SLNmCT(I)*100/TOTmC
            PmgSLNT(I)= SLNmgT(I)*100/TOTmg
            PRSLNT(I)= SLNREAT(I)*100/TOTR
              IF ( UDSGT .EQ. 0) GOTO 33
            PUDSSLNT(I)= UDSGSLN(I)*100/UDSGT
33            DO 34 J=1,8
                 PTmCSL(I,J)=SLNmC(I,J)*100/TOTmC
                 PTmgSL(I,J)=SLNmg(I,J)*100/TOTmg
                 PTmRSL(I,J)=SLNREA(I,J)*100/TOTR
                    IF (mCURISO(J).EQ.0) GOTO 35
                       PJSL(I,J)=SLNmC(I,J)*100/mCURISO(J)
37                  IF (SLNmCT(I).EQ.0) GOTO 36
                      PmCSLN(I,J)= SLNmC(I,J)*100/SLNmCT(I)
                      PRSLN(I,J)= SLNREA(I,J)*100/SLNREAT(I)
                      PmgSLN(I,J)= SLNmg(I,J)*100/SLNmgT(I)
                  GOTO 34
35                    PJSL(I,J)=0
                  GOTO 37
36                   PmCSLN(I,J)=0
                     PRSLN(I,J)=0
                     PmgSLN(I,J)=0
34            CONTINUE
32      CONTINUE
        DO 38 I=1,15
            DO 39 J=1,2
              KgT(I)=KgT(I)+KgSLN(I,J)
39          CONTINUE
        TOTCKg=TOTCKg+KgT(I)
38      CONTINUE
C
C
      TH=1000
      TmoleNa=0
      TmoleK=0
      PEWV=0
      CALV=0
      moleNaC=0
      moleKC=0
      T=1.01E7
        DO 40 I=1,II
          MK=0
          MNa=0
          IF (RAWDATA(I,11) .EQ. 5) MK=RAWDATA(I,14)*.1463
          IF (MK .GE. 1) GOTO 41
          IF (RAWDATA(I,11) .EQ. 7) MNa=RAWDATA(I,15)/4
          IF (RAWDATA(I,11) .EQ.13) MNa=RAWDATA(I,15)/4
          IF (RAWDATA(I,11) .EQ.14) MNa=RAWDATA(I,14)/4
          IF (MNa .GE. 1) GOTO 72
```

```
              IF (RAWDATA(I,11) .EQ. 3) MK=RAWDATA(I,14)/15.8
              IF (MK .GE. 1) GOTO 73
              IF (RAWDATA(I,12) .GT. T) GOTO 74
                 PEWV=PEWV+RAWDATA(I,10)
                 GOTO 40
 41           moleKC=MK*RAWDATA(I,10)
              TmoleK=TmoleK+moleKC
                 GOTO 74
 72           moleNaC=MNa*RAWDATA(I,10)
              TmoleNa=TmoleNa+moleNaC
                 GOTO 74
 73           moleKC=MK*RAWDATA(I,10)
              TmoleK=TmoleK+ moleKC
 74           CALV=CALV+RAWDATA(I,10)
 40         CONTINUE
C
          H2O = KgSLN(1,1)
          HNO3 Kg = KgSLN(2,1) + KgSLN(3,2) + KgSLN(11,2)+ KgSLN(15,2)
          HNO3 L = (KgSLN(2,1) )*(1000./(63.*13.))
          KA KMnO4 = KgSLN(3,1)
          KA MnO4 = KgSLN(3,1)*(119.0/158.0)
          KA K = KgSLN(3,1)*(39.0/158.0)
          KA HNO3 Kg = KgSLN(3,2)
          KA HNO3 L = KgSLN(3,2)*(1000./(63.*13))
          S4521 = KgSLN(4,1)
          S4521 CIT A = KgSLN(4,1) * .05
          S4521 OX A = KgSLN(4,1) * .15
          NH4OXALATE = KgSLN(4,1) * .80
          S4502 = KgSLN(5,1)
          S4502 KMnO4 = KgSLN(5,1) * .20
          S4502 MnO4 = S4502 KMnO4 * (119.0/158.0)
          S4502 KK = S4502 KMnO4 * (39.0/158.0)
          S4502 KOH = KgSLN(5,1) * .77
          KOH = KgSLN(5,1) * .77
          S4502 Na = KgSLN(5,1) * (0.03*46.0/162.0)
          S4502 KB = S4502 KOH * (39.0/56.0)
          S4502 OH = S4502 KOH * (17.0/56.0)
          CITROX = KgSLN(6,1) + KgSLN(6,2)
          CITROX CIT A = KgSLN(6,1)
          CITROX OX A = KgSLN(6,2)
          TARTARIC NaOH = KgSLN(7,2)
          TARTARIC Na = KgSLN(7,2) * 23.0/40.0
          TARTARIC A = KgSLN(7,1)
          S4324 = KgSLN(8,1)
          S4324 Na = S4324 * 0.113
          OXALIC = KgSLN(9,1)
          KMnO4 = KA KMnO4 + S4502 KMnO4
          MnO4 = (KMnO4 + S4502 KMnO4) * (119.0/158.0)
          K1 = (KMnO4 + S4502 KMnO4)*(39.0/158.0)+S4502 KOH *(39.0/56.0)
          CIT A =KgSLN(10,1)
          OXALHNO = KgSLN(11,1)
          NHOH = KgSLN(12,1)
          EDTA = KgSLN(13,1)
          EDTANaOH = KgSLN(13,2)
          EDTA Na = (EDTANaOH*23.0/40.0) + (EDTA*46.0/372.24)
          ARRNaOH = KgSLN(14,1)
          ARRNa = ARRNaOH * 0.412
          HF = KgSLN(15,1)
          NaOH = KgSLN(7,2) + EDTANaOH + ARRNaOH
          OH = 17.0*(S4502 KOH/56.0 + NaOH/40.0 + NHOH/35)
```

```
      Na = TARTARIC Na + EDTA Na + ARRNa + S4502 Na + S4324 Na
      CITRIC A = CITROX CIT A + S4521 CIT A + CIT A
      OXALIC A = CITROX OX A + S4521 OX A + OXALIC + OXALHNO
      TV=TOTV
C
C
      IF (EST.NE.0) WRITE (1,105)
      CALL COUNT(C)
      WRITE (1,110) FILE,(LABEL(I),I=1,17)
      WRITE (1,120) ((RAWDATA(I,J), J=1,17,1), I=1,II,1)
      CALL COUNT(C)
      WRITE (1,130)
        DO 42 I=1,15
          WRITE (1,140) (CNVRSNDT(I,J),J=1,4),I,SOLN(I)
42      CONTINUE
      WRITE (1,150) FILE
C
      SKIP=1
      TV=TOTV
      Z=5
      ZN=1
      CALL SB1 (II,RAWDATA,mCUREA,mCURFLSH,BCFL,Z,ZN,mCURISO,TOTmC,ISO
     * ,SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
      Z=6
      CALL SB1 (II,RAWDATA,mgEA,mgFLSH,BCFL,Z,ZN,mgISO,TOTmg,ISO,SOLN,
     *  TOTB,C,TOTV,SKIP,ANSPROC)
      Z=7
      CALL SB1 (II,RAWDATA,REA,RFLSH,BCFL,Z,ZN,RISO,TOTR,ISO,SOLN,
     *  TOTB,C,TOTV,SKIP,ANSPROC)
      Z=1.0
      CALL SB1 (II,RAWDATA,mCUREA,mCURFLSH,BCFL,Z,ZN,mCURISO,TOTmC,ISO
     * ,SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
      Z=2.0
      CALL SB1 (II,RAWDATA,mgEA,mgFLSH,BCFL,Z,ZN,mgISO,TOTmg,ISO,SOLN,
     * TOTB,C,TOTV,SKIP,ANSPROC)
      Z=3.0
      CALL SB1 (II,RAWDATA,REA,RFLSH,BCFL,Z,ZN,RISO,TOTR,ISO,SOLN,
     * TOTB,C,TOTV,SKIP,ANSPROC)
C
      WRITE (1,160)
      SKIP=7
      Z=1
      ZN=2.0
      CALL SB1 (II,RAWDATA,PmCISFL,PmCISFLT,PBCFLT,Z,ZN,PmCIST,TOTmC,
     * ISO,SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
      Z=2
      WRITE (1,170)
      CALL SB1 (II,RAWDATA,PmgISFL,PmgFLT,PBCFLT,Z,ZN,PmgIST,TOTmg,
     * ISO,SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
      Z=3
      WRITE (1,170)
      CALL SB1 (II,RAWDATA,PRISFL,PRFLT,PBCFLT,Z,ZN,PRIST,TOTR,ISO,
     * SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
C
      SKIP=1
      Z=4
      CALL SB1 (II,RAWDATA,PJ,PmCISFLT,PBCFLT,Z,ZN,PmCIST,
     * TOTmC,ISO,SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
      Z=1
      WRITE (1,180)
```

```
      CALL SB1 (II,RAWDATA,PTmCIS,PmCISFLT,PBCFLT,Z,ZN,PmCIST,
     * TOTmC,ISO,SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
      Z=2
      CALL SB1 (II,RAWDATA,PTmgIS,PmgFLT,PBCFLT,Z,ZN,PmgIST,TOTmg,
     * ISO,SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
      Z=3
      CALL SB1 (II,RAWDATA,PTmRIS,PRFLT,PBCFLT,Z,ZN,PRIST,TOTR,
     * ISO,SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
C
      CALL COUNT (C)
      WRITE (1,200)
      Z=1
      CALL SUB3 (ISO,mCURISO,mgISO,RISO,TOTmC,TOTmg,TOTR,Z,TV)
      WRITE (1,205) TOTB/1000
      CALL COUNT (C)
      WRITE (1,210)
      Z=2
      CALL SUB3 (ISO,PmCIST,PmgIST,PRIST,TOTmC,TOTmg,TOTR,Z,TV)
      CALL COUNT(C)
      WRITE (1,230)
      Z=1
      CALL SUB2 (ISO,SLNmC,SLNmCT,SLNTV,SOLN,Z,TV)
      CALL COUNT(C)
      WRITE (1,240)
      CALL SUB2 (ISO,SLNmg,SLNmgT,SLNTV,SOLN,Z,TV)
      CALL COUNT(C)
      WRITE (1,250)
      CALL SUB2 (ISO,SLNREA,SLNREAT,SLNTV,SOLN,Z,TV)
      CALL COUNT(C)
      WRITE (1,260)
      Z=2
      CALL SUB2 (ISO,PmCSLN,PmCSLNT,PVOLSLNT,SOLN,Z,TV)
      CALL COUNT(C)
      WRITE (1,270)
      CALL SUB2 (ISO,PmgSLN,PmgSLNT,PVOLSLNT,SOLN,Z,TV)
      CALL COUNT(C)
      WRITE (1,280)
      CALL SUB2 (ISO,PRSLN,PRSLNT,PVOLSLNT,SOLN,Z,TV)
      Z=3
      CALL COUNT(C)
      WRITE (1,290)
      CALL SUB2 (ISO, PJSL,PmCSLNT,PVOLSLNT,SOLN,Z,TV)
      CALL COUNT(C)
      WRITE (1,300)
      Z=2
      CALL SUB2 (ISO,PTmCSL,PmCSLNT,PVOLSLNT,SOLN,Z,TV)
      WRITE (1,310) (PmCIST(I),I=1,8)
      CALL COUNT(C)
      WRITE (1,320)
      CALL SUB2 (ISO, PTmgSL,PmgSLNT,PVOLSLNT,SOLN,Z,TV)
      WRITE (1,310) (PmgIST(I),I=1,8)
      CALL COUNT(C)
      WRITE (1,330)
      CALL SUB2 (ISO, PTmRSL,PRSLNT,PVOLSLNT,SOLN,Z,TV)
      WRITE (1,310) (PRIST(I),I=1,8)
      CALL COUNT(C)
      WRITE (1,340)
      WRITE (1,350)
      WRITE (1,360)
       DO 43 I=1,II,1
```

```
            K= RAWDATA(I,11)
            WRITE (1,370) RAWDATA(I,1),RFLSH(I),mgFLSH(I),UDSGFL(I),
     *        mCURFLSH(I),BCFL(I),COSTFL(I),RAWDATA(I,17),SOLN(K),
     *        RAWDATA(I,10)
 43       CONTINUE
        WRITE (1,360)
        WRITE (1,380) TOTR,TOTmg,UDSGT,TOTmC,TOTB,TOTCOST,TOTV2
        WRITE (1,360)
        CALL COUNT(C)
 781    WRITE (1,390)
        WRITE (1,480)
        WRITE (1,447)
          DO 44 I=1,II,1
            IF (RAWDATA(I,1).EQ.0) GOTO 44
            K= RAWDATA(I,11)
            V= RAWDATA(I,10)
             IF (mCURFLSH(I).EQ.0) A=0
             IF (mCURFLSH(I).EQ.0) GOTO 57
            AB=BCFL(I)/mCURFLSH(I)
 57         WRITE (1,405) RAWDATA(I,1),RFLSH(I)/V,mgFLSH(I)/V,
     *        UDSGFL(I)/V,mCURFLSH(I)/V,BCFL(I)/V,AB,
     *        COSTFL(I)/V,RAWDATA(I,17),SOLN(K),V
 44       CONTINUE
        WRITE (1,447)
        WRITE (1,407) TOTR/TV,TOTmg/TV,UDSGT/TV,TOTmC/TV,TOTB/TV,
     *    TOTB/TOTmC,TOTCOST/TV,TV
        WRITE (1,447)
        CALL COUNT(C)
        WRITE (1,410)
        WRITE (1,350)
        WRITE (1,360)
        PROC=RAWDATA(1,17)
          DO 45 I=1,II,1
             IF (ANSPROC.EQ."N") GOTO 52
             IF (PROC.EQ.RAWDATA(I,17)) GOTO 52
 55         WRITE (1,402)
            WRITE (1,404) (Pr(J),J=1,6),PROC,Pr(7)
              DO 56 J=1,8
                 Pr(J)=0
 56           CONTINUE
              IF (I.EQ.II) GOTO 45
            WRITE (1,402)
            PROC=RAWDATA(I,17)
C
 52         IF (RAWDATA(I,1).EQ.0) GOTO 45
            K=RAWDATA(I,11)
            WRITE (1,400) RAWDATA(I,1),PRFLT(I),PmgFLT(I),PUDSFLT(I),
     *        PmCISFLT(I),PBCFLT(I),PCOSTFLT(I),RAWDATA(I,17),SOLN(K),
     *        RAWDATA(I,10)
C
             IF (ANSPROC.EQ."N") GOTO 45
             IF (RAWDATA(I,17).EQ.RAWDATA(1,17) .AND. I.EQ.II) GOTO 45
            Pr(1)=Pr(1)+PRFLT(I)
            Pr(2)=Pr(2)+PmgFLT(I)
            Pr(3)=Pr(3)+PUDSFLT(I)
            Pr(4)=Pr(4)+PmCISFLT(I)
            Pr(5)=Pr(5)+PBCFLT(I)
            Pr(6)=Pr(6)+PCOSTFLT(I)
            Pr(7)=Pr(7)+RAWDATA(I,10)
             IF (I.EQ.II) GOTO 55
```

```
45       CONTINUE
       WRITE (1,360)
       CALL COUNT(C)
       WRITE (1,420)
       WRITE (1,430)
       WRITE (1,440)
         DO 46 I=1,15
            IF (SLNTV(I) .EQ. 0.0) GOTO 46
            WRITE (1,450) SLNREAT(I)/TH,SLNmgT(I)/TH,UDSGSLN(I)/TH,
     *         SLNmCT(I)/TH,SLNBCT(I)/TH,COSTSLN(I),SOLN(I),SLNTV(I)
46       CONTINUE
       WRITE (1,440)
       WRITE (1,380) TOTR/TH,TOTmg/TH,UDSGT/TH,TOTmC/TH,TOTB/TH,
     * TOTCOST,TOTV
       WRITE (1,440)
       CALL COUNT(C)
       WRITE (1,460)
       WRITE (1,430)
       WRITE (1,440)
         DO 47 I=1,15
            IF (SLNTV(I).EQ.0) GOTO 47
            WRITE (1,470) PRSLNT(I),PmgSLNT(I),PUDSSLNT(I),PmCSLNT(I),
     *         PBCSLNT(I),PCOSTSLNT(I),SOLN(I),PVOLSLNT(I)
47       CONTINUE
       WRITE (1,440)
       CALL COUNT(C)
       WRITE (1,475)
       WRITE (1,485)
       WRITE (1,445)
         DO 48 I=1,15
            V = SLNTV(I)
              IF (V.EQ.0.0) GOTO 48
C             IF (SLNmCT(I).EQ.0) A=0
C             IF (SLNmCT(I).EQ.0) GOTO 58
C           AB=SLNBCT(I)/SLNmCT(I)
58          WRITE (1,490) SLNREAT(I)/V,SLNmgT(I)/V,UDSGSLN(I)/V,
     *         SLNmCT(I)/V,SLNBCT(I)/V,SLNBCT(I)/V,COSTSLN(I)/V,
     *         SOLN(I),SLNTV(I)
48       CONTINUE
C
       WRITE (1,445)
       WRITE (1,492) TOTR/TV,TOTmg/TV,UDSGT/TV,TOTmC/TV,TOTB/TV,
     *  TOTCOST/TV,TV
       WRITE (1,445)
       CALL COUNT(C)
       WRITE (1,500)
       WRITE (1,510)
       WRITE (1,440)
         DO 49 I=1,15
            Y=COSTSLN(I)
            IF (SLNTV(I).EQ.0) GOTO 49
              SR = SLNREAT(I)
              Smg = SLNmgT(I)
              UDS = UDSGSLN(I)
              SmC = SLNmCT(I)
              SBC = SLNBCT(I)
            IF (Y.EQ.0) Y=1E30
            WRITE (1,520) SR/Y,Smg/Y,UDS/Y,
     *         SmC/Y,SBC/Y,COSTSLN(I),SOLN(I),SLNTV(I)
49       CONTINUE
```

```
      TC=TOTCOST
      WRITE (1,440)
      WRITE (1,380) TOTR/TC,TOTmg/TC,UDSGT/TC,TOTmC/TC,TOTB/TC,
     * TC,TV
      WRITE (1,440)
      CALL COUNT(C)
C
888   WRITE (1,540)
      TV2=TOTV2
      WRITE (1,550) TOTV2,(TOTV2/3.785)
       CALC=(TOTV2/3.785)*5
      WRITE (1,570) (TOTCKg-HNO3 Kg),((TOTCKg-HNO3 Kg)*2.2)
      SMOLE=(Na/23.)*1000
      WRITE (1,575) SMOLE ,SMOLE/TV2
      MOLEK = ((KA K + S4502 KK + S4502 KB)/39.1)*1000
      WRITE (1,580) MOLEK,MOLEK/TV2
      RMOLE= (MOLEK + SMOLE)/TV2
      WRITE (1,582) MOLEK+SMOLE,RMOLE
      WRITE (1,586) TOTCOST
      WRITE (1,584)
      WRITE (1,660)
      WRITE (1,775)
      IF (SLNTV(1) .GT. 1)
     &   WRITE (1,663) SLNTV(1)
      WRITE (1,775)
      IF (SLNTV(2) .GT. 1)
     &  WRITE (1,666) KgSLN(2,1),SLNTV(2)
      WRITE (1,775)
      IF (SLNTV(3) .GT. 1)
     &  WRITE (1,670) (KA KMnO4,KA K,KA KMnO4+KgSLN(3,2),SLNTV(3))
      WRITE (1,775)
      IF (SLNTV(4) .GT. 1)
     &WRITE (1,680) (S4521 CIT A,S4521 OX A,NH4OXALATE,S4521,SLNTV(4))
      WRITE (1,775)
      IF (SLNTV(5) .GT. 1)
     &  WRITE (1,690) (S4502 KMnO4,S4502 KK,S4502 KB,S4502 Na,
     *        S4502,SLNTV(5))
      WRITE (1,775)
      IF (SLNTV(6) .GT. 1)
     &  WRITE (1,700) (CITROX CIT A,CITROX OX A,CITROX,SLNTV(6))
      WRITE (1,775)
      IF (SLNTV(7) .GT. 1)
     &  WRITE (1,710) (TARTARIC A,(TARTARIC NAOH*23.0/40.0),
     &  (TARTARIC A + TARTARIC NAOH),SLNTV(7) )
      WRITE (1,775)
      IF (SLNTV(8) .GT. 1)
     &  WRITE (1,720) S4324 Na,S4324,SLNTV(8)
      WRITE (1,775)
      IF (SLNTV(9) .GT. 1)
     &  WRITE (1,730) OXALIC,OXALIC,SLNTV(9)
      WRITE (1,775)
      IF (SLNTV(10) .GT. 1)
     &  WRITE (1,735) CIT A,CIT A,SLNTV(10)
      WRITE (1,775)
      IF (SLNTV(11) .GT. 1)
     &  WRITE (1,721) OXALHNO,OXALHNO+KgSLN(11,2),SLNTV(11)
      WRITE (1,775)
      IF (SLNTV(12) .GT. 1)
     &  WRITE (1,722) NHOH,NHOH,SLNTV(12)
      WRITE (1,775)
```

```
      IF (SLNTV(13) .GT. 1)
     & WRITE (1,723) EDTA,EDTA Na,EDTA + EDTANaOH,SLNTV(13)
      WRITE (1,775)
      IF (SLNTV(14) .GT. 1)
     &  WRITE (1,724) ARRNa,KgSLN(14,1),SLNTV(14)
      WRITE (1,775)
      IF (SLNTV(15) .GT. 1)
     & Write (1,725) HF,HF+KgSLN(15,2),SLNTV(15)
      Write (1,775)
      WRITE (1,737) KMnO4,CITRIC A,OXALIC A,
     * NH4OXALATE,TARTARIC A,(KA K + S4502 KK),S4502 KB,
     * Na,(TOTCKg-HNO3 Kg),TV2
      WRITE (1,775)
      TMOLE=(HNO3 KG*1000./63.)-OH*1000/17.
        IF (TMOLE.LT.0) GOTO 59
        IF (TMOLE.EQ.0) GOTO 60
      pH=-ALOG10(TMOLE/TOTV2)
      WRITE (1,770) pH
       GOTO 60
59    pOH=-ALOG10((TMOLE*(-1))/TV2)
      pH= 14-pOH
      WRITE (1,770) pH
C
60    WRITE (1,790) K2
      WRITE (1,792) NWS
C     Cal waste, 1 all to pew, 2 all to tankfarm, 3 mixed
       IF (A .EQ. 1) GOTO 63
       IF (A .EQ. 2) GOTO 64
       IF (A .EQ. 3) GOTO 65
63       WASTEV=750*TV2/14000
C        For each 14000 L deeptank there was approx 750 L acid added
         PEWCOST=(TV2 + WASTEV)/3.785
         NaKWASTE=((SMOLE + MOLEK)/2.5)/3.785
         NaWASTE=(SMOLE/2.5)/3.785
C        Cal vol of waste if boiled down to 2.5 M Na or Na + K
         PEWCALNa=PEWCOST + 5*NaWASTE
         PEWCALNaK=PEWCOST + 5*NaKWASTE
         TOTCNa=PEWCALNa + TOTCOST
         TOTCNaK=PEWCALNaK + TOTCOST
         WRITE (1,605)
         WRITE (1,603) NaWASTE,NaKWASTE
         WRITE (1,601) PEWCALNa,PEWCALNaK
         WRITE (1,602) TOTCNa,TOTCNaK
C        Assumes all solns go to PEW
      IF (A .EQ. 1) STOP
64       WRITE (1,606)
         WRITE (1,600) CALC
         WRITE (1,583) (TOTCOST+CALC)
C        Assumes all solution goes to calciner and includes chem cost
C        Assuming calcination cost is approximately $5 per gallon feed
      IF (A .EQ. 2) STOP
65       BL=TOTB/TOTV2
         MPEW=(MOLEK+SMOLE-TmoleNa-TmoleK)/PEWV
         MOLENAK=MPEW*PEWV
         PEWVNAK=MOLENAK/2.5
            IF (CALV.NE.0) GOTO 61
               MCALC=0
               GOTO 62
61       MCALC=(TmoleNa+TmoleK)/CALV
62       BLENDV=(MPEW*PEWV/.2)-PEWV/10
```

```
            TDV=CALV+PEWVNAK
            CST=TOTCOST+PEWV*1.0/3.785+TDV*5/3.785
            WRITE (1,607)
            WRITE (1,589) PEWV,PEWVNAK,PEWVNAK/3.785,CALV,MCALC,
     &       CALV/3.785,TDV,(MOLEK+SMOLE)/TDV,TDV/3.785,CST
 589   FORMAT (T6,"Waste vol to PEW",9X,I7,1X,"L",
     & T43,"Reduced to",1X,I7,1X,"L",2X,"2.5 M Na K",
     & 3X,I7,1X,"gal",/,
     & T6,"Waste vol bypassing PEW",2X,I7,1X,"L",2X,F4.2,1X,"M Na K",
     & T54,I7,1X,"gal",/,
     & T6,"Total tank farm vol",6X,I7,1X,"L",2X,F4.2,1X,"M Na K",
     & T54,I7,1X,"gal",/,
     & T6,"Cost w/o labor",T31,I7,1X,"$",T44,"PEW $1/gal",
     & T59,"Calcine $ 5/gal")
C      Includes chem cost
C         PEW limits are 4.5 mCi Beta/L or 1E+7 beta/min*ml
 540   FORMAT (//,T2,"Waste Analysis")
 550   FORMAT (/,T10,"Unprocessed",/,T12,"Volume of Waste",T45,I7,1X,
     & "L",6X,I6,1X,"gal")
 585   FORMAT (T15,61("-"))
 570   FORMAT (T12,"Wt of chemicals  w/o HNO3",T45,I7,1X,"Kg",5X,
     * I6,1X,"lbs",)
 575   FORMAT (T12,"Moles of Na+ ; Molarity",T44,I8,1X,"moles",T59,
     & F7.2,1X,"M")
 580   FORMAT (T12,"Moles of K+ ; Molarity",T44,I8,1X,"moles"T59,
     & F7.2,1x,"M")
 582   FORMAT (T12,"Moles Na+ plus K+ ; Molarity",T44,I8,1X,"moles",
     & T59,F7.2,1X,"M")
 586   FORMAT (T12,"Chemical cost 1982 $",T44,I8,1X,"$")
 600   FORMAT (T12,"Calcine cost  $ 5/gal",T44,I8,1X,"$")
 583   FORMAT (T12,"Decon cost w/o labor",T44,I8,1X,"$")
 601   FORMAT (T12,"PEW + Calcine ($1 & $5/gal)",T44,I8,1X,"$   Na",
     * T59,I8,1X,"$   Na + K")
 602   FORMAT (T12,"Decon cost w/o labor",T44,I8,1X,"$   Na",T59,
     * I8,1X,"$   Na + K")
 603   FORMAT (T12,"Vol of 2.5 M waste",T44,I8,1X,"gal Na",T59,
     * I8,1X,"gal Na + K")
 605   FORMAT (/,T4,"Processed waste - assumed all went to PEW")
 606   FORMAT (/,T4,"Processed waste - assumed all bypassed PEW")
 607   FORMAT (/,T4,"Processed waste - mixed PEW & tankfarm, assumed",
     & 1X,"decision point was at cell")
 660   FORMAT (/,T61,"KMnO4",T68,"KOH",T74,"NaOH",/,T20,"KMnO4",
     * T27,"Citric",T35,"Oxalic",T43,"NH Oxal",T52,"Tart A",T63,
     * "K+",T69,"K+",T74,"Na+",T82,"Kg",T90,"L")
 663   FORMAT (T4,"H2O"T85,I8)
 666   FORMAT (T4,"HNO3 ",T79,I5,T85,I8)
 670   FORMAT (T4,"KMnO4/HNO3",T19,I5,T59,I5,T79,I5,T85,I8)
 680   FORMAT (T4,"4521",T26,I5,T34,I5,T44,I5,T79,I5,T85,I8)
 690   FORMAT (T4,"4502",T19,I5,T59,I5,T66,I5,T73,I5,T79,I5,T85,I8)
 700   FORMAT (T4,"Citrox",T26,I5,T34,I5,T79,I5,T85,I8)
 710   FORMAT (T4,"Tart A/NaOH",T52,I5,T73,I5,T79,I5,T85,I8)
 584   FORMAT (//,T2, "Chemical Analysis  (Kg)")
 720   FORMAT (T4,"4324",T73,I5,T79,I5,T85,I8)
 721   FORMAT (T4,"Oxalic/HNO3",T34,I5,T79,I5,T85,I8)
 722   FORMAT (T4,"NH4OH",T13,I5,T79,I5,T85,I8)
 723   FORMAT (T4,"EDTA/NaOH",T13,I5,T73,I5,T79,I5,T85,I8)
 724   FORMAT (T4,"ARR",T73,I5,T79,I5,T85,I8)
 725   Format (T4,"HF/HNO3",T13,I5,T79,I5,T85,I8)
 730   FORMAT (T4,"Oxalic A",T34,I5,T79,I5,T85,I8)
 735   FORMAT (T4,"Citric A",T26,I5,T79,I5,T85,I8)
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737   FORMAT (T4,"Totals",T19,I5,T26,I5,T34,I5,T44,I5,T52,I5,
     * T59,I5,T66,I5,T73,I5,T79,I6,T86,I7)
770   FORMAT (/,T4,"Approx. pH of waste",T24,F6.1)
775   FORMAT (T4,90("-"))
790   FORMAT (T4,"Number of flushes",T26,I4)
792   FORMAT (T4,"Samples taken",T26,I4)
587   FORMAT (T6,"Waste Volume after PEW",T29,I7,1X,"L",T47,I7,1X,
     & "gal")
70    IF (EST.EQ.0) GOTO 50
      GOTO 99
50    DISPLAY " Do you want estimates. Y/N "
      ANS="Y"
      ACCEPT ANS
       IF (ANS.EQ."N") GOTO 99
       IF (ANS.NE."Y" .AND. ANS.NE."N") GOTO 50
51    CALL SUB5 (II,RAWDATA,RAWDATA)
      WRITE (1,115) FILE
      EST=5
      GOTO 75
C
100   FORMAT (E9.3,E12.3,F10.2,F10.2)
105   FORMAT (//,T32,"ESTIMATED VALUES BASED ON AVERAGES",//)
110   FORMAT (/,T20,A20,1X,"FILE AS READ IN",//,T4,A6,T11,A6,T19,A6,
     * T27,A6,T35,A6,T43,A6,T51,A6,T59,A6,T67,A6,T74,A6,T80,A6,T86,
     * A6,T94,A6,T99,A6,T106,A6,T114,A6,T121,A6,/,T11,"dps/ml",T20,
     * "dps",T28,"dps",T36,"dps",T44,"dps",T52,"dps",T60,"dps",T68,
     * "dps",T76,"L",T85,"dpm/ml",T94,"g/L",T100,"% wt",T107,"% wt",
     * T114,"mR/hr",T122,"#",/)
115   FORMAT (//,T20,A20,/)
120   FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,
     * 1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,2X,
     * E7.2,1X,F5.1,2X,F5.2,2X,F5.2,1X,I6,4X,I3)
130   FORMAT (//,T20,"NM FILE AS READ IN",//,T28,"chm 1",T38,
     * "chm 2",/,T2,"mR/hr*dps",T15,"ug/dps",T28,"$/Kg",T38,"$/Kg",
     * T48,"Soln",/)
140   FORMAT (E9.3,E12.3,F10.2,F10.2,5X,I2,2X,A13)
150   FORMAT (//,T2,"DECON INFORMATION ON",1X,A20)
160   FORMAT (//,T2,"Percentage Information based on per flush",
     * 1X,"% direction across rows, -->",/)
170   FORMAT (//," ","% -->")
180   FORMAT (//,T2,"Percentage Information based on total.")
200   FORMAT (//,T2,"Individual Isotope Information",/)
205   FORMAT (T15,"Beta",T23,I8)
210   FORMAT (//,T2,"% Isotope Information",/)
230   FORMAT (//,T2,"Solution Information - curies",/)
240   FORMAT (//,T2,"Solution Information - mg",/)
250   FORMAT (//,T2,"Solution Information - R/hr",/)
260   FORMAT (//,T2,"% Solution Information  curies % -->",/)
270   FORMAT (//,T2,"% Solution Information  mg % -->",/)
280   FORMAT (//,T2,"% Solution Information  R/hr % -->",/)
290   FORMAT (//,T2,"% Solution Info.   curies, mg, R/hr  ",
     *  " % down columns",/)
300   FORMAT (//,T2,"% Solution Info.  curies/tot curies",/)
310   FORMAT (T4,"Tot",2X,8(F4.1,4X),/,T4,104("-"))
320   FORMAT (//,T2,"% Solution Info. mg/tot mg",/)
330   FORMAT (//,T2,"% Solution Info. R/hr/tot R/hr",/
     * )
340   FORMAT (//,T2,"General Solution Information",/)
350   FORMAT(T17,"gamma",T27,"gamma",T37,"UDS",T47,"gamma",T57,
     * "beta",T68,"Cost",/,T5,"Log #",T17,"mR/hr",T28,"ug",T38,"g",
```

```
     * T47,"mcurie",T56,"mcurie",T69,"$",T74,"Proc",T80,"Soln",
     * T96,"Vol-L")
 360  FORMAT (T4,98("-"))
 370  FORMAT (T5,I6,T13,4(I8,2X),I8,2X,I7,4X,I3,3X,A13,2X,I6)
 380  FORMAT (T6,"Total",T13,4(I8,2X),I9,2X,I7,3X,15X,I7)
 390  FORMAT (//,T2,"x/L",/)
 400  FORMAT (T5,I6,T15,4(F7.2,3X),F8.2,2X,F6.2,4X,I3,3X,A13,3X,I5)
 402  FORMAT (T14,63("-"))
 404  FORMAT (T6,"Pr Total",T15,4(F7.2,3X),F8.2,2X,F6.2,4X,I3,18X,I6)
 405  FORMAT (T5,I6,T15,4(F7.2,3X),F8.2,2X,F6.1,2X,F6.2,4X,I3,3X,A13,
     *  4X,I5)
 407  FORMAT (T6,"Total",T15,4(F7.2,3X),F8.2,2X,F6.1,2X,F6.2,24X,I7)
 410  FORMAT (//,T2,"General Solution Information %",/)
 420  FORMAT (//,T2,"Solution Summary",/)
 430  FORMAT (T17,"gamma",T27,"gamma",T37,"UDS",T47,"gamma",
     * T57,"beta",T68,"Cost",/,T17,"R/hr",T28,"mg",T38,"g",T47,
     * "curie",T57,"curie",T69,"$",T80,"Soln",T92,"Vol-L")
 440  FORMAT (T14,88("-"))
 445  FORMAT (T14,98("-"))
 447  FORMAT (T3,109("-"))
 450  FORMAT (T14,4(I7,3X),I8,2X,I7,3X,A13,3X,I6)
 460  FORMAT (//,T2,"Solution Summary %",/)
 470  FORMAT (T14,6(F7.1,3X),A13,3X,F6.1)
 475  FORMAT (//,T2,"Solution Summary x/L",/)
 480  FORMAT (T17,"gamma",T27,"gamma",T38,"UDS",T47,"gamma",T58,
     * "beta",T76,"Cost",/,T5,"Log #",T16,"mR/hr*L",T27,"ug/L",T38,
     * "g/L",T46,"mcurie/L",T57,"mcurie/L",T68,"B/L",T77,"$/L",T82,
     * "Proc",T89,"Soln",T102,"Tot Vol-L")
 485  FORMAT (T18,"gamma",T29,"gamma",T41,"UDS",T50,"gamma",T62,
     * "beta",T80,"Cost",/,T17,"mR/hr*L",T29,"ug/L",T41,"g/L",
     * T49,"mcurie/L",T61,"mcurie/L",T72,"B/L",T81,"$/L",T87,"Soln",
     * T101,"Tot Vol-L")
C490   FORMAT (T15,4(F7.1,4X),F8.2,2X,F6.1,2X,F6.2,4X,A13,4X,I7)
 492  FORMAT (T15,4(F7.1,4X),F8.2,10X,F6.2,21X,I7)
C485   FORMAT (T17,"gamma",T27,"gamma",T37,"UDS",T46,"gamma",T58,
C     * "beta",T76,"Cost",/,T16,"mR/hr*L",T27,"ug/L",T37,
C     * "g/L",T45,"mcurie/L",T57,"mcurie/L",T68,"B/g",T77,"$/L",T87,
C     * "Soln",T101,"Tot Vol-L")
 490  FORMAT (T15,4(F7.1,4X),F8.2,2X,F6.1,2X,F6.2,4X,A13,4X,I7)
C495   FORMAT (T6,"Total",T15,4(F7.1,4X),F8.2,2X,F6.1,2X,F6.2,19X,I7)
 500  FORMAT (//,T2,"Cost Summary x/$",/)
 510  FORMAT (T17,"gamma",T27,"gamma",T37,"UDS",T47,"gamma",T57,
     * "beta",T68,"cost",/,T16,"mR/hr/$",T27,"ug/$",T37,"g/$",T46,
     * "mcurie/$",T56,"mcurie/$",T69,"$",T80,"Soln",T91,"Tot Vol-L"
     * )
 520  FORMAT (T15,5(I6,4X),I6,4X,A13,4X,I5)
 530  FORMAT (//,T6,"Equation for log Ru(dps) vs treatment",T60,
     * "Equation for log B(dpm) vs treatment",/,T10,"slope",T20,F9.4,
     *  T64,"slope",T74,F9.4,/,T10,"intercept",T20,F9.4,T64,
     *  "intercept",T74,F9.4,/,T10,"r",T20,F9.4,
     *  T64,"r",T74,F9.4)
 99   STOP
      END
C
      SUBROUTINE SB1 (I2,RD,X,Y,B,Z2,Z3,S,T,IS,SL,TB,C,TV,SK,AP)
      DIMENSION RD(100,17),X(100,8),B(100),Pr(12)
      REAL Y(100),Z2,Z3,S(8),T,TB
      INTEGER C
      CHARACTER IS*6(8),AP
      CHARACTER SL*13(15)
```

```
        N=0
         IF (Z2.EQ.1) GOTO 1
         IF (Z2.EQ.2) GOTO 2
         IF (Z2.EQ.3) GOTO 3
         IF (Z2.EQ.4) GOTO 5
         IF (Z2.EQ.5) GOTO 7
         IF (Z2.EQ.6) GOTO 8
         GOTO 9
 1         CALL COUNT(C)
           WRITE (1,20)
           WRITE (1,25) (IS(I),I=1,8,1)
         GOTO 11
 2         CALL COUNT(C)
           WRITE (1,45)
 4         WRITE (1,50) (IS(I),I=1,8,1)
         GOTO 11
 3         CALL COUNT(C)
           WRITE (1,65)
         GOTO 4
 5         CALL COUNT(C)
           WRITE (1,70)
           WRITE (1,25) (IS(I),I=1,8)
           Z2=1
           N=1
         GOTO 11
 7         CALL COUNT (C)
           WRITE (1,22)
           WRITE (1,26) (IS(I),I=1,8)
         GOTO 11
 8         CALL COUNT (C)
           WRITE (1,47)
           WRITE (1,50) (IS(I),I=1,8)
         GOTO 11
 9         CALL COUNT (C)
           WRITE (1,67)
           WRITE (1,50) (IS(I),I=1,8)
 11      PROC=RD(1,17)
          DO 18 I=1,12
              Pr(I)=0
 18       CONTINUE
         DO 12 I=1,12
              IF (AP.EQ."N" .OR. SK.EQ.7) GOTO 19
              IF (PROC.EQ.RD(I,17)) GOTO 19
 128        WRITE (1,129)
              IF (Z2.EQ.1 .AND. Z3.EQ.1) GOTO 120
              IF (Z2.EQ.1) GOTO 121
              IF (Z2.EQ.5) GOTO 122
              IF (Z2.GT.5) GOTO 123
              IF (Z2.GT.1 .AND .Z3.EQ.1) GOTO 124
              IF (Z2.GT.1) GOTO 125
 120         WRITE (1,31) (Pr(L),L=1,10),PROC,Pr(11)
            GOTO 148
 121         WRITE (1,33) (Pr(L),L=1,10),PROC,Pr(11)
            GOTO 148
 122        WRITE (1,38) (Pr(L)/Pr(11),L=1,10),Pr(10)/Pr(9),PROC,Pr(11)
            GOTO 148
 123         WRITE (1,61) (Pr(L)/Pr(11),L=1,9),PROC,Pr(11)
            GOTO 148
 124         WRITE (1,56) (Pr(L),L=1,9),PROC,Pr(11)
            GOTO 148
```

```
125        WRITE (1,58) (Pr(L),L=1,9),PROC,Pr(11)
148         IF (I.EQ.I2) GOTO 12
          DO 130 L=1,12
             Pr(L)=0
130       CONTINUE
          PROC=RD(I,17)
          WRITE (1,129)
C
19          IF (RD(I,1).EQ.0) GOTO 12
          K=RD(I,11)
          FV= RD(I,10)
          IF (B(I) .EQ. 0) YB=0
          IF (B(I) .GT. 0) YB=Y(I)/B(I)
          gBT=gBT+ YB
            IF (Z2.EQ.5) GOTO 14
            IF (Z2.GT.5) GOTO 15
            IF(Z2.EQ.1 .AND. Z3.EQ.1) WRITE (1,30) RD(I,1),(X(I,J),
     *        J=1,8,1),Y(I),B(I),RD(I,17),SL(K)
            IF (Z2.EQ.1 .AND. Z3.GT.1) WRITE (1,32) RD(I,1),(X(I,J),
     *        J=1,8,1),Y(I),B(I),RD(I,17),SL(K)
            IF(Z2.GT.1 .AND.Z3.EQ.1) WRITE (1,55) RD(I,1),(X(I,J),
     *        J=1,8,1),Y(I),RD(I,17),SL(K)
            IF(Z2.GT.1 .AND. Z3.GT.1) WRITE (1,57) RD(I,1),(X(I,J),
     *        J=1,8,1),Y(I),RD(I,17),SL(K)
          GOTO 13
14          IF (Y(I).EQ.0) A=0
            IF (Y(I).EQ.0) GOTO 10
          A=B(I)/Y(I)
10        WRITE (1,34) RD(I,1),(X(I,J)/FV,J=1,8),Y(I)/FV,
     *         B(I)/FV,A,RD(I,17),SL(K)
          GOTO 13
15        WRITE (1,59) RD(I,1),(X(I,J)/FV,J=1,8),Y(I)/FV,RD(I,17),
     *         SL(K)
13           IF (AP.EQ."N") GOTO 12
            DO 52 L=1,8
               Pr(L)=Pr(L)+X(I,L)
52          CONTINUE
               Pr(9)=Pr(9)+Y(I)
               Pr(10)=Pr(10)+B(I)
               Pr(11)=Pr(11)+FV
            IF (RD(I,17).EQ.RD(1,17) .AND. I.EQ.I2) GOTO 12
          IF (I.EQ.I2 .AND. SK.NE.7) GOTO 128
12       CONTINUE
      IF (Z2.EQ.5) GOTO 16
      IF (Z2.GT.5) GOTO 17
      IF (N.EQ.1) GOTO 6
      IF (Z2.EQ.1 .AND. Z3.EQ.1) WRITE (1,35) (S(I),I=1,8,1),T,TB
      IF (Z2.EQ.1 .AND. Z3.GT.1) WRITE (1,36) (S(I),I=1,8,1),T,TB
6     IF (Z2.EQ.1) WRITE (1,37)
      IF (Z2.GT.1 .AND. Z3.EQ.1) WRITE (1,60) (S(I),I=1,8,1),T
      IF (Z2.GT.1 .AND. Z3.GT.1) WRITE (1,62) (S(I),I=1,8,1),T
      IF (Z2.GT.1) WRITE (1,40)
      GOTO 99
16    WRITE (1,36) (S(I)/TV,I=1,8),T/TV,TB/TV,TB/T
      WRITE (1,37)
      GOTO 99
17    WRITE (1,62) (S(I)/TV,I=1,8),T/TV
      WRITE (1,40)
C
20    FORMAT (//,T2,"mCurie Information",/)
```

```
 22   FORMAT (//,T2,"mCi/L",/)
 25   FORMAT (4X,"Log #",T14,8(A6,2X),"Total",5X,"mCi Beta",2X,
     * "Proc",3X,"Soln",/,T4,112("-"))
 26   FORMAT (4X,"Log #",T14,8(A6,2X),"Total",5X,"mCi Beta",3X,
     * "B/L",2X,"Proc",4X,"Soln",/,T4,112("-"))
 30   FORMAT (T4,I6,2X,9(I7,1X),3X,I8,4X,I3,3X,A13)
 32   FORMAT (T4,I6,2X,9(F6.1,2X),3X,F6.1,6X,I3,3X,A13)
 34   FORMAT (T4,I6,2X,9(F7.2,1X),4X,F7.2,2X,F5.1,3X,I3,3X,A13)
 35   FORMAT (T4,112("-"),/,T5,"Total",T12,9(I7,1X),2X,I9)
 36   FORMAT(T4,112("-"),/,T5,"Total",T11,8(F7.1,1X),I7,3X,I9,
     *   4X,F4.1)
 37   FORMAT (T4,112("-"))
 40   FORMAT (T4,98("-"))
 45   FORMAT (//,T2,"ug Information",/)
 47   FORMAT (//,T2,"ug/L",/)
 50   FORMAT (4X,"Log #",T14,8(A6,2X),"Total",2X,"Proc",4X,
     * "Soln",/,T4,98("-"))
 55   FORMAT (T4,I6,2X,9(I7,1X),2X,I3,3X,A13)
 57   FORMAT (T4,I6,2X,9(F6.1,2X),2X,I3,3X,A13)
 59   FORMAT (T4,I6,2X,9(F7.2,1X),2X,I3,3X,A13)
 60   FORMAT (T4,98("-"),/,T5,"Total",T12,8(I7,1X),I8)
 62   FORMAT (T4,98("-"),/,T5,"Total",T11,8(F7.1,1X),I8)
 65   FORMAT (//,T2,"mR/hr Information",/)
 67   FORMAT (//,T2,"mR/hr*L",/)
 70   FORMAT (T2,"% Info   mcuries,ug,mR/hr,  % direction",
     * " down columns",/)
 31   FORMAT (T5,"Total",2X,9(I7,1X),3X,I8,4X,I3,2X,I8,1X,"L")
 33   FORMAT (T5,"Total",2X,9(F6.1,2X),3X,F6.1,6X,I3,2X,I8,1X,"L")
 38   FORMAT (T5,"Total",2X,9(F7.2,1X),5X,F6.2,3X,F4.1,3X,I3,2X,I8,
     * 1X,"L")
 61   FORMAT (T5,"Total",2X,9(F7.2,1X),2X,I3,2X,I8,1X,"L")
 56   FORMAT (T5,"Total",2X,9(I7,1X),2X,I3,2X,I8,1X,"L")
 58   FORMAT (T5,"Total",2X,9(F6.1,2X),2X,I3,2X,I8,1X,"L")
 129  FORMAT (T12,90("-"))
 127  FORMAT (" ")
 99   RETURN
      END
C
C
C
      SUBROUTINE SUB2(IS,X,Y,Z,SL,Z2,TV)
      DIMENSION X(15,8),Y(15),Z(15)
      CHARACTER SL*13(15),IS*6(8)
      T=1000
C     GOTO 9
      IF (Z2.EQ.3) GOTO 1
      WRITE (1,130) (IS(I),I=1,8,1)
      GOTO 2
 1    WRITE (1,160) (IS(I),I=1,8)
 2      DO 3 I=1,15
          IF (Z(I).EQ.0) GOTO 3
            IF (Z2.EQ.1) WRITE (1,100) (X(I,J)/T,J=1,8),Y(I)/T,
     *          SL(I),Z(I)
            IF (Z2.EQ.2) WRITE (1,140) (X(I,J),J=1,8),Y(I),SL(I),Z(I)
            IF (Z2.EQ.3) WRITE (1,170) (X(I,J),J=1,8),SL(I),Z(I)
            IF (Z2.EQ.4) WRITE (1,180) (X(I,J)/Z(I),J=1,8),
     *          Y(I)/Z(I),SL(I),Z(I)
 3      CONTINUE
      WRITE (1,120)
      GOTO 99
```

```
100   FORMAT (T6,9(I7,1X),5X,A13,T98,I6)
120   FORMAT (" ",T4,104("-"))
130   FORMAT (T8,8(A6,2X),"Total",6X,"Soln",10X,
     *  "Total Vol",/," ",T4,104("-"))
140   FORMAT (T6,9(F7.1,1X),5X,A13,T98,F6.1)
160   FORMAT (T8,8(A6,2X),11X,"Soln",10X,"Total Vol",/," ",T4,
     * 104("-"))
170   FORMAT (T6,8(F7.1,1X),13X,A13,T98,F6.1)
180   FORMAT (T6,9(F7.2,1X,)5X,A13,T98,I6)
9       WRITE (1,11) (SL(I),I=1,9)
        WRITE (1,14)
      DO 30 J=1,8
          WRITE (1,13) IS(J),(X(I,J),I=1,8)
30    CONTINUE
      WRITE (1,14)
      WRITE (1,15) (Y(I),I=1,8)
      WRITE (1,14)
      WRITE (1,16) (Z(I),I=1,8)
11    FORMAT (//,T12,"Soln",T27,A6,T36,A6,T44,A6,T56,A6,T66,A6,T74,
     * A6,T84,A6,T96,A6,T104,A6)
13    FORMAT (T12,A6,T20,T22,I8,T32,I8,T42,I8,T52,I8,T62,I8,T72,I8,
     * T82,I8,T92,I8,T102,I8)
14    FORMAT (T12,112("-"))
15    FORMAT (T12,"Totals",T22,8(I8,2X))
16    FORMAT (T12,"Tot vol",T22,8(I8,2X))
99    RETURN
      END
C
C
C
      SUBROUTINE SUB3 (IS,X,Y,Z,TmC,Tmg,TR,Z2,TV)
      DIMENSION X(8),Y(8),Z(8)
      CHARACTER IS*6(8)
      T=1000
       IF (Z2.EQ.3) GOTO 5
      WRITE (1,100)
      WRITE (1,120)
       IF (Z2.EQ.2) GOTO 1
C
        DO 2 I=1,8
           WRITE (1,130) Is(I),X(I)/T,Y(I)/T,Z(I)/T
2       CONTINUE
      WRITE (1,120)
      WRITE (1,140) TmC/T,Tmg/T,TR/T
      WRITE (1,120)
       GOTO 99
C
5     WRITE (1,110)
      WRITE (1,120)
        DO 6 I=1,8
           WRITE (1,135) IS(I),X(I)/TV,Y(I)/TV,Z(I)/TV
6       CONTINUE
      WRITE (1,120)
      WRITE (1,145) TmC/TV,Tmg/TV,TR/TV
      WRITE (1,120)
       GOTO 99
C
1       DO 3 I=1,8
           WRITE (1,190) IS(I),X(I),Y(I),Z(I)
3       CONTINUE
```

```
      WRITE (1,120)
C
100   FORMAT (/,T29,"Ci",T38,"mg",T44," R/hr")
110   FORMAT (/,T27,"mCi/L",T36,"ug/L",T43,"mR/hr*L")
130   FORMAT (T15,A6,T24,3(I7,2X))
135   FORMAT (T15,A6,T24,3(F7.1,2X))
140   FORMAT (T15,"Total",T23,3(I8,1X))
145   FORMAT (T15,"Total",T23,3(F8.1,1X))
120   FORMAT (T15,34("-"))
190   FORMAT (T15,A6,T24,3(F7.1,2X))
99    RETURN
      END
C
C
      SUBROUTINE SUB4 (LB,RAWDATA,K2)
      REAL NUM
      DIMENSION RAWDATA(100,17)
1       DO 2 I=1,100
             DO 3 J=1,17
                RAWDATA(I,J)=0
3            CONTINUE
2       CONTINUE
        DO 4 I=1,100
           READ (9@I,100,END=5) (RAWDATA(I,J),J=1,17)
4       CONTINUE
5      K=I
       K2=K-1
      IF (K2.EQ.100) DISPLAY "Only 100 flushes read"
100   FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
     * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,1X,E7.2,1X,F5.1,1X,F5.2,1X,
     * F5.2,1X,I6,1X,I3)
99    RETURN
      END
C
C
      SUBROUTINE SUB5 (I2,RD,Z)
      DIMENSION RD(100,15),RDSLN(15,13),RDT(13),AVSLRD(15,13),
     * AVRD(13),COUNT(15),Z(100,15),T(100),KN(15),VOL(15),
     * VOLSNG(15)
C
C*********************************************************************
C                                                                    *
C       T(I)      is the sum of the gamma for a flush                *
C       K         is the solution number                             *
C       COUNT(K)  is the # of flushes of soln k w log #              *
C       N         is the # of flushes w/o gamma scan                 *
C       KN(K)     is the # of flushes of soln k w/o gamma            *
C       COUNTTOT  is the total # of flushes with log #'s             *
C       VOL(K)    is the volume of soln K w log #s                   *
C       VOLT      is the total volume of sampled flushes             *
C       VOLSNG(K) is the volume of sampled soln k w/o gamma          *
C       VOLSNGT   is the total vol of sampled flushes w/o gamma      *
C       VOLNST    is the total vol of flushes w/o log #s             *
C                                                                    *
C*********************************************************************
C
      COUNTTOT=0
      VOLT=0
      VOLNST=0
      VOLSNGT=0
```

```
      N=0
        DO 1 I=1,12
          T(I)=0
1       CONTINUE
        DO 2 I=1,12
          DO 3 J=2,9
            T(I)=T(I)+RD(I,J)
3         CONTINUE
2       CONTINUE
        DO 4 I=1,15
          COUNT(I)=0
          KN(I)=0
          VOL(I)=0
          VOLSNG(I)=0
            DO 5 J=1,13
              RDSLN(I,J)=0
              AVSLRD(I,J)=0
5           CONTINUE
4       CONTINUE
        DO 6 I=1,13
          RDT(I)=0
          AVRD(I)=0
6       CONTINUE
        DO 7 I=1,12
          IF (RD(I,1).EQ.0) VOLNST=VOLNST+RD(I,10)
          IF (RD(I,1).EQ.0) GOTO 7
          K=RD(I,11)
          COUNT(K)=COUNT(K)+1
          COUNTTOT=COUNTTOT+1
          VOL(K)=VOL(K)+RD(I,10)
          VOLT=VOLT+RD(I,10)
            IF(T(I).EQ.0) GOTO 8
          GOTO 9
8               N=N+1
                KN(K)=KN(K)+1
                VOLSNG(K)=VOLSNG(K)+RD(I,10)
                VOLSNGT=VOLSNGT+RD(I,10)
9             DO 10 J=2,9
                RDSLN(K,J)=RDSLN(K,J)+RD(I,J)*RD(I,10)
                RDT(J)=RDT(J)+RD(I,J)*RD(I,10)
10            CONTINUE
              DO 11 J=12,13
                RDSLN(K,J)=RDSLN(K,J)+RD(I,J)*RD(I,10)
                RDT(J)=RDT(J)+RD(I,J)*RD(I,10)
11            CONTINUE
7       CONTINUE
        DO 12 K=1,15
          IF (COUNT(K).EQ.0) GOTO 12
          IF (COUNT(K).EQ.KN(K)) GOTO 15
C             (If there is no soln k .or. # flshs of soln k= #
C              flshs of soln k w/o gamma) goto 12
          IF (KN(K).GT.0) GOTO 13
C             (If # flshs of soln K w/o g .GT.0) goto 13
C              Only solns with gamma results go to nest step
              DO 14 J=2,9
                AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
14            CONTINUE
           GOTO 15
C               13 is ave of sons k w some flshs w/o gamma
C               Vol(K)-Volsng(K)= vol of soln K w gamma
```

```
13          DO 16 J=2,9
               AVSLRD(K,J)=RDSLN(K,J)/(VOL(K)-VOLSNG(K))
16          CONTINUE
15          DO 17 J=12,13
               AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
17          CONTINUE
12    CONTINUE
            DO 18 J=2,9
               AVRD(J)=RDT(J)/(VOLT-VOLSNGT)
18          CONTINUE
            DO 19 J=12,13
               AVRD(J)=RDT(J)/VOLT
19          CONTINUE
      DO 20 I=1,I2,1
         IF (RD(I,1).GT.0 .AND. T(I).GT.0) GOTO 20
C          Solns w log # and w gammas skip to 20
         IF (RD(I,1).GT.0) GOTO 21
          RD(I,1)=1
21        K=RD(I,11)
C           Working with flushes w/o log #s or no gammas
         IF (COUNT(K).EQ.0) GOTO 22
         IF (COUNT(K).EQ.KN(K)) GOTO 23
           DO 24 J=12,13
              IF (RD(I,J) .GT. 0) GOTO 24
              RD(I,J)=AVSLRD(K,J)
24         CONTINUE
           DO 25 J=2,9
              RD(I,J)=AVSLRD(K,J)
25         CONTINUE
         GOTO 20
C             If soln k has no samples then the ave of all is used
22         DO 26 J=12,13
              RD(I,J)=AVRD(J)
26         CONTINUE
23         DO 27 J=2,9
              RD(I,J)=AVRD(J)
27         CONTINUE
        IF (COUNT(K).EQ.0 .AND. COUNT(K).EQ.KN(K) ) GOTO 20
        IF (RD(I,1).EQ.1 .AND. COUNT(K).EQ.KN(K)) GOTO 30
        GOTO 20
C           For a flush w/o sample, where there are other solns
C             with beta but with no gamma, use soln ave for beta
30       DO 31 J=12,13
            RD(I,J)=AVSLRD(K,J)
31       CONTINUE
20    CONTINUE
      DO 28 I=1,I2
         DO 29 J=1,15
            Z(I,J)=RD(I,J)
29       CONTINUE
28    CONTINUE
99    RETURN
      END
C
C
      SUBROUTINE COUNT(C1)
      INTEGER C1
      C1=C1+1
      WRITE (1,10) C1
10    FORMAT (////,T2,120("-"),T124,"TABLE ",I2)
```

```
      RETURN
      END
C
C
      SUBROUTINE DATAFILE
      CHARACTER*30 NAME,DATA3,PRNT,STRTSP,A*10,DEVN*5
C
      DISPLAY " File name to be accessed"
      ACCEPT A
      DISPLAY "Printer dev number  (local=144,lp=6;default=144)"
      DEVN="144"
      ACCEPT DEVN
C
      NAME[1:11]="FILE FTN09="
      NAME[12:10]=A
      NAME[22:4]=",OLD"
      NAME[26:1]=%15C
       DATA3[1:18]="FILE FTN03=ZNM,OLD"
       DATA3[19:1]=%15C
      PRNT[1:18]="FILE FTN01=LP;DEV="
      PRNT[19:4]=DEVN
      PRNT[23:1]=%15C
       STRTSP[1:14]="STARTSPOOL 144"
       STRTSP[15:1]=%15C
C
      CALL COMMAND (NAME,I1,I2)
      CALL COMMAND (DATA3,I1,I2)
      CALL COMMAND (PRNT,I1,I2)
      CALL COMMAND (STRTSP,I1,I2)
      RETURN
      END
```

```
T ZRD
/L ALL
$CONTROL USLINIT,INIT,NOSOURCE
C
C   ZRD lists data offline
C   FTN09=(File name),OLD
C   FTN01;DEV=(Device #)
C
        DIMENSION RAWDATA(790,17)
C
       CHARACTER LABEL*6(17),FILE*20,ANS
C
       DATA LABEL/"Log #","Ce144","Cs134","Cs137","Nb 95","Ru103",
     * "Ru106","Sb125","Zr 95","Vol-L","Soln","Beta","uds",
     * "% ch 1","% ch 2","mR/hr","Proc"/,Y/"Y"/,N/"N"/
C
C
       CALL DATAFILE
C
C
       I=16
       DISPLAY  "Print size  16,12,10"
       ACCEPT I
         IF (I.EQ.16) WRITE (1,101)
         IF (I.EQ.12) WRITE (1,102)
         IF (I.EQ.10) WRITE (1,103)
 103        FORMAT ("")
 102        FORMAT ("")
 101        FORMAT ("")
C
       DISPLAY "Report name"
       ACCEPT FILE
C
 2     DISPLAY "Do you want to run the program  Y/N  "
        ANS="Y"
        ACCEPT ANS
         IF (ANS.EQ."N") GOTO 99
         IF (ANS.NE."Y") GOTO 2
C
       CALL SUB4 (LABEL,RAWDATA,II)
       WRITE (1,110) FILE,(LABEL(I),I=1,17)
       WRITE (1,120) ((RAWDATA(I,J), J=1,17,1), I=1,II,1)
       WRITE (1,130)
C
 110   FORMAT (/,T20,A20,1X,"FILE AS READ IN",//,T4,A6,T11,A6,T19,A6,
     * T27,A6,T35,A6,T43,A6,T51,A6,T59,A6,T67,A6,T74,A6,T80,A6,T86,
     * A6,T94,A6,T99,A6,T106,A6,T114,A6,T121,A6,/,T11,"dps/ml",T20,
     * "dps",T28,"dps",T36,"dps",T44,"dps",T52,"dps",T60,"dps",T68,
     * "dps",T76,"L",T85,"dpm/ml",T94,"g/L",T100,"% wt",T107,"% wt",
     * T114,"mR/hr",T122,"#",/)
 120   FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,
     * 1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,2X,
     * 1PE7.1,1X,0PF5.1,2X,F5.2,2X,F5.2,1X,I6,2X,I3)
 130   FORMAT (//,T4,"Solutions",/,T6,"1. H2O",T24,"6. Citrox",T45,
     * "11. Oxalic/HNO3",/,T6,"2. HNO3",T24,"7. Tartaric/NaOH",T45,
     * "12. NH4OH",/,T6,"3. KMnO4/HNO3",T24,"8. 4324",T45,
     * "13. EDTA/NaOH",/,T6,"4. 4521",T24,"9. Oxalic",T45,
     * "14. ARR",/,T6,"5. 4502",T23,"10. Citric A",T45,"15. HF/HNO3")
 99    STOP
       END
```

```
C
C
C
      SUBROUTINE SUB4 (LB,RAWDATA,K2)
      REAL NUM
      DIMENSION RAWDATA(790,17)
      CHARACTER LB*6(17),ANS
1       DO 2 I=1,790
             DO 3 J=1,17
                RAWDATA(I,J)=0
3            CONTINUE
2       CONTINUE
        DO 4 I=1,790
           READ (9@I,100,END=5) (RAWDATA(I,J),J=1,17)
4       CONTINUE
5     K2=I-1
100   FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
     * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,1X,E7.2,1X,F5.1,1X,F5.2,1X,
     * F5.2,1X,I6,1X,I3)
99    RETURN
      END
C
C
      SUBROUTINE DATAFILE
      CHARACTER*30 NAME,PRNT,STRTSP,A*10,DEVN*5
C
      DISPLAY " File name to be accessed"
      ACCEPT A
      DISPLAY "Printer dev number  (local=144,lp=6;default=144)"
      DEVN="144"
      ACCEPT DEVN
C
      NAME[1:11]="FILE FTN09="
      NAME[12:10]=A
      NAME[22:4]=",OLD"
      NAME[26:1]=%15C
      PRNT[1:18]="FILE FTN01=LP;DEV="
      PRNT[19:4]=DEVN
      PRNT[23:1]=%15C
       STRTSP[1:14]="STARTSPOOL 144"
       STRTSP[15:1]=%15C
C
      CALL COMMAND (NAME,I1,I2)
      CALL COMMAND (PRNT,I1,I2)
      CALL COMMAND (STRTSP,I1,I2)
      RETURN
      END
```

```
T ZSUMEA
/L ALL
$CONTROL USLINIT,INIT,NOSOURCE
$INTEGER*4
C
C  NAME PROGRAM  SHORT FORM (ZSUMEA)
C      FILE FTN03=ZNM,OLD
C      FILE FTN09=(FILE TO BE ACCESSED),OLD
C      FILE FTN01;DEV=LP;CCTL
C
        DIMENSION RAWDATA(790,16),CNVRSNDT(15,4),
      * RISO(8),DPSISO(8),
      * SLNTV(15),COSTSLN(15),SLNNO(15)
C
       REAL mgISO(8),mCURISO(8),TOTmC,KgSLN(15,2),KgT(15),Z,
      * TOTmg,TOTR,LOGN,PmCIST(8),PmgIST(8),PRIST(8),MPEW,MCALC
C
       CHARACTER ISO*6(8),ANS,LABEL*6(16),FILE*30
C
       DATA ISO/"Ce144","Cs134","Cs137","Nb 95","Ru103","Ru106",
      * "Sb125","Zr 95"/
C
C
       CALL DATAFILE
C
       I=16
       DISPLAY  "Print size  16,12,10"
       ACCEPT I
         IF (I.EQ.16) WRITE (1,101)
         IF (I.EQ.12) WRITE (1,102)
         IF (I.EQ.10) WRITE (1,103)
  103         FORMAT ("")
  102         FORMAT ("")
  101       FORMAT ("")
C
       DISPLAY " Report name"
       ACCEPT FILE
         DO 804 I=1,790
            READ (9@I,800,END=805) (RAWDATA(I,J),J=1,16)
  804    CONTINUE
  805     K=I
         K2=K-1
       C=0
C
        II=K2
  1    DISPLAY K2,"flushes  "
C
  98   DISPLAY "Do you want to run the program  Y/N  "
        ANS="Y"
        ACCEPT ANS
         IF (ANS.EQ."N") STOP
         IF (ANS.NE."Y") GOTO 98
C
  2    DISPLAY "Estimates only Y/N"
        ANS="Y"
        ACCEPT ANS
         IF (ANS.EQ."Y") GOTO 51
         IF (ANS.NE."N") GOTO 2
          EST=2
C
```

```
3     DISPLAY "Include averaged data  Y/N"
       ANS="Y"
       ACCEPT ANS
        IF (ANS.EQ."N") GOTO 4
        IF (ANS.NE."Y") GOTO 3
         EST=3
C
4        DISPLAY "1. All went to PEW"
         DISPLAY "2. All went to Tankfarm"
         DISPLAY "3. Mixed, PEW & Tankfarm"
         DISPLAY "4. Calc. all the above Processes"
         DISPLAY "Waste Processing   default = 4 "
           A=4
           ACCEPT A
           IF (A.EQ.1 .OR. A.EQ.2 .OR. A.EQ.3) GOTO 6
           IF (A.NE.4) GOTO 4
C
6     WRITE (1,115) FILE
        DO 8 I=1,8,1
           RISO(I)=0
           DPSISO(I)=0
           mgISO(I)=0
           mCURISO(I)=0
           PmgIST(I)=0
           PmCIST(I)=0
           PRIST(I)=0
8       CONTINUE
        DO 9 I=1,15,1
           SLNTV(I)=0
           SLNNO(I)=0
           COSTSLN(I)=0
           KgT(I)=0
            DO 11 J=1,2,1
               KgSLN(I,J)=0
11          CONTINUE
            DO 12 J=1,4
               CNVRSNDT(I,J)=0
12          CONTINUE
9       CONTINUE
      TOTmC=0
      TOTR=0
      TOTmg=0
      TOTB=0
      TOTV=0
      TOTCOST=0
      TOTCKg=0
      NWS=0
C
        DO 13 I=1,15
           READ (3@I,100,END=14) (CNVRSNDT(I,J), J=1,4,1)
13      CONTINUE
C
14      DO 15 J=2,9
            DO 16 I=1,II
                LOGN=RAWDATA(I,1)
                IF (LOGN.EQ.0) GOTO 16
                IF (LOGN.EQ.1 .AND. EST.LE.2) GOTO 16
                DPSISO(J-1)=DPSISO(J-1)+RAWDATA(I,J)*RAWDATA(I,10)
     *            *1000
C     Multiplying by 1000 converts ml to L
```

```
16          CONTINUE
15       CONTINUE
         DO 19 I=1,8
            mCURISO(I)=DPSISO(I)/3.7E7
            RISO(I)=DPSISO(I)*CNVRSNDT(I,1)
            mgISO(I)=DPSISO(I)*CNVRSNDT(I,2)
19       CONTINUE
         DO 20 I=1,8
            TOTmC=TOTmC+mCURISO(I)
            TOTmg=TOTmg+mgISO(I)
            TOTR=TOTR+RISO(I)
20       CONTINUE
         DO 22 I=1,II,1
              LOGN=RAWDATA(I,1)
              IF (LOGN.GT.1) NWS=NWS+1
              IF (LOGN.EQ.1 .AND. EST.LE.2) RAWDATA(I,12)=0
            S1= RAWDATA(I,10)
            B=S1*RAWDATA(I,12)*1000/(60*3.7E7)
            K= RAWDATA(I,11)
            SLNTV(K)=SLNTV(K)+S1
            SLNNO(K)=SLNNO(K)+1
            TOTV=TOTV+S1
            TOTB=TOTB+B
            KgSLN(K,1)= KgSLN(K,1)+ (S1*RAWDATA(I,14))/100
            COSTSLN(K)= KgSLN(K,1)*CNVRSNDT(K,3)
              IF (K.EQ.3 .OR. K.EQ.6 .OR. K.EQ.7) GOTO 23
              IF (K.EQ.11 .OR. K.EQ.13 .OR. K.EQ.15) GOTO 23
            GOTO 24
23            KgSLN(K,2)= KgSLN(K,2)+S1*RAWDATA(I,15)/100
              COSTSLN(K)= COSTSLN(K)+KgSLN(K,2)*CNVRSNDT(K,4)
C             IF (RAWDATA(I,1).EQ.0) GOTO 22
24              DO 25 J=1,8,1
                    T1=RAWDATA(I,J+1)*S1
                    PmCIST(J)=mCURISO(J)*100/TOTmC
                    PmgIST(J)=mgISO(J)*100/TOTmg
                    PRIST(J)=RISO(J)*100/TOTR
25              CONTINUE
22       CONTINUE
         DO 30 I=1,15,1
            TOTCOST=TOTCOST+COSTSLN(I)
30       CONTINUE
         DO 38 I=1,15,1
            DO 39 J=1,2,1
              KgT(I)=KgT(I)+KgSLN(I,J)
39          CONTINUE
         TOTCKg=TOTCKg+KgT(I)
38       CONTINUE
C
      TmoleNa=0
      TmoleK=0
      PEWV=0
      CALV=0
      moleNaC=0
      moleKC=0
      T=1.01E7
         DO 40 I=1,II
           MK=0
           MNa=0
           IF (RAWDATA(I,11) .EQ. 5) MK=RAWDATA(I,14)*.1463
           IF (MK .GE. 1) GOTO 41
```

```
           IF (RAWDATA(I,11) .EQ. 7) MNa=RAWDATA(I,15)/4
           IF (RAWDATA(I,11) .EQ.13) MNa=RAWDATA(I,15)/4
           IF (RAWDATA(I,11) .EQ.14) MNa=RAWDATA(I,14)/4
           IF (MNa .GE. 1) GOTO 42
           IF (RAWDATA(I,11) .EQ. 3) MK=RAWDATA(I,14)/15.8
           IF (MK .GE. 1) GOTO 43
           IF (RAWDATA(I,12) .GT. T) GOTO 44
              PEWV=PEWV+RAWDATA(I,10)
              GOTO 40
 41        moleKC=MK*RAWDATA(I,10)
           TmoleK=TmoleK+moleKC
              GOTO 44
 42        moleNaC=MNa*RAWDATA(I,10)
           TmoleNa=TmoleNa+moleNaC
              GOTO 44
 43        moleKC=MK*RAWDATA(I,10)
           TmoleK=TmoleK+ moleKC
 44        CALV=CALV+RAWDATA(I,10)
 40      CONTINUE
       H2O = KgSLN(1,1)
       HNO3 Kg = KgSLN(2,1) + KgSLN(3,2) + KgSLN(11,2)+KgSLN(15,2)
       HNO3 L = (KgSLN(2,1) )*(1000./(63.*13.))
       KA KMnO4 = KgSLN(3,1)
       KA MnO4 = KgSLN(3,1)*(119.0/158.0)
       KA K = KgSLN(3,1)*(39.0/158.0)
       KA HNO3 Kg = KgSLN(3,2)
       KA HNO3 L = KgSLN(3,2)*(1000./(63.*13))
       S4521 = KgSLN(4,1)
       S4521 CIT A = KgSLN(4,1) * .05
       S4521 OX A = KgSLN(4,1) * .15
       NH4OXALATE = KgSLN(4,1) * .80
       S4502 = KgSLN(5,1)
       S4502 KMnO4 = KgSLN(5,1) * .20
       S4502 MnO4 = S4502 KMnO4 * (119.0/158.0)
       S4502 KK = S4502 KMnO4 * (39.0/158.0)
       S4502 KOH = KgSLN(5,1) * .77
       KOH = KgSLN(5,1) * .77
       S4502 KB = S4502 KOH * (39.0/56.0)
       S4502 OH = S4502 KOH * (17.0/56.0)
       S4502 Na = KgSLN(5,1) * 0.03*46.0/162.0
       CITROX = KgSLN(6,1) + KgSLN(6,2)
       CITROX CIT A = KgSLN(6,1)
       CITROX OX A = KgSLN(6,2)
       TARTARIC NaOH = KgSLN(7,2)
       TARTARIC Na = KgSLN(7,2)*23.0/40.0
       TARTARIC A = KgSLN(7,1)
       S4324 = KgSLN(8,1)
       S4324 Na = KgSLN(8,1) * 0.113
       OXALIC = KgSLN(9,1)
       KMnO4 = KA KMnO4 + S4502 KMnO4
       MnO4 = (KMnO4 + S4502 KMnO4) * (119.0/158.0)
       K1 = (KMnO4 + S4502 KMnO4)*(39.0/158.0)+S4502 KOH *(39.0/56.0)
       CIT A =KgSLN(10,1)
       OXALHNO = KgSLN(11,1)
       NHOH = KgSLN(12,1)
       EDTA = KgSLN(13,1)
       EDTANaOH = KgSLN(13,2)
       EDTA Na = (EDTANaOH*23.0/40.0) + (EDTA*46/372.24)
       ARRNaOH = KgSLN(14,1) * 0.69
       ARRNa = KgSLN(14,1) * 0.412
```

```
      HF = KgSLN(15,1)
      NaOH = KgSLN(7,2) + EDTANaOH + ARRNaOH
      OH = 17.0*(S4502 KOH /56.0 + NaOH/40.0 + NHOH/35)
      Na = TARTARIC Na + EDTA Na + ARRNa + S4502 Na + S4324 Na
      CITRIC A = CITROX CIT A + S4521 CIT A + CIT A
      OXALIC A = CITROX OX A + S4521 OX A + OXALIC + OXALHNO
      TV=TOTV
C
C    TOTB is in mCi
C
888   WRITE (1,540)
      WRITE (1,550) TOTV,(TOTV/3.785)
       CALC=(TOTV/3.785)*5
      WRITE (1,570) (TOTCKg-HNO3 Kg),((TOTCKg-HNO3 Kg)*2.2)
      SMOLE=(Na/23.)*1000
      WRITE (1,575) SMOLE ,SMOLE/TV
      MOLEK = ((KA K + S4502 KK + S4502 KB)/39.1)*1000
      WRITE (1,580) MOLEK,MOLEK/TV
      RMOLE= (MOLEK + SMOLE)/TV
      WRITE (1,582) MOLEK+SMOLE,RMOLE
      WRITE (1,586) TOTCOST
      WRITE (1,584)
      WRITE (1,660)
      WRITE (1,775)
      IF (SLNTV(1) .GT. 1) WRITE (1,663)  SLNTV(1),SLNNO(1)
      WRITE (1,775)
      IF (SLNTV(2) .GT. 1) WRITE (1,666) KgSLN(2,1),SLNTV(2),SLNNO(2)
      WRITE (1,775)
      IF (SLNTV(3) .GT. 1)  WRITE (1,670)  KA KMnO4, KA K,
     *    KA KMnO4 + KgSLN(3,2), SLNTV(3),SLNNO(3)
      WRITE (1,775)
      IF (SLNTV(4) .GT. 1) WRITE (1,680) S4521 CIT A, S4521 OX A,
     *    NH4OXALATE, S4521, SLNTV(4),SLNNO(4)
      WRITE (1,775)
      IF (SLNTV(5) .GT. 1)  WRITE (1,690) S4502 KMnO4,(S4502 KK +
     *    S4502 KB), S4502 Na, S4502, SLNTV(5),SLNNO(5)
      WRITE (1,775)
      IF (SLNTV(6) .GT. 1)  WRITE (1,700) CITROX CIT A, CITROX OX A,
     *    CITROX, SLNTV(6),SLNNO(6)
      WRITE (1,775)
      IF (SLNTV(7) .GT. 1) WRITE (1,710) TARTARIC A,
     *    (TARTARIC NAOH * 23.0/40.0),
     *    (TARTARIC A + TARTARIC NAOH), SLNTV(7),SLNNO(7)
      WRITE (1,775)
      IF (SLNTV(8) .GT. 1)  WRITE (1,720) S4324 Na, S4324, SLNTV(8),
     * SLNNO(8)
      WRITE (1,775)
      IF (SLNTV(9) .GT. 1)  WRITE(1,730) OXALIC, OXALIC, SLNTV(9),
     * SLNNO(9)
      WRITE (1,775)
      IF (SLNTV(10) .GT. 1)  WRITE (1,735) CIT A, CIT A, SLNTV(10),
     * SLNNO(10)
      WRITE (1,775)
      IF (SLNTV(11) .GT. 1) WRITE(1,721) OXALHNO,OXALHNO+KgSLN(11,2),
     *  SLNTV(11),SLNNO(11)
      WRITE (1,775)
      IF (SLNTV(12) .GT. 1) WRITE (1,722) NHOH, NHOH, SLNTV(12),
     *  SLNNO(12)
      WRITE (1,775)
      IF (SLNTV(13) .GT. 1) WRITE (1,723) EDTA,
```

```
     *    (EDTA Na), (EDTA + EDTANaOH), SLNTV(13),
     *    SLNNO(13)
      WRITE (1,775)
      IF (SLNTV(14) .GT. 1) WRITE (1,724) ARRNa, KgSLN(14,1),
     *    SLNTV(14),SLNNO(14)
      WRITE (1,775)
      IF (SLNTV(15) .GT. 1) WRITE (1,725) HF, (HF + KgSLN(15,2)),
     *    SLNTV(15),SLNNO(15)
      WRITE (1,775)
      WRITE (1,737) KMnO4,CITRIC A,OXALIC A,
     * NH4OXALATE,TARTARIC A,(KA K + S4502 KK + S4502 KB),
     * Na,(TOTCKg-HNO3 Kg),TV,K2
      WRITE (1,775)
      TMOLE=(HNO3 KG*1000./63.)-OH*1000/17.
        IF (TMOLE.LT.0) GOTO 59
        IF (TMOLE.EQ.0) GOTO 60
      pH=-ALOG10(TMOLE/TOTV)
      WRITE (1,770) pH
       GOTO 60
 59   pOH=-ALOG10((TMOLE*(-1))/TV)
      pH= 14-pOH
      WRITE (1,770) pH
C
 60   WRITE (1,790) K2
      WRITE (1,792) NWS
C     Cal waste, 1 all to pew, 2 all to tankfarm, 3 mixed
       IF (A .EQ. 1) GOTO 63
       IF (A .EQ. 2) GOTO 64
       IF (A .EQ. 3) GOTO 65
 63      WASTEV=750*TV/14000
C        For each 14000 L deeptank there was approx 750 L acid added
         PEWCOST=(TV + WASTEV)/3.785
         NaKWASTE=((SMOLE + MOLEK)/2.5)/3.785
         NaWASTE=(SMOLE/2.5)/3.785
C        Cal vol of waste if boiled down to 2.5 M Na or Na + K
         PEWCALNa=PEWCOST + 5*NaWASTE
         PEWCALNaK=PEWCOST + 5*NaKWASTE
         TOTCNa=PEWCALNa + TOTCOST
         TOTCNaK=PEWCALNaK + TOTCOST
         WRITE (1,605)
         WRITE (1,603) NaWASTE,NaKWASTE
         WRITE (1,601) PEWCALNa,PEWCALNaK
         WRITE (1,602) TOTCNa,TOTCNaK
C        Assumes all solns go to PEW
      IF (A .EQ. 1) GOTO 588
         IF (A .EQ. 4) WRITE (1,604)
 64      WRITE (1,606)
         WRITE (1,600) CALC
         WRITE (1,583) (TOTCOST+CALC)
C        Assumes all solution goes to calciner and includes chem cost
C        Assuming calcination cost is approximately $5 per gallon feed
      IF (A .EQ. 2) GOTO 588
 65      BL=TOTB/TOTV
         MPEW=(MOLEK+SMOLE-TmoleNa-TmoleK)/PEWV
         MOLENAK=MPEW*PEWV
         PEWVNAK=MOLENAK/2.5
            IF (CALV.NE.0) GOTO 61
               MCALC=0
               GOTO 62
 61      MCALC=(TmoleNa+TmoleK)/CALV
```

```
62      BLENDV=(MPEW*PEWV/.2)-PEWV/10
        TDV=CALV+PEWVNAK
         IF (TDV .EQ. 0.0) GOTO 66
          MOLARKS = (MOLEK+SMOLE)/TDV
          GOTO 67
66      MOLARKS = 0
67      CST=TOTCOST+PEWV*1.0/3.785+TDV*5/3.785
        WRITE (1,607)
        WRITE (1,589) PEWV,PEWVNAK,PEWVNAK/3.785,CALV,MCALC,
     &    CALV/3.785,TDV,MOLARKS,TDV/3.785,CST
589  FORMAT (T6,"Waste vol to PEW",9X,I7,1X,"L",
     & T43,"Reduced to",1X,I7,1X,"L",2X,"2.5 M Na K",
     & 3X,I7,1X,"gal",/,
     & T6,"Waste vol bypassing PEW",2X,I7,1X,"L",2X,F4.2,1X,"M Na K",
     & T54,I7,1X,"gal",/,
     & T6,"Total tank farm vol",6X,I7,1X,"L",2X,F4.2,1X,"M Na K",
     & T54,I7,1X,"gal",/,
     & T6,"Cost w/o labor",T31,I7,1X,"$",T44,"PEW $1/gal",
     & T59,"Calcine $ 5/gal")
C    Includes chem cost
C      PEW limits are 4.5 mCi Beta/L or 1E+7 beta/min*ml
588  IF (A .NE. 4)  WRITE (1,604)
     IF (A .NE. 4) WRITE (1,115) FILE
       WRITE (1,200)
       Z=1
       CALL SUB3 (ISO,mCURISO,mgISO,RISO,TOTmC,TOTmg,TOTR,Z,TOTV)
       WRITE (1,202) TOTB/1000
       Z=3
       WRITE (1,205)
       CALL SUB3 (ISO,mCURISO,mgISO,RISO,TOTmC,TOTmg,TOTR,Z,TOTV)
       WRITE (1,207) TOTB/TOTV,(TOTB*2.22E6/TOTV)
       WRITE (1,210)
83     Z=2
       CALL SUB3 (ISO,PmCIST,PmgIST,PRIST,TOTmC,TOTmg,TOTR,Z,TOTV)
     GOTO 99
51   CALL SUB5 (II,RAWDATA,RAWDATA)
C    WRITE (1,115) FILE
     EST=5
     GOTO 4
C
100  FORMAT (E9.3,E12.3,F10.2,F10.2)
115  FORMAT (/,T20,A30)
C116  FORMAT (/////,T20,A30)
200  FORMAT (//,T2,"Individual Isotope Information")
202  FORMAT (T15,"Beta",T26,I8)
205  FORMAT (//,T2,"X/L Isotope Information")
207  FORMAT (T15,"Beta",T26,F8.1,T40,"B/min/ml=",T51,1PE7.1)
210  FORMAT (//,T2,"% Isotope Information")
540  FORMAT (/,T2,"Waste Analysis")
550  FORMAT (T10,"Unprocessed",/,T12,"Volume of Waste",T45,I7,1X,
     & "L",6X,I6,1X,"gal")
585  FORMAT (T15,61("-"))
570  FORMAT (T12,"Wt of chemicals  w/o HNO3",T45,I7,1X,"Kg",5X,
     * I6,1X,"lbs",)
575  FORMAT (T12,"Moles of Na+ ; Molarity",T44,I8,1X,"moles",T59,
     & F7.2,1X,"M")
580  FORMAT (T12,"Moles of K+ ; Molarity",T44,I8,1X,"moles"T59,
     & F7.2,1x,"M")
582  FORMAT (T12,"Moles Na+ plus K+ ; Molarity",T44,I8,1X,"moles",
     & T59,F7.2,1X,"M")
```

```
586   FORMAT (T12,"Chemical cost 1982 $",T44,I8,1X,"$")
600   FORMAT (T12,"Calcine cost  $ 5/gal",T44,I8,1X,"$")
583   FORMAT (T12,"Decon cost w/o labor",T44,I8,1X,"$")
601   FORMAT (T12,"PEW + Calcine ($1 & $5/gal)",T44,I8,1X,"$   Na",
     * T59,I8,1X,"$   Na + K")
602   FORMAT (T12,"Decon cost w/o labor",T44,I8,1X,"$   Na",T59,
     * I8,1X,"$   Na + K")
603   FORMAT (T12,"Vol of 2.5 M waste",T44,I8,1X,"gal Na",T59,
     * I8,1X,"gal Na + K")
C        FORMAT 604 HAS AN ESC&l1V escape sequence, don't screen!
584   FORMAT (/,T2, "Chemical Analysis  (Kg)")
604   FORMAT ("")
605   FORMAT (/,T4,"Processed waste - assumed all went to PEW")
606   FORMAT (/,T4,"Processed waste - assumed all bypassed PEW")
607   FORMAT (/,T4,"Processed waste - mixed PEW & tankfarm, assumed",
     & 1X,"decision point was at cell")
C660   FORMAT (T61,"KMnO4",T68,"KOH",T74,"NaOH",T96,"# of",/,
660    FORMAT (T91,"# of",/,
     * T20,"KMnO4",T27,"Citric",T35,"Oxalic",T43,"NH Oxal",T52,
     * "Tart A",T62,"K+",T69,"Na+",T76,"Kg",T85,"L",T90,
     * "Flushes")
663   FORMAT (T4,"H2O"T80,I8,T92,I3)
666   FORMAT (T4,"HNO3 ",T74,I5,T80,I8,T92,I3)
670   FORMAT (T4,"KMnO4/HNO3",T19,I5,T59,I5,T74,I5,T80,I8,T92,I3)
680   FORMAT (T4,"4521",T26,I5,T34,I5,T44,I5,T74,I5,T80,I8,T92,I3)
690   FORMAT (T4,"4502",T19,I5,T59,I5,T66,I5,T74,I5,T80,I8,
     * T92,I3)
700   FORMAT (T4,"Citrox",T26,I5,T34,I5,T74,I5,T80,I8,T92,I3)
710   FORMAT (T4,"Tart A/NaOH",T52,I5,T66,I5,T74,I5,T80,I8,T92,I3)
720   FORMAT (T4,"4324",T66,I5,T74,I5,T80,I8,T92,I3)
721   FORMAT (T4,"Oxalic/HNO3",T34,I5,T74,I5,T80,I8,T92,I3)
722   FORMAT (T4,"NH4OH",T13,I5,T74,I5,T80,I8,T92,I3)
723   FORMAT (T4,"EDTA/NaOH",T13,I5,T66,I5,T74,I5,T80,I8,T92,I3)
724   FORMAT (T4,"ARR",T66,I5,T74,I5,T80,I8,T92,I3)
725   FORMAT (T4,"HF/HNO3",T13,I5,T74,I5,T80,I8,T92,I3)
730   FORMAT (T4,"Oxalic A",T34,I5,T74,I5,T80,I8,T92,I3)
735   FORMAT (T4,"Citric A",T26,I5,T74,I5,T80,I8,T92,I3)
737   FORMAT (T4,"Totals",T19,I5,T26,I5,T34,I5,T44,I5,T52,I5,
     * T59,I5,T66,I5,T73,I6,T80,I8,T92,I3)
770   FORMAT (/,T4,"Approx. pH of waste",T24,F6.1)
775   FORMAT (T4,93("-"))
790   FORMAT (T4,"Number of flushes",T26,I4)
792   FORMAT (T4,"Samples taken",T26,I4)
587   FORMAT (T6,"Waste Volume after PEW",T29,I7,1X,"L",T47,I7,1X,
     & "gal")
794   FORMAT (/,T4,"mCi gamma/Kg waste",T25,I5)
795   FORMAT (/,T4,"Cost per flush",T22,"$",T24,I4)
796   FORMAT (/,,T4,"Cost per L",T22,"$",T24,F4.2)
800   FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
     * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,1X,E7.2,1X,F5.1,1X,F5.2,1X,
     * F5.2,1X,I6)
99    STOP
      END
C
      SUBROUTINE SUB5 (I2,RD,Z)
      DIMENSION RD(790,15),RDSLN(15,13),RDT(13),AVSLRD(15,13),
     * AVRD(13),COUNT(15),Z(790,15),T(790),KN(15),VOL(15),
     * VOLSNG(15)
C
C*********************************************************************
```

```
C                                                                    *
C        T(I)      is the sum of the gamma for a flush               *
C        K         is the solution number                            *
C        COUNT(K)  is the # of flushes of soln k w log #             *
C        N         is the # of flushes w/o gamma scan                *
C        KN(K)     is the # of flushes of soln k w/o gamma           *
C        COUNTTOT  is the total # of flushes with log #'s            *
C        VOL(K)    is the volume of soln K w log #s                  *
C        VOLT      is the total volume of sampled flushes            *
C        VOLSNG(K) is the volume of sampled soln k w/o gamma         *
C        VOLSNGT   is the total vol of sampled flushes w/o gamma     *
C        VOLNST    is the total vol of flushes w/o log #s            *
C                                                                    *
C*********************************************************************
C
      COUNTTOT=0
      VOLT=0
      VOLNST=0
      VOLSNGT=0
      N=0
        DO 1 I=1,12
           T(I)=0
 1      CONTINUE
        DO 2 I=1,12
           DO 3 J=2,9
              T(I)=T(I)+RD(I,J)
 3         CONTINUE
 2      CONTINUE
        DO 4 I=1,15
           COUNT(I)=0
           KN(I)=0
           VOL(I)=0
           VOLSNG(I)=0
             DO 5 J=1,13
                RDSLN(I,J)=0
                AVSLRD(I,J)=0
 5           CONTINUE
 4      CONTINUE
        DO 6 I=1,13
           RDT(I)=0
           AVRD(I)=0
 6      CONTINUE
        DO 7 I=1,12
           IF (RD(I,1).EQ.0) VOLNST=VOLNST+RD(I,10)
           IF (RD(I,1).EQ.0) GOTO 7
           K=RD(I,11)
           COUNT(K)=COUNT(K)+1
           COUNTTOT=COUNTTOT+1
           VOL(K)=VOL(K)+RD(I,10)
           VOLT=VOLT+RD(I,10)
             IF(T(I).EQ.0) GOTO 8
           GOTO 9
 8              N=N+1
                KN(K)=KN(K)+1
                VOLSNG(K)=VOLSNG(K)+RD(I,10)
                VOLSNGT=VOLSNGT+RD(I,10)
 9           DO 10 J=2,9
                RDSLN(K,J)=RDSLN(K,J)+RD(I,J)*RD(I,10)
                RDT(J)=RDT(J)+RD(I,J)*RD(I,10)
 10          CONTINUE
```

```
            DO 11 J=12,13
               RDSLN(K,J)=RDSLN(K,J)+RD(I,J)*RD(I,10)
               RDT(J)=RDT(J)+RD(I,J)*RD(I,10)
11          CONTINUE
7     CONTINUE
      DO 12 K=1,15
         IF (COUNT(K).EQ.0) GOTO 12
         IF (COUNT(K).EQ.KN(K)) GOTO 15
C             (If there is no soln k .or. # flshs of soln k= #
C              flshs of soln k w/o gamma) goto 12
         IF (KN(K).GT.0) GOTO 13
C             (If # flshs of soln K w/o g .GT.0) goto 13
C              Only solns with gamma results go to nest step
            DO 14 J=2,9
               AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
14          CONTINUE
          GOTO 15
C               13 is ave of sons k w some flshs w/o gamma
C               Vol(K)-Volsng(K)= vol of soln K w gamma
13          DO 16 J=2,9
               AVSLRD(K,J)=RDSLN(K,J)/(VOL(K)-VOLSNG(K))
16          CONTINUE
15          DO 17 J=12,13
               AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
17          CONTINUE
12    CONTINUE
            DO 18 J=2,9
               AVRD(J)=RDT(J)/(VOLT-VOLSNGT)
18          CONTINUE
            DO 19 J=12,13
               AVRD(J)=RDT(J)/VOLT
19          CONTINUE
      DO 20 I=1,I2,1
         IF (RD(I,1).GT.0 .AND. T(I).GT.0) GOTO 20
C          Solns w log # and w gammas skip to 20
         IF (RD(I,1).GT.0) GOTO 21
          RD(I,1)=1
21        K=RD(I,11)
C           Working with flushes w/o log #s or no gammas
         IF (COUNT(K).EQ.0) GOTO 22
         IF (COUNT(K).EQ.KN(K)) GOTO 23
           DO 24 J=12,13
              IF (RD(I,J) .GT. 0) GOTO 24
              RD(I,J)=AVSLRD(K,J)
24         CONTINUE
           DO 25 J=2,9
              RD(I,J)=AVSLRD(K,J)
25         CONTINUE
         GOTO 20
C             If soln k has no samples then the ave of all is used
22         DO 26 J=12,13
              RD(I,J)=AVRD(J)
26         CONTINUE
23         DO 27 J=2,9
              RD(I,J)=AVRD(J)
27         CONTINUE
        IF (COUNT(K).EQ.0 .AND. COUNT(K).EQ.KN(K) ) GOTO 20
        IF (RD(I,1).EQ.1 .AND. COUNT(K).EQ.KN(K)) GOTO 30
        GOTO 20
C             For a flush w/o sample, where there are other solns
```

```
C             with beta but with no gamma, use soln ave for beta
 30        DO 31 J=12,13
              RD(I,J)=AVSLRD(K,J)
 31        CONTINUE
 20     CONTINUE
        DO 28 I=1,I2
           DO 29 J=1,15
              Z(I,J)=RD(I,J)
 29        CONTINUE
 28     CONTINUE
 99   RETURN
      END
C
      SUBROUTINE SUB3 (IS,X,Y,Z,TmC,Tmg,TR,Z2,TV)
      DIMENSION X(8),Y(8),Z(8),XX(8),YY(8),ZZ(8)
      CHARACTER IS*6(8),IS2*9(8)
      DATA IS2/"Zr 95","Nb 95","Ru103","Ru106","Sb125","Cs134",
     * "Cs137","Ce144"/
C
       DO 12 I=4,7
          XX(I-2)=X(I)
          YY(I-2)=Y(I)
          ZZ(I-2)=Z(I)
 12    CONTINUE
      XX(1)=X(8)
      XX(6)=X(2)
      XX(7)=X(3)
      XX(8)=X(1)
       YY(1)=Y(8)
       YY(6)=Y(2)
       YY(7)=Y(3)
       YY(8)=Y(1)
      ZZ(1)=Z(8)
      ZZ(6)=Z(2)
      ZZ(7)=Z(3)
      ZZ(8)=Z(1)
 10   T=1000
       IF (Z2.EQ.3) GOTO 5
      WRITE (1,100)
      WRITE (1,120)
       IF (Z2.EQ.2) GOTO 1
C
        DO 2 I=1,8
           WRITE (1,130) Is2(I),XX(I)/T,YY(I)/T,ZZ(I)/T
 2      CONTINUE
      WRITE (1,120)
      WRITE (1,140) TmC/T,Tmg/T,TR/T
      WRITE (1,120)
       GOTO 99
C
 5    WRITE (1,110)
      WRITE (1,120)
        DO 6 I=1,8
           WRITE (1,135) IS2(I),XX(I)/TV,YY(I)/TV,ZZ(I)/TV
 6      CONTINUE
      WRITE (1,120)
      WRITE (1,145) TmC/TV,Tmg/TV,TR/TV
      WRITE (1,120)
       GOTO 99
C
```

```
1         DO 3 I=1,8
             WRITE (1,190) IS2(I),XX(I),YY(I),ZZ(I)
3         CONTINUE
        WRITE (1,120)
C
100     FORMAT (T32,"Ci",T41,"mg",T47," R/hr")
110     FORMAT (T30,"mCi/L",T39,"ug/L",T46,"mR/hr*L")
130     FORMAT (T15,A9,T27,6(I7,2X))
135     FORMAT (T15,A9,T27,6(F7.1,2X))
140     FORMAT (T15,"Total",T26,3(I8,1X))
145     FORMAT (T15,"Total",T26,3(F8.1,1X))
120     FORMAT (T15,37("-"))
190     FORMAT (T15,A9,T27,6(F7.1,2X))
99      RETURN
        END
C
C
C
        SUBROUTINE DATAFILE
        CHARACTER*30 NAME,DATA3,PRNT,STRTSP,A*10,DEVN*5
C
        DISPLAY " File name to be accessed"
        ACCEPT A
        DISPLAY "Printer dev number  (local=144,lp=6;default=144)"
        DEVN="144"
        ACCEPT DEVN
C
        NAME[1:11]="FILE FTN09="
        NAME[12:10]=A
        NAME[22:4]=",OLD"
        NAME[26:1]=%15C
         DATA3[1:18]="FILE FTN03=ZNM,OLD"
         DATA3[19:1]=%15C
        PRNT[1:18]="FILE FTN01=LP;DEV="
        PRNT[19:4]=DEVN
        PRNT[23:1]=%15C
         STRTSP[1:14]="STARTSPOOL 144"
         STRTSP[15:1]=%15C
C
        CALL COMMAND (NAME,I1,I2)
        CALL COMMAND (DATA3,I1,I2)
        CALL COMMAND (PRNT,I1,I2)
        CALL COMMAND (STRTSP,I1,I2)
        RETURN
        END
```

```
T ZTOTAL
/L ALL
      $CONTROL USLINIT,INIT,NOSOURCE
      $INTEGER*4
      C  NAME PROGRAM  SHORT FORM (ZTOTAL)
      C     FILE FTN03=ZNM,OLD
      C     FILE FTN09=(FILE TO BE ACCESSED),OLD
      C     FILE FTN01;DEV=LP;CCTL
      C
              DIMENSION RAWDATA(720,16),CNVRSNDT(15,4),
            * RISO(8),DPSISO(8),
            * SLNmC(15,8),SLNmg(15,8),SLNREA(15,8),SLNBCT(15),
            * SLNmCT(15),SLNmgT(15),SLNREAT(15),SLNTV(15),SLNNO(15),
            * COSTSLN(15),
            * UDSGSLN(15),
            * PmCIST(8),PmgIST(8),PRIST(8),
            * PmCSLN(15,8),PRSLN(15,8),PmgSLN(15,8),
            * PmCSLNT(15),PmgSLNT(15),PRSLNT(15),PUDSSLNT(15),PBCSLNT(15),
            * PCOSTSLNT(15),PVOLSLNT(15),
            * PJSL(15,8),
            * PTmgSL(15,8),PTmRSL(15,8),PTmCSL(15,8)
      C
             REAL mgISO(8),mCURISO(8),
            * TOTmC,TOTmg,TOTR,KgSLN(15,2),KgT(15),Z
      C
             INTEGER C
      C
             CHARACTER ISO*6(8),SOLN*13(15),ANS,LABEL*6(16),FILE*20
      C
             DATA ISO/"Ce144","Cs134","Cs137","Nb 95","Ru103",
            * "Ru106","Sb125","Zr 95"/
             DATA SOLN/"H2O","HNO3","KMn04/HNO3","4521","4502","CITROX",
            * "Tartaric/NaOH","4324","Oxalic","Citric A","Oxalic/HNO3",
            * "NH4OH","EDTA/NaOH","ARR","HF/HNO3"/
             DATA LABEL/"Log #","Ce144","Cs134","Cs137","Nb 95","Ru103",
            * "Ru106","Sb125","Zr 95","Vol-L","Soln","Beta","uds",
            * "% ch 1","% ch 2","mR/hr"/,Y/"Y"/,N/"N"/
      C
      C
             CALL DATAFILE
      C
             I=16
             DISPLAY  "Print size  16,12,10"
             ACCEPT I
               IF (I.EQ.16) WRITE (1,101)
               IF (I.EQ.12) WRITE (1,102)
               IF (I.EQ.10) WRITE (1,103)
      102        FORMAT ("")
      103        FORMAT ("")
      101        FORMAT ("")
      C
      C
             DISPLAY " Report name"
             ACCEPT FILE
               DO 804 I=1,720
                  READ (9@I,800,END=805) (RAWDATA(I,J),J=1,16)
      804      CONTINUE
      805       K=I
               K2=K-1
             EST =0
```

```
      C=0
C
       II=K2
1     DISPLAY " How many flushes  ", K2
       ACCEPT II
C
98    DISPLAY "Do you want to run the program  Y/N  "
       ANS="Y"
       ACCEPT ANS
        IF (ANS.EQ."N") STOP
        IF (ANS.NE."Y") GOTO 98
C
2     DISPLAY "Estimates only Y/N"
       ANS="Y"
       ACCEPT ANS
        IF (ANS.EQ."Y") GOTO 51
        IF (ANS.NE."N") GOTO 2
         EST=2
C
3     DISPLAY "Include averaged data  Y/N"
       ANS="Y"
       ACCEPT ANS
        IF (ANS.EQ."N") GOTO 4
        IF (ANS.NE."Y") GOTO 3
         EST=3
C
4       DO 8 I=1,8,1
           RISO(I)=0
           DPSISO(I)=0
           mgISO(I)=0
           mCURISO(I)=0
           PRIST(I)=0
8       CONTINUE
        DO 9 I=1,15
           SLNBCT(I)=0
           SLNmCT(I)=0
           SLNmgT(I)=0
           SLNREAT(I)=0
           SLNTV(I)=0
           SLNNO(I)=0
           COSTSLN(I)=0
           KgT(I)=0
           UDSGSLN(I)=0
           PmCSLNT(I)=0
           PmgSLNT(I)=0
           PRSLNT(I)=0
           PUDSSLNT(I)=0
           PBCSLNT(I)=0
           PCOSTSLNT(I)=0
           PVOLSLNT(I)=0
            DO 10 J=1,8
              SLNmC(I,J)=0
              SLNmg(I,J)=0
              SLNREA(I,J)=0
              PmCSLN(I,J)=0
              PRSLN(I,J)=0
              PmgSLN(I,J)=0
              PJSL(I,J)=0
              PTmCSL(I,J)=0
              PTmgSL(I,J)=0
```

```
                PTmRSL(I,J)=0
   10        CONTINUE
             DO 11 J=1,2
                KgSLN(I,J)=0
   11        CONTINUE
             DO 12 J=1,4
                CNVRSNDT(I,J)=0
   12        CONTINUE
    9     CONTINUE
        T=1000
        TOTmC=0
        TOTR=0
        TOTmg=0
        TOTV=0
        TOTB=0
        TOTCOST=0
        TOTCKg=0
        UDSGT=0
        NWS=0
C
          DO 13 I=1,15
             READ (3@I,100,END=14) (CNVRSNDT(I,J), J=1,4,1)
   13     CONTINUE
C
C  Multiply by 1000 to covert ml to L
   14     DO 15 J=2,9
              DO 16 I=1,II
                 IF (RAWDATA(I,1).EQ.0) GOTO 16
                 DPSISO(J-1)=DPSISO(J-1)+RAWDATA(I,J)*RAWDATA(I,10)
     *             *1000
   16         CONTINUE
   15     CONTINUE
          DO 19 I=1,8
             mCURISO(I)=DPSISO(I)/3.7E7
             RISO(I)=DPSISO(I)*CNVRSNDT(I,1)
             mgISO(I)=DPSISO(I)*CNVRSNDT(I,2)
   19     CONTINUE
          DO 20 I=1,8
             TOTmC=TOTmC+mCURISO(I)
             TOTmg=TOTmg+mgISO(I)
             TOTR=TOTR+RISO(I)
   20     CONTINUE
          DO 22 I=1,II
               IF (RAWDATA(I,1).GT.1) NWS=NWS+1
               IF (RAWDATA(I,1).EQ.0) GOTO 22
             S1= RAWDATA(I,10)
             B=S1*RAWDATA(I,12)*1000/(60*3.7E7)
             K= RAWDATA(I,11)
             TOTV=TOTV+S1
             TOTB=TOTB+B
             UDSGSLN(K)= UDSGSLN(K)+S1*RAWDATA(I,13)
             SLNTV(K)= SLNTV(K)+S1
             SLNNO(K)= SLNNO(K)+1
             SLNBCT(K)= SLNBCT(K)+B
             KgSLN(K,1)= KgSLN(K,1)+S1*RAWDATA(I,14)/100
             COSTSLN(K)= KgSLN(K,1)*CNVRSNDT(K,3)
               IF (K.EQ.3 .OR. K.EQ.6 .OR. K.EQ.7) GOTO 23
               IF (K.EQ.11 .OR. K.EQ.13 .OR. K.EQ.15) GOTO 23
             GOTO 24
   23          KgSLN(K,2)= KgSLN(K,2)+S1*RAWDATA(I,15)/100
```

```
            COSTSLN(K)= COSTSLN(K)+KgSLN(K,2)*CNVRSNDT(K,4)
24            DO 25 J=1,8,1
                T1=RAWDATA(I,J+1)*S1
                SLNmC(K,J)= SLNmC(K,J)+(T1*1000)/3.7E7
                SLNmg(K,J)= SLNmg(K,J)+T1*CNVRSNDT(J,2)*1000
                SLNREA(K,J)= SLNREA(K,J)+T1*1000*CNVRSNDT(J,1)
                PmCIST(J)= mCURISO(J)*100/TOTmC
                PmgIST(J)= mgISO(J)*100/TOTmg
                PRIST(J)= RISO(J)*100/TOTR
25            CONTINUE
22      CONTINUE
        DO 30 I=1,15
           DO 31 J=1,8
             SLNmCT(I)=SLNmCT(I)+SLNmC(I,J)
             SLNmgT(I)=SLNmgT(I)+SLNmg(I,J)
             SLNREAT(I)=SLNREAT(I)+SLNREA(I,J)
31         CONTINUE
           TOTCOST=TOTCOST+COSTSLN(I)
           UDSGT=UDSGT+UDSGSLN(I)
30      CONTINUE
        DO 32 I=1,15
           V=SLNTV(I)
             IF (V.EQ.0) GOTO 32
           PBCSLNT(I)= SLNBCT(I)*100/TOTB
           PCOSTSLNT(I)= COSTSLN(I)*100/TOTCOST
           PVOLSLNT(I)= SLNTV(I)*100/TOTV
           PmCSLNT(I)= SLNmCT(I)*100/TOTmC
           PmgSLNT(I)= SLNmgT(I)*100/TOTmg
           PRSLNT(I)= SLNREAT(I)*100/TOTR
             IF ( UDSGT .EQ. 0) GOTO 33
           PUDSSLNT(I)= UDSGSLN(I)*100/UDSGT
33           DO 34 J=1,8
                PTmCSL(I,J)=SLNmC(I,J)*100/TOTmC
                PTmgSL(I,J)=SLNmg(I,J)*100/TOTmg
                PTmRSL(I,J)=SLNREA(I,J)*100/TOTR
                   IF (mCURISO(J).EQ.0) GOTO 35
                      PJSL(I,J)=SLNmC(I,J)*100/mCURISO(J)
37                 IF (SLNmCT(I).EQ.0) GOTO 36
                     PmCSLN(I,J)= SLNmC(I,J)*100/SLNmCT(I)
                     PRSLN(I,J)= SLNREA(I,J)*100/SLNREAT(I)
                     PmgSLN(I,J)= SLNmg(I,J)*100/SLNmgT(I)
                 GOTO 34
35                   PJSL(I,J)=0
                 GOTO 37
36                  PmCSLN(I,J)=0
                    PRSLN(I,J)=0
                    PmgSLN(I,J)=0
34           CONTINUE
32      CONTINUE
        DO 38 I=1,15
           DO 39 J=1,2
             KgT(I)=KgT(I)+KgSLN(I,J)
39         CONTINUE
        TOTCKg=TOTCKg+KgT(I)
38      CONTINUE
C
       H2O = KgSLN(1,1)
       HNO3 Kg = KgSLN(2,1) + KgSLN(3,2) + KgSLN(11,2)+ KgSLN(15,2)
       HNO3 L = (KgSLN(2,1) )*(1000./(63.*13.))
       KA KMnO4 = KgSLN(3,1)
```

```
      KA MnO4 = KgSLN(3,1)*(119.0/158.0)
      KA K = KgSLN(3,1)*(39.0/158.0)
      KA HNO3 Kg = KgSLN(3,2)
      KA HNO3 L = KgSLN(3,2)*(1000./(63.*13))
      S4521 = KgSLN(4,1)
      S4521 CIT A = KgSLN(4,1) * .05
      S4521 OX A = KgSLN(4,1) * .15
      NH4OXALATE = KgSLN(4,1) * .80
      S4502 = KgSLN(5,1)
      S4502 KMnO4 = KgSLN(5,1) * .20
      S4502 MnO4 = S4502 KMnO4 * (119.0/158.0)
      S4502 KK = S4502 KMnO4 * (39.0/158.0)
      S4502 KOH = KgSLN(5,1) * .77
      KOH = KgSLN(5,1) * .77
      S4502 Na =KgSLN(5,1) * 0.03*46.0/162.0
      S4502 KB = S4502 KOH * (39.0/56.0)
      S4502 OH = S4502 KOH * (17.0/56.0)
      CITROX = KgSLN(6,1) + KgSLN(6,2)
      CITROX CIT A = KgSLN(6,1)
      CITROX OX A = KgSLN(6,2)
      TARTARIC NaOH = KgSLN(7,2)
      TARTARIC Na = KgSLN(7,2)*23.0/40.0
      TARTARIC A = KgSLN(7,1)
      S4324 = KgSLN(8,1)
      S4324 Na = S4324 * 0.113
      OXALIC = KgSLN(9,1)
      KMnO4 = KA KMnO4 + S4502 KMnO4
      MnO4 = (KMnO4 + S4502 KMnO4) * (119.0/158.0)
      K1 = (KMnO4 + S4502 KMnO4)*(39.0/158.0)+S4502 KOH *(39.0/56.0)
      CIT A =KgSLN(10,1)
      OXALHNO = KgSLN(11,1)
      NHOH = KgSLN(12,1)
      EDTA = KgSLN(13,1)
      EDTANaOH = KgSLN(13,2)
      EDTA Na = (EDTANaOH*23.0/40.0) + (EDTA*46/372.24)
      ARRNaOH = KgSLN(14,1)
      ARRNa = ARRNaOH * 0.412
      NaOH = KgSLN(7,2) + EDTANaOH + ARRNaOH
      HF = KgSLN(15,1)
      OH = 17.0*(S4502 KOH/56.0 + NaOH/40.0 + NHOH/35)
      Na = TARTARIC Na + EDTA Na + ARRNa + S4502 Na + S4324 Na
      CITRIC A = CITROX CIT A + S4521 CIT A + CIT A
      OXALIC A = CITROX OX A + S4521 OX A + OXALIC + OXALHNO
      TV=TOTV
C
C
      IF (EST.NE.0) WRITE (1,105)
      WRITE (1,150) FILE
C
      CALL COUNT (C)
      WRITE (1,200)
      Z=1
      CALL SUB3 (ISO,mCURISO,mgISO,RISO,TOTmC,TOTmg,TOTR,Z,TOTV)
      WRITE (1,202) TOTB/1000.
      CALL COUNT (C)
      Z=3
      WRITE (1,205)
      CALL SUB3 (ISO,mCURISO,mgISO,RISO,TOTmC,TOTmg,TOTR,Z,TOTV)
      WRITE (1,207) TOTB/TOTV,(TOTB*2.22E6/TOTV)
      CALL COUNT (C)
```

```
      WRITE (1,210)
      Z=2
      CALL SUB3 (ISO,PmCIST,PmgIST,PRIST,TOTmC,TOTmg,TOTR,Z,TOTV)
      CALL COUNT(C)
      WRITE (1,235)
      Z=4
      CALL SUB2(ISO,SLNmC,SLNmCT,SLNTV,SOLN,Z,TOTV)
      WRITE (1,315) (mCURISO(I)/TOTV,I=1,8),TOTmC/TOTV;TOTV
      CALL COUNT(C)
      WRITE (1,245)
      CALL SUB2(ISO,SLNmg,SLNmgT,SLNTV,SOLN,Z,TOTV)
      WRITE (1,315) ((mgISO(I)/TOTV),I=1,8),TOTmg/TOTV,TOTV
      CALL COUNT(C)
      WRITE (1,255)
      CALL SUB2(ISO,SLNREA,SLNREAT,SLNTV,SOLN,Z,TOTV)
      WRITE (1,315) ((RISO(I)/TOTV),I=1,8),TOTR/TOTV,TOTV
      CALL COUNT(C)
      Z=1
      WRITE (1,230)
      CALL SUB2 (ISO,SLNmC,SLNmCT,SLNTV,SOLN,Z,TOTV)
      CALL COUNT(C)
      WRITE (1,240)
      CALL SUB2 (ISO,SLNmg,SLNmgT,SLNTV,SOLN,Z,TOTV)
      CALL COUNT(C)
      WRITE (1,250)
      CALL SUB2 (ISO,SLNREA,SLNREAT,SLNTV,SOLN,Z,TOTV)
      CALL COUNT(C)
      WRITE (1,260)
      Z=2
      CALL SUB2 (ISO,PmCSLN,PmCSLNT,PVOLSLNT,SOLN,Z,TOTV)
      CALL COUNT(C)
      WRITE (1,270)
      CALL SUB2 (ISO,PmgSLN,PmgSLNT,PVOLSLNT,SOLN,Z,TOTV)
      CALL COUNT(C)
      WRITE (1,280)
      CALL SUB2 (ISO,PRSLN,PRSLNT,PVOLSLNT,SOLN,Z,TOTV)
      Z=3
      CALL COUNT(C)
      WRITE (1,290)
      CALL SUB2 (ISO, PJSL,PmCSLNT,PVOLSLNT,SOLN,Z,TOTV)
      CALL COUNT(C)
      WRITE (1,300)
      Z=2
      CALL SUB2 (ISO,PTmCSL,PmCSLNT,PVOLSLNT,SOLN,Z,TOTV)
      WRITE (1,310) (PmCIST(I),I=1,8)
      CALL COUNT(C)
      WRITE (1,320)
      CALL SUB2 (ISO, PTmgSL,PmgSLNT,PVOLSLNT,SOLN,Z,TOTV)
      WRITE (1,310) (PmgIST(I),I=1,8)
      CALL COUNT(C)
      WRITE (1,330)
      CALL SUB2 (ISO, PTmRSL,PRSLNT,PVOLSLNT,SOLN,Z,TOTV)
      WRITE (1,310) (PRIST(I),I=1,8)
      CALL COUNT(C)
      WRITE (1,420)
      WRITE (1,430)
      WRITE (1,440)
        DO 46 I=1,15
           IF (SLNTV(I) .EQ. 0.0) GOTO 46
           WRITE (1,450) SLNREAT(I)/T,SLNmgT(I)/T,UDSGSLN(I)/T,
```

```
     *       SLNmCT(I)/T,SLNBCT(I)/T,COSTSLN(I),SOLN(I),SLNTV(I)
 46     CONTINUE
      WRITE (1,440)
      WRITE (1,380) TOTR/T,TOTmg/T,UDSGT/T,TOTmC/T,TOTB/T,TOTCOST,TOTV
      WRITE (1,440)
      CALL COUNT(C)
      WRITE (1,460)
      WRITE (1,430)
      WRITE (1,440)
        DO 47 I=1,15
           IF (SLNTV(I).EQ.0) GOTO 47
           WRITE (1,470) PRSLNT(I),PmgSLNT(I),PUDSSLNT(I),PmCSLNT(I),
     *       PBCSLNT(I),PCOSTSLNT(I),SOLN(I),PVOLSLNT(I)
 47     CONTINUE
      WRITE (1,440)
      CALL COUNT(C)
      WRITE (1,475)
      WRITE (1,480)
      WRITE (1,445)
        DO 48 I=1,15
           V = SLNTV(I)
           IF (V.EQ.0.0) GOTO 48
           WRITE (1,490) SLNREAT(I)/V,SLNmgT(I)/V,UDSGSLN(I)/V,
     *       SLNmCT(I)/V,SLNBCT(I)/V,SLNBCT(I)/V,COSTSLN(I)/V,
     *       SOLN(I),SLNTV(I)
 48     CONTINUE
C
      WRITE (1,445)
      TC=TOTCOST
      TV=TOTV
      WRITE (1,492) TOTR/TV,TOTmg/TV,UDSGT/TV,TOTmC/TV,TOTB/TV,TC/TV,
     *  TV
      WRITE (1,445)
      CALL COUNT(C)
      WRITE (1,500)
      WRITE (1,510)
      WRITE (1,440)
        DO 49 I=1,15
           Y=COSTSLN(I)
           IF (SLNTV(I).EQ.0) GOTO 49
             SR = SLNREAT(I)
             Smg = SLNmgT(I)
             UDS = UDSGSLN(I)
             SmC = SLNmCT(I)
             SBC = SLNBCT(I)
            IF (Y.EQ.0) Y=1E50
           WRITE (1,520) SR/Y,Smg/Y,UDS/Y,
     *       SmC/Y,SBC/Y,COSTSLN(I),SOLN(I),SLNTV(I)
 49     CONTINUE
      WRITE (1,440)
      WRITE (1,386) TOTR/TC,TOTmg/TC,UDSGT/TC,TOTmC/TC,TOTB/TC,TC/TC,
     *  TV/TC
      WRITE (1,440)
      CALL COUNT(C)
      WRITE (1,540)
C     WRITE (1,550) TOTV
C      CALC=(TOTV/3.785)*5.5
C     WRITE (1,560) TOTCKg,(TOTCKg-HNO3 Kg),TOTCOST,
C    *  CALC,(TOTCOST+CALC)
      WRITE (1,550) TOTV,(TOTV/3.785)
```

```
      CALC=(TOTV/3.785)*5
      WRITE (1,570) (TOTCKg-HNO3 Kg),((TOTCKg-HNO3 Kg)*2.2)
      SMOLE=(Na/23.)*1000
      WRITE (1,575) SMOLE ,SMOLE/TV
      MOLEK = ((KA K + S4502 KK + S4502 KB)/39.1)*1000
      WRITE (1,580) MOLEK,MOLEK/TV
      RMOLE= (MOLEK + SMOLE)/TV
      WRITE (1,582) MOLEK+SMOLE,RMOLE
      WRITE (1,584) TOTCOST
      WRITE (1,585)
C
      WRITE (1,660)
      WRITE (1,775)
      IF (SLNTV(1) .GT. 1) WRITE (1,663)  SLNTV(1),SLNNO(1)
      WRITE (1,775)
      IF (SLNTV(2) .GT. 1) WRITE (1,666) KgSLN(2,1),SLNTV(2),SLNNO(2)
      WRITE (1,775)
      IF (SLNTV(3) .GT. 1)  WRITE (1,670)  KA KMnO4, KA K,
     *    KA KMnO4 + KgSLN(3,2), SLNTV(3),SLNNO(3)
      WRITE (1,775)
      IF (SLNTV(4) .GT. 1) WRITE (1,680) S4521 CIT A, S4521 OX A,
     *    NH4OXALATE, S4521, SLNTV(4),SLNNO(4)
      WRITE (1,775)
      IF (SLNTV(5) .GT. 1)  WRITE (1,690) S4502 KMnO4,(S4502 KK +
     *    S4502 KB), S4502 Na, S4502, SLNTV(5),SLNNO(5)
      WRITE (1,775)
      IF (SLNTV(6) .GT. 1)  WRITE (1,700) CITROX CIT A, CITROX OX A,
     *    CITROX, SLNTV(6),SLNNO(6)
      WRITE (1,775)
      IF (SLNTV(7) .GT. 1) WRITE (1,710) TARTARIC A,
     *    (TARTARIC NAOH * 23.0/40.0),
     *    (TARTARIC A + TARTARIC NAOH), SLNTV(7),SLNNO(7)
      WRITE (1,775)
      IF (SLNTV(8) .GT. 1)  WRITE (1,720) S4324 Na, S4324, SLNTV(8),
     * SLNNO(8)
      WRITE (1,775)
      IF (SLNTV(9) .GT. 1)  WRITE(1,730) OXALIC, OXALIC, SLNTV(9),
     * SLNNO(9)
      WRITE (1,775)
      IF (SLNTV(10) .GT. 1)  WRITE (1,735) CIT A, CIT A, SLNTV(10),
     * SLNNO(10)
      WRITE (1,775)
      IF (SLNTV(11) .GT. 1) WRITE(1,721) OXALHNO,OXALHNO+KgSLN(11,2),
     *  SLNTV(11),SLNNO(11)
      WRITE (1,775)
      IF (SLNTV(12) .GT. 1) WRITE (1,722) NHOH, NHOH, SLNTV(12),
     *  SLNNO(12)
      WRITE (1,775)
      IF (SLNTV(13) .GT. 1) WRITE (1,723) EDTA,
     *    (EDTA Na), (EDTA + EDTANaOH), SLNTV(13),
     *    SLNNO(13)
      WRITE (1,775)
      IF (SLNTV(14) .GT. 1) WRITE (1,724) ARRNa, KgSLN(14,1),
     *    SLNTV(14),SLNNO(14)
      WRITE (1,775)
      IF (SLNTV(15) .GT. 1) WRITE (1,725) HF, (HF + KgSLN(15,2)),
     *    SLNTV(15),SLNNO(15)
      WRITE (1,775)
      WRITE (1,737) KMnO4,CITRIC A,OXALIC A,
     * NH4OXALATE,TARTARIC A,(KA K + S4502 KK + S4502 KB),
```

```
     * Na,(TOTCKg-HNO3 Kg),TV,K2
      WRITE (1,775)
      TMOLE=(HNO3 KG*1000./63.)-(OH*1000./17.)
       IF (TMOLE.LT.0) GOTO 50
       IF (TMOLE.EQ.0) GOTO 60
      pH=-ALOG10(TMOLE/TOTV)
      WRITE (1,770) pH
       GOTO 60
50    pOH = -ALOG10 ((TMOLE*(-1))/TV)
      pH= 14-pOH
      WRITE (1,770) pH
60    WRITE (1,790) K2
      WRITE (1,792) NWS
C
C
       STOP
51    CALL SUB5 (II,RAWDATA,RAWDATA)
      EST=5
      GOTO 4
C
C
100   FORMAT (E9.3,E12.3,F10.2,F10.2)
105   FORMAT (//,T32,"ESTIMATED VALUES BASED ON AVERAGES")
110   FORMAT (/,T20,A20,1X,"FILE AS READ IN",//," ",T4,A6,T11,A6,
     *T19,A6,T27,A6,T35,A6,T43,A6,T51,A6,T59,A6,T67,A6,T74,A6,T80,A6,
     * T86,A6,T94,A6,T99,A6,T106,A6,T115,A6,/," ",T11,"dps/ml",T20,
     * "dps",T28,"dps",T36,"dps",T44,"dps",T52,"dps",T60,"dps",T68,
     * "dps",T76,"L",T85,"dpm/ml",T94,"g/L",T100,"% wt",T107,"% wt",
     * T116,"mR/hr",/)
115   FORMAT (//,T20,A10,/)
120   FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
     * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,2X,E7.2,1X,F5.1,2X,F5.2,2X,
     * F5.2,1X,I6)
130   FORMAT (//," ",T20,"NM FILE AS READ IN",//," ",T28,"chm 1",T38,
     * "chm 2",/,T2,"mR/hr*dps",T15,"ug/dps",T28,"$/Kg",T38,"$/Kg",
     * T48,"Soln",/)
140   FORMAT (E9.3,E12.3,F10.2,F10.2,5X,I2,2X,A13)
150   FORMAT (//,T2,"DECON INFORMATION ON",1X,A20)
200   FORMAT (//," ",T2,"Individual Isotope Information",/)
202   FORMAT (T15,"Beta",T23,I8)
205   FORMAT (//,T2,"X/L Isotope Information",/)
207   FORMAT (T15,"Beta",T23,F8.1,T36,"Beta/min/ml="T49,1PE7.1)
210   FORMAT (//," ",T2,"% Isotope Information",/)
230   FORMAT (//,T2,"Solution Information - curies",/)
235   FORMAT (//,T2,"Solution Information - mCi/L",/)
240   FORMAT (//,T2,"Solution Information - mg",/)
245   FORMAT (//,T2,"Solution Information - ug/L",/)
250   FORMAT (//,T2,"Solution Information - R/hr",/)
255   FORMAT (//,T2,"Solution Information - mR/hr*L",/)
260   FORMAT (//,T2,"% Solution Information  curies % -->",/)
270   FORMAT (//,T2,"% Solution Information  mg % -->",/)
280   FORMAT (//,T2,"% Solution Information  R/hr % -->",/)
290   FORMAT (//,T2,"% Solution Info.    curies,mg,R/hr  ",
     *  " % down columns",/)
300   FORMAT (//,T2,"% Solution Info.   curies/tot curies",/)
310   FORMAT (" ",T4,"Tot",2X,8(F4.1,4X),/," ",T4,104("-"))
315   FORMAT (,T3,"Tot",,9(F7.2,1X),T97,I7,/,T4,104("-"))
320   FORMAT (//,T2,"% Solution Info. mg/tot mg",/)
330   FORMAT (//,T2,"% Solution Info.  R/hr/tot R",/
     * )
```

```
380   FORMAT (T6,"Total",T14,4(I7,3X),I8,2X,I7,3X,15X,I7)
385   FORMAT (T6,"Total",T12,4(I7,3X),1X,I8,11X,F7.2,21X,I7)
386   FORMAT (T6,"Total",T16,4(I7,3X),I7,1X,F7.2,21X,F7.2)
420   FORMAT (//,T2,"Solution Summary",/)
430   FORMAT (T17,"gamma",T27,"gamma",T37,"UDS",T47,"gamma",
     * T57,"beta",T68,"Cost",/,T17," R/hr",T28,"mg",T38,"g",T47,
     * " curie",T56," curie",T69,"$",T80,"Soln",T92,"Vol-L")
440   FORMAT (T14,88("-"))
445   FORMAT (T14,98("-"))
450   FORMAT (T14,4(I7,3X),I8,2X,I7,3X,A13,3X,I7)
460   FORMAT (//,T2,"Solution Summary %",/)
470   FORMAT (T14,6(F7.1,3X),A13,3X,F6.1)
475   FORMAT (//,T2,"Solution Summary x/L",/)
480   FORMAT (T18,"gamma",T29,"gamma",T41,"UDS",T50,"gamma",T62,
     * "beta",T80,"Cost",/,T17,"mR/hr*L",T29,"ug/L",T41,"g/L",
     * T49,"mcurie/L",T61,"mcurie/L",T72,"B/L",T81,"$/L",T87,"Soln",
     * T101,"Tot Vol-L")
490   FORMAT (T15,4(F7.1,4X),F8.2,2X,F6.1,2X,F6.2,4X,A13,4X,I7)
492   FORMAT (T15,4(F7.1,4X),F8.2,10X,F6.2,21X,I7)
500   FORMAT (//,T2,"Cost Summary x/$",/)
510   FORMAT (T17,"gamma",T27,"gamma",T37,"UDS",T47,"gamma",T57,
     * "beta",T68,"cost",/,T16,"mR/hr/$",T27,"ug/$",T37,"g/$",T46
     * ,"mcurie/$",T56,"mcurie/$",T69,"$",T80,"Soln",T91,"Tot Vol-L")
520   FORMAT (T15,5(I8,2X),I6,4X,A13,4X,I7)
540   FORMAT (//,T2,"Waste Analysis")
550   FORMAT (/,T12,"Volume of Waste",T45,I7,1X,"L",5X,I6,1X,"gal")
570   FORMAT (T12,"Wt of chemicals  w/o HNO3",T45,I7,1X,"Kg",4X,
     * I6,1X,"lbs",)
575   FORMAT (T12,"Moles of Na+ ; Molarity",T44,I8,1X,"moles",T58,
     & F7.2,1X,"M")
580   FORMAT (T12,"Moles of K+ ; Molarity",T44,I8,1X,"moles"T58,
     & F7.2,1x,"M")
582   FORMAT (T12,"Moles Na+ plus K+ ; Molarity",T44,I8,1X,"moles",
     & T58,F7.2,1X,"M")
584   FORMAT (T12,"Chemical cost 1982 $",T44,I8,1X,"$")
585   FORMAT (///,T4,"Chemical Analysis (Kg)",/)
660    FORMAT (T91,"# of",/,
     * T20,"KMnO4",T27,"Citric",T35,"Oxalic",T43,"NH Oxal",T52,
     * "Tart A",T62,"K+",T69,"Na+",T76,"Kg",T85,"L",T90,
     * "Flushes")
663   FORMAT (T4,"H2O"T80,I8,T92,I3)
666   FORMAT (T4,"HNO3 ",T74,I5,T80,I8,T92,I3)
670   FORMAT (T4,"KMnO4/HNO3",T19,I5,T59,I5,T74,I5,T80,I8,T92,I3)
680   FORMAT (T4,"4521",T26,I5,T34,I5,T44,I5,T74,I5,T80,I8,T92,I3)
690   FORMAT (T4,"4502",T19,I5,T59,I5,T66,I5,T74,I5,T80,I8,
     * T92,I3)
700   FORMAT (T4,"Citrox",T26,I5,T34,I5,T74,I5,T80,I8,T92,I3)
710   FORMAT (T4,"Tart A/NaOH",T52,I5,T66,I5,T74,I5,T80,I8,T92,I3)
720   FORMAT (T4,"4324",T66,I5,T74,I5,T80,I8,T92,I3)
721   FORMAT (T4,"Oxalic/HNO3",T34,I5,T74,I5,T80,I8,T92,I3)
722   FORMAT (T4,"NH4OH",T13,I5,T74,I5,T80,I8,T92,I3)
723   FORMAT (T4,"EDTA/NaOH",T13,I5,T66,I5,T74,I5,T80,I8,T92,I3)
724   FORMAT (T4,"ARR",T66,I5,T74,I5,T80,I8,T92,I3)
725   FORMAT (T4,"HF/HNO3",T13,I5,T74,I5,T80,I8,T92,I3)
730   FORMAT (T4,"Oxalic A",T34,I5,T74,I5,T80,I8,T92,I3)
735   FORMAT (T4,"Citric A",T26,I5,T74,I5,T80,I8,T92,I3)
737   FORMAT (T4,"Totals",T19,I5,T26,I5,T34,I5,T44,I5,T52,I5,
     * T59,I5,T66,I5,T73,I6,T80,I8,T92,I3)
770   FORMAT (/,T20,"Approx. pH",T40,F6.1)
775   FORMAT (T4,93("-"))
```

```
C780   FORMAT (/,T20,"Moles OH",T40,I6)
C785   FORMAT (/,T20,"M OH",T40,F6.1)
 790  FORMAT (T20,"Number of flushes",T40,I4)
 792  FORMAT (T20,"Samples taken",T40,I4)
C795   FORMAT (/,T20,"Cost per flush",T38,"$",T40,I4)
C796   FORMAT (/,T20,"Cost per L",T38,"$",T40,F4.2)
 800  FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
     * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,1X,E7.2,1X,F5.1;1X,F5.2,1X,
     * F5.2,1X,I6)
 99   STOP
      END
C
C
C
      SUBROUTINE SUB2(IS,X,Y,Z,SL,Z2,TV)
      DIMENSION X(15,8),Y(15),Z(15)
      CHARACTER SL*13(15),IS*6(8)
      T=1000
C     GOTO 9
      IF (Z2.EQ.3) GOTO 1
      WRITE (1,130) (IS(I),I=1,8,1)
      GOTO 2
 1    WRITE (1,160) (IS(I),I=1,8)
 2      DO 3 I=1,15
           IF (Z(I).EQ.0) GOTO 3
              IF (Z2.EQ.1) WRITE (1,100) (X(I,J)/T,J=1,8),Y(I)/T,
     *              SL(I),Z(I)
              IF (Z2.EQ.2) WRITE (1,140) (X(I,J),J=1,8),Y(I),SL(I),Z(I)
              IF (Z2.EQ.3) WRITE (1,170) (X(I,J),J=1,8),SL(I),Z(I)
              IF (Z2.EQ.4) WRITE (1,180) (X(I,J)/Z(I),J=1,8),
     *              Y(I)/Z(I),SL(I),Z(I)
 3      CONTINUE
      WRITE (1,120)
      GOTO 99
 100  FORMAT (T6,9(I7,1X),5X,A13,T98,I6)
 120  FORMAT (" ",T4,104("-"))
 130  FORMAT (T8,8(A6,2X),"Total",6X,"Soln",10X,
     *  "Total Vol",/," ",T4,104("-"))
 140  FORMAT (T6,9(F7.1,1X),5X,A13,T98,F6.1)
 160  FORMAT (T8,8(A6,2X),11X,"Soln",10X,"Total Vol",/," ",T4,
     * 104("-"))
 170  FORMAT (T6,8(F7.1,1X),13X,A13,T98,F6.1)
 180  FORMAT (T6,9(F7.2,1X,)5X,A13,T98,I6)
 9      WRITE (1,11) (SL(I),I=1,9)
        WRITE (1,14)
      DO 30 J=1,8
          WRITE (1,13) IS(J),(X(I,J),I=1,8)
 30   CONTINUE
      WRITE (1,14)
      WRITE (1,15) (Y(I),I=1,8)
      WRITE (1,14)
      WRITE (1,16) (Z(I),I=1,8)
 11   FORMAT (//,T12,"Soln",T27,A6,T36,A6,T44,A6,T56,A6,T66,A6,T74,
     * A6,T84,A6,T96,A6,T104,A6)
 13   FORMAT (T12,A6,T20,T22,I8,T32,I8,T42,I8,T52,I8,T62,I8,T72,I8,
     * T82,I8,T92,I8,T102,I8)
 14   FORMAT (T12,112("-"))
 15   FORMAT (T12,"Totals",T22,8(I8,2X))
 16   FORMAT (T12,"Tot vol",T22,8(I8,2X))
 99   RETURN
```

```
      END
C
C
      SUBROUTINE SUB3 (IS,X,Y,Z,TmC,Tmg,TR,Z2,TV)
      DIMENSION X(8),Y(8),Z(8),XX(8),YY(8),ZZ(8)
      CHARACTER IS*6(8),IS2*9(8)
      DATA IS2/"Zr 95","Nb 95","Ru103","Ru106","Sb125","Cs134",
     * "Cs137","Ce144"/
C
       DO 12 I=4,7
          XX(I-2)=X(I)
          YY(I-2)=Y(I)
          ZZ(I-2)=Z(I)
 12    CONTINUE
      XX(1)=X(8)
      XX(6)=X(2)
      XX(7)=X(3)
      XX(8)=X(1)
       YY(1)=Y(8)
       YY(6)=Y(2)
       YY(7)=Y(3)
       YY(8)=Y(1)
      ZZ(1)=Z(8)
      ZZ(6)=Z(2)
      ZZ(7)=Z(3)
      ZZ(8)=Z(1)
 10   T=1000
       IF (Z2.EQ.3) GOTO 5
      WRITE (1,100)
      WRITE (1,120)
       IF (Z2.EQ.2) GOTO 1
C
        DO 2 I=1,8
           WRITE (1,130) Is2(I),XX(I)/T,YY(I)/T,ZZ(I)/T
 2      CONTINUE
      WRITE (1,120)
      WRITE (1,140) TmC/T,Tmg/T,TR/T
      WRITE (1,120)
       GOTO 99
C
 5    WRITE (1,110)
      WRITE (1,120)
        DO 6 I=1,8
           WRITE (1,135) IS2(I),XX(I)/TV,YY(I)/TV,ZZ(I)/TV
 6      CONTINUE
      WRITE (1,120)
      WRITE (1,145) TmC/TV,Tmg/TV,TR/TV
      WRITE (1,120)
       GOTO 99
C
 1      DO 3 I=1,8
           WRITE (1,190) IS2(I),XX(I),YY(I),ZZ(I)
 3      CONTINUE
      WRITE (1,120)
C
 100  FORMAT (T32,"Ci",T41,"mg",T47," R/hr")
 110  FORMAT (T30,"mCi/L",T39,"ug/L",T46,"mR/hr*L")
 130  FORMAT (T15,A9,T27,6(I7,2X))
 135  FORMAT (T15,A9,T27,6(F7.1,2X))
 140  FORMAT (T15,"Total",T26,3(I8,1X))
```

```
 145    FORMAT (T15,"Total",T26,3(F8.1,1X))
 120    FORMAT (T15,37("-"))
 190    FORMAT (T15,A9,T27,6(F7.1,2X))
 99     RETURN
        END
C
C
C
C
        SUBROUTINE SUB5 (I2,RD,Z)
        DIMENSION RD(720,15),RDSLN(15,13),RDT(13),AVSLRD(15,13),
       * AVRD(13),COUNT(15),Z(720,15),T(720),KN(15),VOL(15),
       * VOLSNG(15)
C
C*********************************************************************
C                                                                    *
C         T(I)       is the sum of the gamma for a flush             *
C         K          is the solution number                          *
C         COUNT(K)   is the # of flushes of soln k w log #           *
C         N          is the # of flushes w/o gamma scan              *
C         KN(K)      is the # of flushes of soln k w/o gamma         *
C         COUNTTOT   is the total # of flushes with log #'s          *
C         VOL(K)     is the volume of soln K w log #s                *
C         VOLT       is the total volume of sampled flushes          *
C         VOLSNG(K)  is the volume of sampled soln k w/o gamma       *
C         VOLSNGT    is the total vol of sampled flushes w/o gamma   *
C         VOLNST     is the total vol of flushes w/o log #s          *
C                                                                    *
C*********************************************************************
C
        COUNTTOT=0
        VOLT=0
        VOLNST=0
        VOLSNGT=0
        N=0
          DO 1 I=1,I2
             T(I)=0
 1        CONTINUE
          DO 2 I=1,I2
             DO 3 J=2,9
                T(I)=T(I)+RD(I,J)
 3           CONTINUE
 2        CONTINUE
          DO 4 I=1,15
             COUNT(I)=0
             KN(I)=0
             VOL(I)=0
             VOLSNG(I)=0
               DO 5 J=1,13
                  RDSLN(I,J)=0
                  AVSLRD(I,J)=0
 5             CONTINUE
 4        CONTINUE
          DO 6 I=1,13
             RDT(I)=0
             AVRD(I)=0
 6        CONTINUE
          DO 7 I=1,I2
             IF (RD(I,1).EQ.0) VOLNST=VOLNST+RD(I,10)
             IF (RD(I,1).EQ.0) GOTO 7
```

```
            K=RD(I,11)
            COUNT(K)=COUNT(K)+1
            COUNTTOT=COUNTTOT+1
            VOL(K)=VOL(K)+RD(I,10)
            VOLT=VOLT+RD(I,10)
              IF(T(I).EQ.0) GOTO 8
            GOTO 9
 8                N=N+1
                  KN(K)=KN(K)+1
                  VOLSNG(K)=VOLSNG(K)+RD(I,10)
                  VOLSNGT=VOLSNGT+RD(I,10)
 9              DO 10 J=2,9
                  RDSLN(K,J)=RDSLN(K,J)+RD(I,J)*RD(I,10)
                  RDT(J)=RDT(J)+RD(I,J)*RD(I,10)
 10             CONTINUE
                DO 11 J=12,13
                  RDSLN(K,J)=RDSLN(K,J)+RD(I,J)*RD(I,10)
                  RDT(J)=RDT(J)+RD(I,J)*RD(I,10)
 11             CONTINUE
 7        CONTINUE
          DO 12 K=1,15
            IF (COUNT(K).EQ.0) GOTO 12
            IF (COUNT(K).EQ.KN(K)) GOTO 15
 C               (If there is no soln k .or. # flshs of soln k= #
 C                flshs of soln k w/o gamma) goto 12
            IF (KN(K).GT.0) GOTO 13
 C               (If # flshs of soln K w/o g .GT.0) goto 13
 C                Only solns with gamma results go to nest step
                DO 14 J=2,9
                  AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
 14             CONTINUE
              GOTO 15
 C                 13 is ave of sons k w some flshs w/o gamma
 C                 Vol(K)-Volsng(K)= vol of soln K w gamma
 13             DO 16 J=2,9
                  AVSLRD(K,J)=RDSLN(K,J)/(VOL(K)-VOLSNG(K))
 16             CONTINUE
 15             DO 17 J=12,13
                  AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
 17             CONTINUE
 12       CONTINUE
                DO 18 J=2,9
                  AVRD(J)=RDT(J)/(VOLT-VOLSNGT)
 18             CONTINUE
                DO 19 J=12,13
                  AVRD(J)=RDT(J)/VOLT
 19             CONTINUE
          DO 20 I=1,I2,1
            IF (RD(I,1).GT.0 .AND. T(I).GT.0) GOTO 20
 C            Solns w log # and w gammas skip to 20
            IF (RD(I,1).GT.0) GOTO 21
             RD(I,1)=1
 21          K=RD(I,11)
 C              Working with flushes w/o log #s or no gammas
            IF (COUNT(K).EQ.0) GOTO 22
            IF (COUNT(K).EQ.KN(K)) GOTO 23
              DO 24 J=12,13
                IF (RD(I,J) .GT. 0) GOTO 24
                RD(I,J)=AVSLRD(K,J)
 24           CONTINUE
```

```
            DO 25 J=2,9
               RD(I,J)=AVSLRD(K,J)
 25         CONTINUE
          GOTO 20
C              If soln k has no samples then the ave of all is used
 22         DO 26 J=12,13
               RD(I,J)=AVRD(J)
 26         CONTINUE
 23         DO 27 J=2,9
               RD(I,J)=AVRD(J)
 27         CONTINUE
         IF (COUNT(K).EQ.0 .AND. COUNT(K).EQ.KN(K) ) GOTO 20
         IF (RD(I,1).EQ.1 .AND. COUNT(K).EQ.KN(K)) GOTO 30
         GOTO 20
C             For a flush w/o sample, where there are other solns
C               with beta but with no gamma, use soln ave for beta
 30       DO 31 J=12,13
             RD(I,J)=AVSLRD(K,J)
 31       CONTINUE
 20    CONTINUE
       DO 28 I=1,I2
          DO 29 J=1,15
             Z(I,J)=RD(I,J)
 29       CONTINUE
 28    CONTINUE
 99    RETURN
       END
C
C
       SUBROUTINE COUNT(C1)
       INTEGER C1
       C1=C1+1
       WRITE (1,10) C1
 10    FORMAT (////,T2,120("-"),T124,"TABLE ",I2)
       RETURN
       END
C
C
C
       SUBROUTINE DATAFILE
       CHARACTER*30 NAME,DATA3,PRNT,STRTSP,A*10,DEVN*5
C
       DISPLAY " File name to be accessed"
       ACCEPT A
       DISPLAY "Printer dev number  (local=144,lp=6;default=144)"
       DEVN="144"
       ACCEPT DEVN
C
       NAME[1:11]="FILE FTN09="
       NAME[12:10]=A
       NAME[22:4]=",OLD"
       NAME[26:1]=%15C
        DATA3[1:18]="FILE FTN03=ZNM,OLD"
        DATA3[19:1]=%15C
       PRNT[1:18]="FILE FTN01=LP;DEV="
       PRNT[19:4]=DEVN
       PRNT[23:1]=%15C
        STRTSP[1:14]="STARTSPOOL 144"
        STRTSP[15:1]=%15C
C
```

```
      CALL COMMAND (NAME,I1,I2)
      CALL COMMAND (DATA3,I1,I2)
      CALL COMMAND (PRNT,I1,I2)
      CALL COMMAND (STRTSP,I1,I2)
      RETURN
      END
```