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

Steven K. Zohner

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

Steven K. Zohner

Published March 1996

**Idaho National Engineering Laboratory
Department of Environmental Protection
Lockheed Idaho Technologies Company
Idaho Falls, Idaho 83415**

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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.

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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, $1.0E-4 = 1.0 \times 10^{-4}$
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, 1×10^6 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 mi² (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 3.7×10^{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.

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

(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 $1.0 \times 10^{+7}$ $\beta/\text{min/mL}$ 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 $5.9 \times 10^{+7}$ $\beta/\text{min/mL}$.

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 ₂ O	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 ₄ OH	0.1	0.09	0.28	1
Total	12,600 Ci	32,500 R/h	26,800 gal	634

F96 0007

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.

The data is based on the activity of gamma-emitting radionuclides removed during internal flushing. R/h assumes a point source at one foot.

F96 0014

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

Figure 3. 1982–1989 first cycle decontaminations.

Total Removed: 32,500 R/h.
Assumes a point source at one foot.

Total Removed: 12,600 Curies.

F96 0009

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.

Ce-144	% Ci, mg, R/h shown down columns ^a				Solution
	Cs-134/137	Zr/Nb-95	Ru-106	Sb-125	
4.9	6.5	9.1	6.0	2.0	H ₂ O
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 ₂ O	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 1.5×10^{-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	μ g/L
H ₂ O	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.

G96 0005

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

G96 0006

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

G96 0007

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

G96 0008

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

G96 0009

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

G96 0010

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

Total Removed: 1,070 R/h.
Assumes a point source at one foot.

Total Removed: 1,140 Curies.

F96 0010

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.

Ce-144	% Ci, mg, R/h shown down columns ^a				Solution
	Cs-134/137	Zr/Nb-95	Ru-106	Sb-125	
45.3	23.9	4.6	11.6	5.7	H ₂ O
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 ₂ O	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 3.6×10^{-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 ₂ O	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

G96 0011

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

G96 0012

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

G96 0013

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

G96 0014

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

G96 0015

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

G96 0016

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

G96 0017

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

F96 0011

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	$\mu\text{g/L}$
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.

G96 0018

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 ₂ O
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 ₄ OH
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 ₂ O	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 ₄ OH	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 1.1×10^{-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 ₂ O	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 ₄ OH	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

G96 0019

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

G96 0020

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

G96 0021

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

G96 0022

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

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F96 0012

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 ₂ O
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/HNO₃ 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/HNO₃ 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/HNO₃ 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/HNO₃ sequence. The results show that the HF flush was significantly less effective than the Turco 4502 and oxalic/HNO₃ 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 5.8×10^{-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 ₂ O	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/HNO₃ 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	$\mu\text{g/L}$
H ₂ O	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	<u>1.1</u>	<u>1.3</u>	<u>2.9</u>
Total	13.5	21.5	52.4

G96 0024

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

G96 0025

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

G96 0026

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

G96 0027

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

F96 0013

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.

Solution	Activity removed		Volume (gal)	Number of flushes
	Curies	R/h		
H ₂ O	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 ₄ OH	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	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	$\mu\text{g/L}$
H ₂ O	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 ₄ OH	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	<u>1.1</u>	<u>1.3</u>	<u>2.9</u>
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 kept 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 ₂ O	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 ₄ OH	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					Total
	1982	1983	1984	1986	1990	
H ₂ O	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 ₄ OH	—	—	—	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					Total
	1982	1983	1984	1986	1990	
H ₂ O	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 ₄ OH	—	—	—	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.
KMnO₄/HNO₃ 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/HNO₃ 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/HNO₃ 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

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

where

$$\begin{aligned}\text{dps} &= N(\lambda) &= (\ln 2)/t_{1/2} \\ N &= \text{dps}/\lambda &\lambda = (\ln 2)/t_{1/2} \\ \ln N_1/\ln N_2 & &= \lambda(t_2 - t_1)\end{aligned}$$

$$\begin{aligned}(\text{R/h})/\text{dps at 1 ft (gamma)} &= 6(\text{Ci})(\text{E})(n) \text{ this is a good approximation} \\ &= 6(\times \text{dps}/3.7 \times 10^{10} \text{ dps})(\text{E})(n/100) \\ (\text{R/h})/\text{dps} &= (1.62 \times 10^{-12})(\text{E})(\%) \end{aligned}$$

where

$$\begin{aligned}\text{Ci} &= 3.7 \times 10^{10} \text{ dps} \\ \text{E} &= \text{MeV/decay gamma} \\ n &= \% \text{ gamma/decay}\end{aligned}$$

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 - $\mu\text{g}/\text{L}$
Table 6	Solution information - mR/h*L
Table 7	Solution information - curies
Table 8	Solution information - mg
Table 9	Solution information - R/hr

Table 10	% solution information - Ci % -->
Table 11	% solution information - mg % -->
Table 12	% solution information - R/hr % -->
Table 13	% solution information - Ci, mg, R/hr, % down columns
Table 14	% solution information - Ci/total Ci
Table 15	% solution information - mg/total mg
Table 16	% solution information - R/hr / total R/hr
Table 17	Solution summary
Table 18	Solution summary %
Table 19	Solution summary x/L
Table 20	Cost summary x/\$
Table 21	Waste analysis

Data	H-100 1982
Data	H-103 1982
Data	H-134 1982
Data	H-mix 1982
Data	G-101 1982
Data	G-106 1982
Data	G-111 1982

&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	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	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	20.84	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	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	28.7	.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 % -->

Cel144	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

Cel144	Cs134	Cs137	Nb 95	Ru103	Ru106	Sb125	Zr 95	Soln	Total Vol
4.9	9.7	6.9	9.7	3.6	8.0	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

Cel144	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	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	.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	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	KMnO4/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	KMnO4/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	266	6225	1953	KMnO4/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	349	1.00		5.22

TABLE 21

Waste Analysis

Volume of Waste
 Wt of chemicals w/o HNO₃
 Moles of Na⁺ : Molarity
 Moles of K⁺ : Molarity
 Moles Na⁺ plus K⁺ : Molarity
 Chemical cost 1982 \$

195250 L
 6855 Kg
 53391 moles
 18225 moles
 71616 moles
 37386 \$

51585 gal
 15081 lbs
 .27 M
 .09 M
 .37 M

Chemical Analysis (Kg)

	KMnO ₄	Citric	Oxalic	NH	Oxal	Tart A	K ⁺	Na ⁺	Kg	L	# of Flushes
H ₂ O										59950	57
HNO ₃									16216	42450	38
KMnO ₄ /HNO ₃	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
 Number of flushes 171
 Samples taken 112

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H-100 1982 FILE AS READ IN																
Log #	Cel144 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+08	.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+08	.65E+04	.95E+08	.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+08	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	.88E+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	.18E+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	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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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+08	.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+08	.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	.18E+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	0	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	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-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

&k2S

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	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
51808	.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	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

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:

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

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 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

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 - $\mu\text{g/L}$
Table 6	Solution information - mR/h*L
Table 7	Solution information - curies
Table 8	Solution information - mg
Table 9	Solution information - R/hr
Table 10	% solution information - Ci % -->
Table 11	% solution information - mg % -->
Table 12	% solution information - R/hr % -->
Table 13	% solution information - Ci, mg, R/hr, % down columns
Table 14	% solution information - Ci/total Ci
Table 15	% solution information - mg/total mg
Table 16	% solution information - R/hr / total R/hr
Table 17	Solution summary
Table 18	Solution summary %
Table 19	Solution summary x/L
Table 20	Cost summary x/\$
Table 21	Waste analysis
Data	F-Cell 1983
Data	J-127 1983
Data	J-128 1983
Data	J-134 1983
Data	J-135 1983
Data	G-Cell 1984
Data	H-Cell 1984
Data	E-Cell 1984

&k2S

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	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
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TABLE 6

Solution Information - mR/hr*L

Cel144	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	108.41	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	96.97		221850

TABLE 7

Solution Information - curies

Cel144	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

Cel144	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 % -->

Cel144	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 % -->

Cel144	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

Cel144	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	.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	.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	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	95.8
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	
Number of flushes	174
Samples taken	143

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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	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	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

D-14

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	.85E+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	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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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
10118	.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	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

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FILE AS READ IN

Log #	Cel144 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	.83E+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	6. Citrex	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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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	.67E+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	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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E Cell 1984

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Log #	Cel144 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
41608	.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	1800	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	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

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:

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

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 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

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 - $\mu\text{g/L}$
Table 6	Solution information - mR/h*L
Table 7	Solution information - curies
Table 8	Solution information - mg
Table 9	Solution information - R/hr
Table 10	% solution information - Ci % -->
Table 11	% solution information - mg % -->
Table 12	% solution information - R/hr % -->
Table 13	% solution information - Ci, mg, R/hr, % down columns
Table 14	% solution information - Ci/total Ci
Table 15	% solution information - mg/total mg
Table 16	% solution information - R/hr / total R/hr
Table 17	Solution summary
Table 18	Solution summary %
Table 19	Solution summary x/L
Table 20	Cost summary x/\$
Table 21	Waste analysis

Data 1984 Rover Decon

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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	.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	78.3	.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

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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
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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	.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	.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	17.8	.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	4861	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	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	.86E+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	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

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:

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

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 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

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 - $\mu\text{g/L}$
Table 6	Solution information - mR/h*L
Table 7	Solution information - curies
Table 8	Solution information - mg
Table 9	Solution information - R/hr
Table 10	% solution information - Ci % -->
Table 11	% solution information - mg % -->
Table 12	% solution information - R/hr % -->
Table 13	% solution information - Ci, mg, R/hr, % down columns
Table 14	% solution information - Ci/total Ci
Table 15	% solution information - mg/total mg
Table 16	% solution information - R/hr / total R/hr
Table 17	Solution summary
Table 18	Solution summary %
Table 19	Solution summary x/L
Table 20	Cost summary x/\$
Table 21	Waste analysis
Data	E-Cell 1986
Data	F-Cell 1986
Data	G and H Cells 1986

&k2S

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

	Cl	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

	.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

	Cel144	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

	Cel144	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

Cel144	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

Cel144	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	28	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 % -->

Cel144	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	18.0	.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	.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	.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	KMnO4/HNO3	5.2
5.5	.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	.08	HNO3	65658
2.2	4.6	.0	.8	.84	.8	.10	KMnO4/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	KMnO4/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	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 #
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	2258	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

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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 #	Cel144 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	3718	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	.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	.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	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

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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	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

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:

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

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 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

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 - $\mu\text{g/L}$
Table 6	Solution information - mR/h*L
Table 7	Solution information - curies
Table 8	Solution information - mg
Table 9	Solution information - R/hr
Table 10	% solution information - Ci % -->
Table 11	% solution information - mg % -->
Table 12	% solution information - R/hr % -->
Table 13	% solution information - Ci, mg, R/hr, % down columns
Table 14	% solution information - Ci/total Ci
Table 15	% solution information - mg/total mg
Table 16	% solution information - R/hr / total R/hr
Table 17	Solution summary
Table 18	Solution summary %
Table 19	Solution summary x/L
Table 20	Cost summary x/\$
Table 21	Waste analysis
Data	U-Cell 1988
Data	G-Cell 1988
Data	H-Cell 1989

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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	238	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

	.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 curves % -->

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	4.8	.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

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
.0	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	.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	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

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
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	32.66	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

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	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

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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	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	2.8E+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	3.8E+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	.58E+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	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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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 #
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+08	.56E+05	.00E+00	5618	2	9.8E+07	.0	18.80	.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+08	.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
10138	.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	.11E+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	.32E+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

G-16

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

&k2S

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	4608	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	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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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:

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

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 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

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 - $\mu\text{g/L}$
Table 6	Solution information - mR/h*L
Table 7	Solution information - curies
Table 8	Solution information - mg
Table 9	Solution information - R/hr
Table 10	% solution information - Ci % -->
Table 11	% solution information - mg % -->
Table 12	% solution information - R/hr % -->
Table 13	% solution information - Ci, mg, R/hr, % down columns
Table 14	% solution information - Ci/total Ci
Table 15	% solution information - mg/total mg
Table 16	% solution information - R/hr / total R/hr
Table 17	Solution summary
Table 18	Solution summary %
Table 19	Solution summary x/L
Table 20	Cost summary x/\$
Table 21	Waste analysis

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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	258	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	1.88	.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	.08	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

.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

Cel144	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	.01	1.79	1.23	.63	32.02		1014386

TABLE 7

Solution Information - curies

Cel144	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

Cel144	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

Cel144	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
	88	225	9	45	69	41237	4502	114628
	353	311	58	124	43	2754	CITROX	21819
	1188	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	20
ARR								176	428	5
HF/HNO3	100								1837	4
Totals		2338	1286	6716	3423	2193	5384	5206	32899	1014386

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

L ALL

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	Isotope	R/hr/dps	mg/dps	t1/2		gamma	E	QB	%gamma															
3	H 3	----	2.79E-12	12.33	y	---	---	.019	---															
4	K 40	2.53E-11	3.86E-03	1.277E+9	y	1.461	1.312	10.67																
5	Mn 54	1.35E-10	3.49E-12	312	d	.835	.697	100.																
6	Co 60	4.06E-10	2.39E-11	5.271	y	1.332	2.824	100.																
7						1.173		100.																
8	Kr 85	3.58E-13	6.86E-11	10.7	y	0.514	.687	0.43																
9	Sr 90	----	1.96E-10	28.8	y	---	.546	---																
10	Y 90	----	4.97E-14	64.1	h		2.284																	
11	Nb 95	1.24E-10	6.88E-13	35	d	.766	.926	99.82																
12	Zr 95	6.70E-11	1.26E-12	64	d	.757	1.123	54.6																
13	Ru103	6.96E-11	8.53E-13	40	d	.497	2.35	86.4																
14	Rh106	Ru106	Ru106	130	m	.512	3.541	19																
15	Ru106	1.58E-11	8.01E-12	1	y	---	.039	---																
16	Cd113			9 E 15	y																			
17	Sb125	2.08E-11	2.55E-11	2.7	y	.428	.767	30																
18	I 129	4.86E-13	1.54E-04	1.58E07	y	.040	.150	7.5																
19	Cs134	9.57E-11	2.09E-11	2.062	y	.605	2.058	97.6																
20	Cs137	9.12E-11	3.10E-10	30	y	.662	1.173	85																
21	Ce141	1.14E-11	9.48E-13	32.5	d	.145	.58	48.4																
22	Ce144	2.41E-12	8.49E-12	285	d	.134	.318	11.1																
23	Pr144	----	3.58E-16	17.3	m	---	3.00	---																
24	Eu154	7.33E-11	9.89E-11	8.5	y	1.274	1.978	35.5																
25	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

38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
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 mg	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																

T ZNM
/L ALL

1	2.41E- 9	8.49E- 9	0.00	0.0
2	9.57E- 8	2.09E- 8	0.28	0.0
3	9.12E- 8	3.10E- 7	7.86	0.28
4	1.24E- 7	6.88E-10	9.66	0.0
5	6.96E- 8	8.53E-10	4.60	0.0
6	1.58E- 8	8.01E- 9	2.31	1.62
7	2.08E- 8	2.55E- 8	2.93	0.72
8	6.70E- 8	1.26E- 9	0.64	0.0
9	0.0	0.0	1.62	0.0
10	0.0	0.0	2.31	0.0
11	0.0	0.0	1.62	0.28
12	0.0	0.0	2.15	0.0
13	0.0	0.0	30.06	0.72
14	0.0	0.0	2.12	0.0
15	0.0	0.0	1.54	0.28

16 C First column is mR/hr*dps at 1 ft (30.5cm)

17 C Second column is microgram/dps.

18 C Order of nuclides is:

19 C 1. Ce144 3. Cs137 5. Ru103 7. Sb125

20 C 2. Cs134 4. Nb 95 6. Ru106 8. Zr 95

21 C Third column is \$/Kg.

22 C Fourth column is the second chemical, if present.

23 C Order of chemicals is:

24 C 1. H2O 6. Citrox 11. Oxalic/HNO3

25 C 2. HNO3 7. Tartaric/NaOH 12. NH4OH

26 C 3. KMnO4/HNO3 8. 4324 13. EDTA/NaOH

27 C 4 4521 9. Oxalic 14. ARR

28 C 5. 4502 10. Citric A 15. HF/HNO3

29 C

30 C For more information see file ZCONV

```

T ZADD
/L ALL
1  $CONTROL USLINIT,INIT,NOSOURCE
2  C Text is ZADD
3      DIMENSION RAWDATA(300,17)
4      REAL NUM
5      CHARACTER LB*8(17),ANS
6      DATA LB/"Log #","Ce144","Cs134","Cs137","Nb 95","Ru103",
7      * "Ru106","Sb125","Zr 95","Vol-L","Soln #","Beta","uds g/l",
8      * "% chem 1","% chem 2","mR/hr","Proc #"/,Y/"Y"/,N/"N"/
9  C
10 C
11 CALL CHANGE
12 C
13 99 DISPLAY "Do you want to run the program Y/N "
14     ANS="Y"
15     ACCEPT ANS
16     IF (ANS.EQ."N") STOP
17     IF (ANS.NE."Y") GOTO 99
18 C
19 13 DO 1 I=1,300
20     DO 2 J=1,17
21         RAWDATA(I,J)=0
22     2 CONTINUE
23     1 CONTINUE
24     DO 3 I=1,300
25         READ (9@I,100,END=4,ERR=16) (RAWDATA(I,J),J=1,17)
26     3 CONTINUE
27 16 DISPLAY "Reading error"
28 STOP
29 4 K=I
30 DISPLAY "This flush number",K
31 5 DISPLAY "Modify old data N/Y "
32     ANS="N"
33     ACCEPT ANS
34     IF (ANS.EQ."Y") GOTO 21
35     IF (ANS.NE."N") GOTO 5
36 6 DO 7 J=1,17,1
37     IF (J.EQ.2) WRITE (6,601)
38     IF (J.EQ.11) WRITE (6,602)
39     DISPLAY J,LB(J)
40     ACCEPT RAWDATA(K,J)
41 7 CONTINUE
42 601 FORMAT (T18,"dps/ml",/)
43 602 FORMAT (T8,"1. H2O",T32,"6. Citrox (citric/oxalic)",T59,
44     & "11. Oxalic/HNO3",/,T8,"2. HNO3",T32,"7. Tartaric/NaOH",T59,
45     & "12. NH4OH",/,T8,"3. KMnO4/HNO3",T32,"8. 4324",T59,
46     & "13. EDTA/NaOH",/,T8,"4. 4521 (Citrox+NH4)",T32,"9. Oxalic",
47     & T59,"14. ARR",/,T8,"5. 4502 (KMnO4/NaOH)",T31,"10. Citric",
48     & T59,"15. HF/HNO3",/)
49 8 DO 9 J=1,17
50     DISPLAY J,LB(J),RAWDATA(K,J)
51 9 CONTINUE
52 10 DISPLAY "Is the data correct Y/N "
53     ANS="Y"
54     ACCEPT ANS
55     IF (ANS.EQ."Y") GOTO 11
56     IF (ANS.EQ."N") GOTO 12
57     DISPLAY "Answer Y or N"
58     GOTO 10

```

```

59 12 DISPLAY "Which number do you want changed"
60 ACCEPT J
61 RAWDATA(K,J)=0
62 DISPLAY "Enter the correct data"
63 ACCEPT NUM
64 RAWDATA(K,J)=NUM
65 GOTO 8
66 11 WRITE (9@K,100) (RAWDATA(K,J),J=1,17)
67 15 DISPLAY "Is there any more data Y/N"
68 ANS="Y"
69 ACCEPT ANS
70 IF (ANS.EQ."Y") GOTO 13
71 IF (ANS.EQ."N") GOTO 14
72 DISPLAY "Answer Y or N"
73 GOTO 15
74 21 DISPLAY "What flush number"
75 ACCEPT K
76 GOTO 8
77 100 FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
78 * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,1X,E7.2,1X,F5.1,1X,F5.2,1X,
79 * F5.2,1X,I6,1X,I3)
80 14 STOP
81 END
82 C
83 C
84 SUBROUTINE CHANGE
85 DIMENSION TEMP(300,17)
86 CHARACTER*70 EQFILE,PRGE,BLD,FILE*10,ANS*1
87 INTEGER N
88 5 DISPLAY "Creating a new data file (N/Y)"
89 ANS="N"
90 ACCEPT ANS
91 IF (ANS.EQ."Y") GOTO 6
92 IF (ANS.NE."N") GOTO 5
93 6 DISPLAY "Name of file "
94 ACCEPT FILE
95 C
96 EQFILE[1:11]="FILE FTN09= "
97 EQFILE[12:10]=FILE
98 EQFILE[22:4]=",OLD"
99 EQFILE[26:1]=%15C
100 PRGE[1:6]="PURGE "
101 PRGE[7:10]=FILE
102 PRGE[17:1]=%15C
103 BLD[1:6]="BUILD "
104 BLD[7:10]=FILE
105 BLD[17:16]=";REC=80,,F,ASCII"
106 BLD[33:1]=%15C
107 IF (ANS.EQ."Y") GOTO 40
108 C
109 CALL COMMAND (EQFILE,I1,I2)
110 DO 10 I=1,300
111 READ (9@I,100,END=15,ERR=20) (TEMP(I,J),J=1,17)
112 10 CONTINUE
113 20 DISPLAY "Reading error"
114 STOP
115 15 K=I-1
116 CALL UNITCONTROL(9,8)
117 CALL COMMAND (PRGE,I1,I2)
118 CALL COMMAND (BLD,I1,I2)

```

```

119      CALL COMMAND (EQFILE,I1,I2)
120      IF (K.EQ.0) GOTO 31
121      DO 30 I=1,K
122          WRITE(991,100) (TEMP(I,J),J=1,17)
123      30  CONTINUE
124      31  CALL UNITCONTROL(9,8)
125          GOTO 99
126      C
127      40  CALL COMMAND (BLD,I1,I2)
128          CALL COMMAND (EQFILE,I1,I2)
129      C
130      100  FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
131          * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,1X,E7.2,1X,F5.1,1X,F5.2,1X,
132          * F5.2,1X,I6,1X,I3)
133      99  RETURN
134      END

```


T ZAVER

/L ALL

```

1  $CONTROL USLINIT,INIT,NOSOURCE
2  C
3  C NAME PROGRAM SHORT FORM (ZAVER)
4  C FTN01=[FILE TO BE READ INTO]
5  C FTN09=[FILE WHERE ORIGINAL DATA FROM]
6  C
7  DIMENSION RAWDATA(790,17)
8  C
9  CHARACTER ANS
10 CALL DATAFILE
11 C
12 DO 804 I=1,790
13 READ (901,800,END=805) (RAWDATA(I,J),J=1,17)
14 804 CONTINUE
15 805 K2=I-1
16 II=K2
17 DISPLAY "Flushes",K2
18 2 DISPLAY "Do you want to run the program Y/N "
19 ANS="Y"
20 ACCEPT ANS
21 IF (ANS.EQ."N") GOTO 99
22 IF (ANS.NE."Y") GOTO 2
23 CALL SUB5 (II,RAWDATA,RAWDATA)
24 DO 6 I=1,II
25 WRITE (1,800) (RAWDATA(I,J),J=1,17)
26 6 CONTINUE
27 C
28 110 FORMAT (/ ,T20,A10,1X,"FILE AS READ IN",//," ",T4,A6,T11,A6,
29 *T19,A6,T27,A6,T35,A6,T43,A6,T51,A6,T59,A6,T67,A6,T74,A6,T80,A6,
30 * T86,A6,T94,A6,T99,A6,T106,A6,T115,A6,/, " ",T11,"dps/ml",T20,
31 * "dps",T28,"dps",T36,"dps",T44,"dps",T52,"dps",T60,"dps",T68,
32 * "dps",T76,"L",T85,"dpm/ml",T94,"g/L",T100,"% wt",T107,"% wt",
33 * T116,"mR/hr",/)
34 800 FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
35 * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,1X,E7.2,1X,F5.1,1X,F5.2,1X,
36 * F5.2,1X,I6,1X,I3)
37 99 STOP
38 END
39 C
40 C
41 SUBROUTINE SUB5 (I2,RD,Z)
42 DIMENSION RD(790,15),RDSLN(15,13),RDT(13),AVSLRD(15,13),
43 * AVR(13),COUNT(15),Z(790,15),T(790),KN(15),VOL(15),
44 * VOLSNG(15)
45 C
46 C*****
47 C
48 C T(I) is the sum of the gamma for a flush *
49 C K is the solution number *
50 C COUNT(K) is the # of flushes of soln k w log # *
51 C N is the # of flushes w/o gamma scan *
52 C KN(K) is the # of flushes of soln k w/o gamma *
53 C COUNTTOT is the total # of flushes with log #'s *
54 C VOL(K) is the volume of soln K w log #s *
55 C VOLT is the total volume of sampled flushes *
56 C VOLSNG(K) is the volume of sampled soln k w/o gamma *
57 C VOLSNGT is the total vol of sampled flushes w/o gamma *
58 C VOLNST is the total vol of flushes w/o log #s *
```

```

59  C
60  C*****
61  C
62      COUNTTOT=0
63      VOLT=0
64      VOLNST=0
65      VOLSNGT=0
66      N=0
67      DO 1 I=1,I2
68          T(I)=0
69  1      CONTINUE
70      DO 2 I=1,I2
71          DO 3 J=2,9
72              T(I)=T(I)+RD(I,J)
73  3      CONTINUE
74  2      CONTINUE
75      DO 4 I=1,15
76          COUNT(I)=0
77          KN(I)=0
78          VOL(I)=0
79          VOLSNG(I)=0
80          DO 5 J=1,13
81              RDSLNI(I,J)=0
82              AVSLRD(I,J)=0
83  5      CONTINUE
84  4      CONTINUE
85      DO 6 I=1,13
86          RDT(I)=0
87          AVRDI(I)=0
88  6      CONTINUE
89      DO 7 I=1,I2
90          IF (RDI(I,1).EQ.0) VOLNST=VOLNST+RDI(I,10)
91          IF (RDI(I,1).EQ.0) GOTO 7
92          K=RDI(I,11)
93          COUNT(K)=COUNT(K)+1
94          COUNTTOT=COUNTTOT+1
95          VOL(K)=VOL(K)+RDI(I,10)
96          VOLT=VOLT+RDI(I,10)
97          IF (T(I).EQ.0) GOTO 8
98      GOTO 9
99  8      N=N+1
100         KN(K)=KN(K)+1
101         VOLSNG(K)=VOLSNG(K)+RDI(I,10)
102         VOLSNGT=VOLSNGT+RDI(I,10)
103  9      DO 10 J=2,9
104          RDSLNI(K,J)=RDSLNI(K,J)+RDI(I,J)*RDI(I,10)
105          RDT(J)=RDT(J)+RDI(I,J)*RDI(I,10)
106  10      CONTINUE
107      DO 11 J=12,13
108          RDSLNI(K,J)=RDSLNI(K,J)+RDI(I,J)*RDI(I,10)
109          RDT(J)=RDT(J)+RDI(I,J)*RDI(I,10)
110  11      CONTINUE
111  7      CONTINUE
112      DO 12 K=1,15
113          IF (COUNT(K).EQ.0) GOTO 12
114          IF (COUNT(K).EQ.KN(K)) GOTO 15
115  C          (If there is no soln k .or. # flshs of soln k= #
116  C          flshs of soln k w/o gamma) goto 12
117          IF (KN(K).GT.0) GOTO 13
118  C          (If # flshs of soln K w/o g .GT.0) goto 13

```



```

119 C          Only solns with gamma results go to nest step
120          DO 14 J=2,9
121          AVSLRD(K,J)=RDSL(N(K,J))/VOL(K)
122 14        CONTINUE
123          GOTO 15
124 C          13 is ave of sons k w some flshs w/o gamma
125 C          Vol(K)-Volsng(K)= vol of soln K w gamma
126 13        DO 16 J=2,9
127          AVSLRD(K,J)=RDSL(N(K,J))/(VOL(K)-VOLSNG(K))
128 16        CONTINUE
129 15        DO 17 J=12,13
130          AVSLRD(K,J)=RDSL(N(K,J))/VOL(K)
131 17        CONTINUE
132 12        CONTINUE
133          DO 18 J=2,9
134          AVR(D(J))=RDT(J)/(VOLT-VOLSNGT)
135 18        CONTINUE
136          DO 19 J=12,13
137          AVR(D(J))=RDT(J)/VOLT
138 19        CONTINUE
139          DO 20 I=1,12,1
140          IF (RD(I,1).GT.0 .AND. T(I).GT.0) GOTO 20
141 C          Solns w log # and w gammas skip to 20
142          IF (RD(I,1).GT.0) GOTO 21
143          RD(I,1)=1
144 21        K=RD(I,11)
145 C          Working with flushes w/o log #s or no gammas
146          IF (COUNT(K).EQ.0) GOTO 22
147          IF (COUNT(K).EQ.KN(K)) GOTO 23
148          DO 24 J=12,13
149          IF (RD(I,J) .GT. 0) GOTO 24
150          RD(I,J)=AVSLRD(K,J)
151 24        CONTINUE
152          DO 25 J=2,9
153          RD(I,J)=AVSLRD(K,J)
154 25        CONTINUE
155          GOTO 20
156 C          If soln k has no samples then the ave of all is used
157 22        DO 26 J=12,13
158          RD(I,J)=AVR(D(J))
159 26        CONTINUE
160 23        DO 27 J=2,9
161          RD(I,J)=AVR(D(J))
162 27        CONTINUE
163          IF (COUNT(K).EQ.0 .AND. COUNT(K).EQ.KN(K) ) GOTO 20
164          IF (RD(I,1).EQ.1 .AND. COUNT(K).EQ.KN(K)) GOTO 30
165          GOTO 20
166 C          For a flush w/o sample, where there are other solns
167 C          with beta but with no gamma, use soln ave for beta
168 30        DO 31 J=12,13
169          RD(I,J)=AVSLRD(K,J)
170 31        CONTINUE
171 20        CONTINUE
172          DO 28 I=1,12
173          DO 29 J=1,15
174          Z(I,J)=RD(I,J)
175 29        CONTINUE
176 28        CONTINUE
177 99        RETURN
178          END

```

```

179 C
180 C
181 SUBROUTINE DATAFILE
182 CHARACTER*40 FILE9,FILE1,PRG,BLD,NAME*10,A*10
183 C
184 DISPLAY " File name to be accessed"
185 ACCEPT A
186 DISPLAY " File name for averaged data"
187 ACCEPT NAME
188 C
189 FILE9[1:11]="FILE FTO9="
190 FILE9[12:10]=A
191 FILE9[22:4]=",OLD"
192 FILE9[26:1]=%15C
193 FILE1[1:11]="FILE FTO1="
194 FILE1[12:10]=NAME
195 FILE1[22:4]=",OLD"
196 FILE1[26:1]=%15C
197 PRG[1:6]="PURGE "
198 PRG[7:10]=NAME
199 PRG[17:1]=%15C
200 BLD[1:6]="BUILD "
201 BLD[7:10]=NAME
202 BLD[17:16]=";REC=80,,F,ASCII"
203 BLD[33:1]=%15C
204 C
205 CALL COMMAND (FILE9,11,12)
206 CALL COMMAND (FILE1,11,12)
207 CALL COMMAND (PRG,11,12)
208 CALL COMMAND (BLD,11,12)
209 RETURN
210 END

```

T ZFLUSH

/L ALL

```

1  $CONTROL USLINIT,INIT,NOSOURCE
2  $INTEGER*4
3  C
4  C NAME PROGRAM SHORT FORM (ZFLUSH)
5  C FILE FTN03=ZNM,OLD
6  C FILE FTN09=(FILE TO BE ACCESSED),OLD
7  C FILE FTN01;DEV=LP;CTL
8  C
9  DIMENSION RAWDATA(250,17),CNVRSNDT(15,4),DPSFLSH(250),
10 * REA(250,8),RFLSH(250),RISO(8),DPSISO(8),BCFL(250),PROCT(5)
11 C
12 REAL mgISO(8),mgFLSH(250),mgEA(250,8),mCURFLSH(250),mCURISO(8),
13 * mCUREA(250,8),Z,TOTmC,TOTmg,TOTB,TOTR,TOTV
14 C
15 INTEGER C
16 C
17 CHARACTER ISO*6(8),SOLN*13(15),ANS,LABEL*6(17),FILE*30,ANSPROC
18 C
19 DATA ISO/"Ce144","Cs134","Cs137","Nb 95","Ru103",
20 * "Ru106","Sb125","Zr 95"/
21 C
22 DATA SOLN/"H2O","HNO3","KMnO4/HNO3","4521","4502","CITROX",
23 * "Tartaric/NaOH","4324","Oxalic","Citric A","Oxalic/HNO3",
24 * "NH4OH","EDTA/NaOH","ARR","HF/HNO3"/
25 C
26 C
27 CALL DATAFILE
28 C
29 C
30 I=16
31 DISPLAY "Print size 16,12,10"
32 ACCEPT I
33 IF (I.EQ.16) WRITE (1,101)
34 IF (I.EQ.12) WRITE (1,102)
35 IF (I.EQ.10) WRITE (1,103)
36 103 FORMAT ("")
37 102 FORMAT ("")
38 101 FORMAT ("")
39 C
40 C
41 DISPLAY " Report name"
42 ACCEPT FILE
43 CALL SUB4 (LABEL,RAWDATA,II)
44 C=0
45 C
46 1 DISPLAY " How many flushes ", II
47 ACCEPT II
48 C
49 DISPLAY "Procedure totals Y/N"
50 ANSPROC="Y"
51 ACCEPT ANSPROC
52 C
53 2 DISPLAY "Do you want to run the program Y/N "
54 ANS="Y"
55 ACCEPT ANS
56 IF (ANS.EQ."N") GOTO 99
57 IF (ANS.NE."Y") GOTO 2
58 C

```

```

59 3   DISPLAY "Estimates only N/Y "
60     ANS="N"
61     ACCEPT ANS
62     IF (ANS.EQ."N") GOTO 7
63     IF (ANS.NE."Y") GOTO 3
64     GOTO 51
65 C
66 7   EST = 2
67 C
68 10  DISPLAY "Include averaged data Y/N"
69     ANS="Y"
70     ACCEPT ANS
71     IF (ANS.EQ."N") GOTO 4
72     IF (ANS.NE."Y") GOTO 10
73     EST=3
74 C
75 4   DO 5 I=1,11,1
76     DPSFLSH(I)= 0
77     RFLSH(I)= 0
78     BCFL(I)= 0
79     mgFLSH(I)= 0
80     mCURFLSH(I)= 0
81     DO 6 J=1,8,1
82       mCUREA(I,J)=0
83       REA(I,J)=0
84       mgEA(I,J)=0
85 6   CONTINUE
86 5   CONTINUE
87     DO 8 I=1,8
88       RISO(I)=0
89       DPSISO(I)=0
90       mgISO(I)=0
91       mCURISO(I)=0
92 8   CONTINUE
93     TOTmC=0
94     TOTR=0
95     TOTmg=0
96     TOTV=0
97     TOTB=0
98     DO 9 I=1,15
99       DO 12 J=1,4
100        CNVRSNDT(I,J)=0
101 12  CONTINUE
102 9   CONTINUE
103 C
104     DO 13 I=1,15
105       READ (3aI,100,END=14) (CNVRSNDT(I,J), J=1,4,1)
106 13  CONTINUE
107 C
109 14  DO 15 J=2,9
110     DO 16 I=1,11,1
111       LOGN=RAWDATA(I,1)
112       IF (LOGN.EQ.0) GOTO 16
113       IF (LOGN.EQ.1 .AND. EST.LE.2) GOTO 16
114       DPSISO(J-1)=DPSISO(J-1)+RAWDATA(I,J)*RAWDATA(I,10)
115       *
116       REA(I,J-1)=RAWDATA(I,J)*RAWDATA(I,10)*1000*CNVRSN
117       *
118       DT(J-1,1)
119       mgEA(I,J-1)=RAWDATA(I,J)*RAWDATA(I,10)*CNVRSNDT(J-1,2)
120       mCUREA(I,J-1)=(RAWDATA(I,J)*RAWDATA(I,10)*1000)/3.7E7

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```

120 16      CONTINUE
121 15      CONTINUE
122      DO 17 I=1,II
123          TOTV=TOTV+RAWDATA(I,10)
124          LOGN=RAWDATA(I,1)
125          IF (LOGN.EQ.0) GOTO 17
126          IF (LOGN.EQ.1 .AND. EST.LE.2) GOTO 17
127          DO 18 J=2,9,1
128              DPSFLSH(I)=DPSFLSH(I)+RAWDATA(I,J)*RAWDATA(I,10)*1000
129              RFLSH(I)=RFLSH(I)+REA(I,J-1)
130              mgFLSH(I)=mgFLSH(I)+mgEA(I,J-1)
131 18      CONTINUE
132          BCFL(I)=(RAWDATA(I,12)*RAWDATA(I,10)*1000/(60*3.7E07))
133          mCURFLSH(I)=DPSFLSH(I)/3.7E7
134          TOTmC=TOTmC+mCURFLSH(I)
135          TOTR=TOTR+RFLSH(I)
136 17      CONTINUE
137          DO 20 I=1,II
138              IF (RAWDATA(I,1).EQ.0) GOTO 20
139              IF (RAWDATA(I,1).EQ.1 .AND. EST.LE.2) GOTO 20
140              mgFLSH(I)=1000*mgFLSH(I)
141              TOTmg=TOTmg+mgFLSH(I)
142              TOTB=TOTB+BCFL(I)
143 20      CONTINUE
144  C
145          WRITE (1,948) FILE
146          WRITE (1,949)
147 948      FORMAT (T5,A20,/)
148 949      FORMAT (T5,"Log #",T19,"Ci",T30,"Ci",T42,"mg",T52,
149          & "R/hr",T62,"mCi/L",T73,"mCi/L",T84,"mR/L",T95,"VOL",T104,
150          & "Pred#",T111,"Soln",/,T117,"gamma",T29,"beta",T39,"isotopes",
151          & T51,"gamma",T62,"gamma",T73,"beta",T83,"gamma",T96,
152          & "L",/),
153          K =1000
154          END=0
155          PRNUM=RAWDATA(1,17)
156          DO 950 I=1,II
157              IF (PRNUM.NE.RAWDATA(I,17)) GOTO 952
158 954      FV=RAWDATA(I,10)
159              J=RAWDATA(I,11)
160              PROCT(1)=PROCT(1)+mCURFLSH(I)
161              PROCT(2)=PROCT(2)+BCFL(I)
162              PROCT(3)=PROCT(3)+mgFLSH(I)
163              PROCT(4)=PROCT(4)+RFLSH(I)
164              PROCT(5)=PROCT(5)+FV
165              WRITE (1,951) RAWDATA(I,1),mCURFLSH(I)/K,BCFL(I)/K,
166          & mgFLSH(I)/K,RFLSH(I)/K,mCURFLSH(I)/FV,BCFL(I)/FV,
167          & RFLSH(I)/FV,RAWDATA(I,10),RAWDATA(I,17),SOLN(J)
168              IF (I.EQ.II) END=1
169              IF (I.EQ.II) GOTO 952
170              GOTO 950
171  C952      WRITE (1,953)
172 952      IF (ANSPROC.EQ."N") GOTO 958
173          WRITE (1,956) (PROCT(IJ)/K,IJ=1,4),PROCT(1)/PROCT(5),
174          & PROCT(2)/PROCT(5),PROCT(4)/PROCT(5),PROCT(5),PRNUM
175 958      WRITE (1,953)
176          IF (I.EQ.II .AND. END.EQ.0) GOTO 959
177          IF (I.EQ.II) WRITE (1,956) TOTmC/K,TOTB/K,TOTmg/K,
178          & TOTR/K,TOTmC/TOTV,TOTB/TOTV,TOTR/TOTV,TOTV
179          IF (I.EQ.II) GOTO 950

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```

180 959 PRNUM=RAWDATA(I,17)
181 DO 957 J=1,5
182 PROCT(J)=0
183 957 CONTINUE
184 GOTO 954
185 950 CONTINUE
186 951 FORMAT (T4,I6,T14,F8.1,T25,F8.1,T36,F8.1,T47,F8.1,T58,F8.1,
187 & T69,F8.1,T80,F8.1,T91,I8,T104,I3,T111,A13)
188 953 FORMAT (T4,120("-",),)
189 956 FORMAT (T4,"Total",T12,I8,T23,I8,T34,I8,T45,I8,T58,F8.1,T69,
190 & F8.1,T80,F8.1,T91,I8,T104,I3)
191 GOTO 99
192 C
193 51 CALL SUB5 (I1,RAWDATA,RAWDATA)
194 EST=5
195 GOTO 4
196 C
197 100 FORMAT (E9.3,E12.3,F10.2,F10.2)
198 99 STOP
199 END
200 C
201 C
202 SUBROUTINE SUB4 (LB,RAWDATA,K2)
203 REAL NUM
204 DIMENSION RAWDATA(250,17)
205 1 DO 2 I=1,250
206 DO 3 J=1,17
207 RAWDATA(I,J)=0
208 3 CONTINUE
209 2 CONTINUE
210 DO 4 I=1,250
211 READ (9#I,100,END=5) (RAWDATA(I,J),J=1,17)
212 4 CONTINUE
213 5 K=I
214 K2=K-1
215 IF(K2.EQ.250)DISPLAY"! Data exceeded capacity, only 250 read !"
216 &
217 100 FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
218 * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,1X,E7.2,1X,F5.1,1X,F5.2,1X,
219 * F5.2,1X,I6,1X,I3)
220 99 RETURN
221 END
222 C
223 C
224 SUBROUTINE SUB5 (I2,RD,Z)
225 DIMENSION RD(250,15),RDSLN(15,13),RDT(13),AVSLRD(15,13),
226 * AVR(13),COUNT(15),Z(250,15),T(250),KN(15),VOL(15),
227 * VOLSNG(15)
228 C
229 C*****
230 C
231 C T(I) is the sum of the gamma for a flush
232 C K is the solution number
233 C COUNT(K) is the # of flushes of soln k w log #
234 C N is the # of flushes w/o gamma scan
235 C KN(K) is the # of flushes of soln k w/o gamma
236 C COUNTTOT is the total # of flushes with log #'s
237 C VOL(K) is the volume of soln K w log #s
238 C VOLT is the total volume of sampled flushes
239 C VOLSNG(K) is the volume of sampled soln k w/o gamma

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```

240 C      VOLSNGT  is the total vol of sampled flushes w/o gamma *
241 C      VOLNST   is the total vol of flushes w/o log #s      *
242 C                                                     *
243 C*****
244 C
245     COUNTTOT=0
246     VOLT=0
247     VOLNST=0
248     VOLSNGT=0
249     N=0
250     DO 1 I=1,12
251         T(I)=0
252 1     CONTINUE
253     DO 2 I=1,12
254         DO 3 J=2,9
255             T(I)=T(I)+RD(I,J)
256 3     CONTINUE
257 2     CONTINUE
258     DO 4 I=1,15
259         COUNT(I)=0
260         KN(I)=0
261         VOL(I)=0
262         VOLSNG(I)=0
263         DO 5 J=1,13
264             RDSLNI(I,J)=0
265             AVSLRD(I,J)=0
266 5     CONTINUE
267 4     CONTINUE
268     DO 6 I=1,13
269         RDT(I)=0
270         AVRDI(I)=0
271 6     CONTINUE
272     DO 7 I=1,12
273         IF (RDI(I,1).EQ.0) VOLNST=VOLNST+RDI(I,10)
274         IF (RDI(I,1).EQ.0) GOTO 7
275         K=RDI(I,11)
276         COUNT(K)=COUNT(K)+1
277         COUNTTOT=COUNTTOT+1
278         VOL(K)=VOL(K)+RDI(I,10)
279         VOLT=VOLT+RDI(I,10)
280         IF (T(I).EQ.0) GOTO 8
281     GOTO 9
282 8     N=N+1
283         KN(K)=KN(K)+1
284         VOLSNG(K)=VOLSNG(K)+RDI(I,10)
285         VOLSNGT=VOLSNGT+RDI(I,10)
286 9     DO 10 J=2,9
287         RDSLNI(K,J)=RDSLNI(K,J)+RDI(I,J)*RDI(I,10)
288         RDT(J)=RDT(J)+RDI(I,J)*RDI(I,10)
289 10    CONTINUE
290         DO 11 J=12,13
291             RDSLNI(K,J)=RDSLNI(K,J)+RDI(I,J)*RDI(I,10)
292             RDT(J)=RDT(J)+RDI(I,J)*RDI(I,10)
293 11    CONTINUE
294 7     CONTINUE
295     DO 12 K=1,15
296         IF (COUNT(K).EQ.0) GOTO 12
297         IF (COUNT(K).EQ.KN(K)) GOTO 15
298 C      (if there is no soln k .or. # flshs of soln k = #
299 C      flshs of soln k w/o gamma) goto 12

```

```

300      IF (KN(K).GT.0) GOTO 13
301      C      (If # flshs of soln K w/o g .GT.0) goto 13
302      C      Only solns with gamma results go to nest step
303      DO 14 J=2,9
304      AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
305      14      CONTINUE
306      GOTO 15
307      C      13 is ave of sons k w some flshs w/o gamma
308      C      Vol(K)-Volsng(K)= vol of soln K w gamma
309      13      DO 16 J=2,9
310      AVSLRD(K,J)=RDSLN(K,J)/(VOL(K)-VOLSN(K))
311      16      CONTINUE
312      15      DO 17 J=12,13
313      AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
314      17      CONTINUE
315      12      CONTINUE
316      DO 18 J=2,9
317      AVR(D(J))=RDT(J)/(VOLT-VOLSNGT)
318      18      CONTINUE
319      DO 19 J=12,13
320      AVR(D(J))=RDT(J)/VOLT
321      19      CONTINUE
322      DO 20 I=1,12,1
323      IF (RD(I,1).GT.0 .AND. T(I).GT.0) GOTO 20
324      C      Solns w log # and w gammas skip to 20
325      IF (RD(I,1).GT.0) GOTO 21
326      RD(I,1)=1
327      21      K=RD(I,11)
328      C      Working with flushes w/o log #s or no gammas
329      IF (COUNT(K).EQ.0) GOTO 22
330      IF (COUNT(K).EQ.KN(K)) GOTO 23
331      DO 24 J=12,13
332      IF (RD(I,J) .GT. 0) GOTO 24
333      RD(I,J)=AVSLRD(K,J)
334      24      CONTINUE
335      DO 25 J=2,9
336      RD(I,J)=AVSLRD(K,J)
337      25      CONTINUE
338      GOTO 20
339      C      If soln k has no samples then the ave of all is used
340      22      DO 26 J=12,13
341      RD(I,J)=AVRD(J)
342      26      CONTINUE
343      23      DO 27 J=2,9
344      RD(I,J)=AVRD(J)
345      27      CONTINUE
346      IF (COUNT(K).EQ.0 .AND. COUNT(K).EQ.KN(K) ) GOTO 20
347      IF (RD(I,1).EQ.1 .AND. COUNT(K).EQ.KN(K)) GOTO 30
348      GOTO 20
349      C      For a flush w/o sample, where there are other solns
350      C      with beta but with no gamma, use soln ave for beta
351      30      DO 31 J=12,13
352      RD(I,J)=AVSLRD(K,J)
353      31      CONTINUE
354      20      CONTINUE
355      DO 28 I=1,12
356      DO 29 J=1,15
357      Z(I,J)=RD(I,J)
358      29      CONTINUE
359      28      CONTINUE

```



```

360 99 RETURN
361 END
362 C
363 C
364 C
365 SUBROUTINE DATAFILE
366 CHARACTER*30 NAME,DATA3,PRNT,STRTSP,A*10,DEVN*5
367 C
368 DISPLAY " File name to be accessed"
369 ACCEPT A
370 DISPLAY "Printer dev number (local=144,lp=6;default=144)"
371 DEVN="144"
372 ACCEPT DEVN
373 C
374 NAME[1:11]="FILE FTN09="
375 NAME[12:10]=A
376 NAME[22:4]=",OLD"
377 NAME[26:1]=%15C
378 DATA3[1:18]="FILE FTN03=ZNM,OLD"
379 DATA3[19:1]=%15C
380 PRNT[1:18]="FILE FTN01=LP;DEV="
381 PRNT[19:4]=DEVN
382 PRNT[23:1]=%15C
383 STRTSP[1:14]="STARTSPOOL 144"
384 STRTSP[15:1]=%15C
385 C
386 CALL COMMAND (NAME,I1,I2)
387 CALL COMMAND (DATA3,I1,I2)
388 CALL COMMAND (PRNT,I1,I2)
389 CALL COMMAND (STRTSP,I1,I2)
390 RETURN
391 END

```


T ZP
/L ALL

```

1  $CONTROL USLINIT,INIT,NOSOURCE
2  C
3  C NAME PROGRAM SHORT FORM (ZP)
4  C FILE FTN03=ZNM,OLD
5  C FILE FTN09=(FILE TO BE ACCESSED),OLD
6  C FILE FTN01;DEV=LP;CCTL
7  C
8  DIMENSION RAWDATA(100,17),CNVRSNDT(15,4),DPSFLSH(100),
9  * REA(100,8),RFLSH(100),RISO(8),DPSISO(8),BCFL(100),
10 * SLNmC(15,8),SLNmG(15,8),SLNREA(15,8),SLNBCT(15),
11 * SLNmCT(15),SLNmGT(15),SLNREAT(15),SLNTV(15),
12 * COSTFL(100),COSTSLN(15),
13 * UDSGFL(100),UDSGSLN(15),
14 * PmCISFL(100,8),PmgISFL(100,8),PRISFL(100,8),
15 * PmCISFLT(100),PmgISFLT(100),PRISFLT(100),PUDSFLT(100),
16 * PBCFLT(100),PCOSTFLT(100),PVOLFLT(100),PmgFLT(100),PRFLT(100),
17 * PmCIST(8),PmgIST(8),PRIST(8),
18 * PmCSLN(15,8),PRSLN(15,8),PmgSLN(15,8),
19 * PmCSLNT(15),PmgSLNT(15),PRSLNT(15),PUDSSLNT(15),PBCSLNT(15),
20 * PCOSTSLNT(15),PVOLSLNT(15),
21 * PTmCIS(100,8),PTmGIS(100,8),PTmRIS(100,8),PJSL(15,8),
22 * PTmGSL(15,8),PTmRSL(15,8),PTmCSL(15,8),PJ(100,8),Pr(12)
23 C
24 REAL mgISO(8),mgFLSH(100),mgEA(100,8),mCURFLSH(100),mCURISO(8),
25 * mCUREA(100,8),TOTmC,TOTmg,TOTR,KgSLN(15,2),KgT(15),KgFL(100,2),
26 * Z,MPEW,MCALC
26.1 C REAL MOLEK,PEWCALNa,PEWCOST,NaWASTE,NaKWASTE
27 C
28 DOUBLE PRECISION LOGN,MOLEK,NaWASTE,NaKWASTE
29 INTEGER C
30 C
31 CHARACTER ISO*6(8),SOLN*13(15),ANS,LABEL*6(17),FILE*20,ANSPROC
32 C
33 DATA ISO/"Ce144","Cs134","Cs137","Nb 95","Ru103",
34 * "Ru106","Sb125","Zr 95"/
35 C
36 DATA SOLN/"H2O","HNO3","KMnO4/HNO3","4521","4502","CITROX",
37 * "Tartaric/NaOH","4324","Oxalic","Citric A","Oxalic/HNO3",
38 * "NH4OH","NaOH/EDTA","ARR","HF/HNO3"/
39 C
40 DATA LABEL/"Log #","Ce144","Cs134","Cs137","Nb 95","Ru103",
41 * "Ru106","Sb125","Zr 95","Vol-L","Soln","Beta","uds",
42 * "% ch 1","% ch 2","mR/hr","Proc"/,Y/Y"/,N/N"/
43 C
44 C
45 CALL DATAFILE
46 C
47 C
48 I=16
49 DISPLAY "Print size 16,12,10"
50 ACCEPT I
51 IF (I.EQ.16) WRITE (1,101)
52 IF (I.EQ.12) WRITE (1,102)
53 IF (I.EQ.10) WRITE (1,103)
54 103 FORMAT (" ")
55 102 FORMAT (" ")
56 101 FORMAT ("")
57 C

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58 C
59 DISPLAY " Report name"
60 ACCEPT FILE
61 CALL SUB4 (LABEL,RAWDATA,II)
62 EST =0
63 C=0
64 C
65 1 DISPLAY " How many flushes ", II
66 ACCEPT II
67 K2=II
68 C
69 DISPLAY "Procedure totals N/Y"
70 ANSPROC="N"
71 ACCEPT ANSPROC
72 C
73 98 DISPLAY "Do you want to run the program Y/N "
74 ANS="Y"
75 ACCEPT ANS
76 IF (ANS.EQ."N") STOP
77 IF (ANS.NE."Y") GOTO 98
78 C
79 2 DISPLAY "Estimates only Y/N"
80 ANS="Y"
81 ACCEPT ANS
82 IF (ANS.EQ."Y") GOTO 51
83 IF (ANS.NE."N") GOTO 2
84 EST=2
85 C
86 3 DISPLAY "Include averaged data Y/N"
87 ANS="Y"
88 ACCEPT ANS
89 IF (ANS.EQ."N") GOTO 75
90 IF (ANS.NE."Y") GOTO 3
91 EST=3
92 C
93 75 DISPLAY "1. All went to PEW"
94 DISPLAY "2. All went to Tankfarm"
95 DISPLAY "3. Mixed, PEW & Tankfarm"
96 DISPLAY "4. Calc. all the above Processes"
97 DISPLAY "Waste Processing default = 4 "
98 A=4
99 ACCEPT A
100 IF (A.EQ.1 .OR. A.EQ.2 .OR. A.EQ.3) GOTO 4
101 IF (A.NE.4) GOTO 75
102 C
103 C
104 4 DO 5 I=1,II,1
105 DPSFLSH(I)= 0
106 RFLSH(I)= 0
107 BCFL(I)= 0
108 COSTFL(I)= 0
109 PRISFLT(I)=0
110 PmgISFLT(I)=0
111 mgFLSH(I)= 0
112 mCURFLSH(I)= 0
113 UDSGFL(I)= 0
114 PmCISFLT(I)=0
115 PmgFLT(I)=0
116 PRFLT(I)=0
117 PUDSFLT(I)=0

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118      PBCFLT(I)=0
119      PCOSTFLT(I)=0
120      PVOLFLT(I)=0
121      DO 6 J=1,8,1
122          mCUREA(I,J)=0
123          REA(I,J)=0
124          mgEA(I,J)=0
125          PmCISFL(I,J)=0
126          PmgISFL(I,J)=0
127          PRISFL(I,J)=0
128          PTmCIS(I,J)=0
129          PTmgIS(I,J)=0
130          PTmRIS(I,J)=0
131          PJ(I,J)=0
132      6      CONTINUE
133      DO 7 J=1,2
134          KgFL(I,J)=0
135      7      CONTINUE
136      5      CONTINUE
137      DO 8 I=1,8
138          RISO(I)=0
139          DPSISO(I)=0
140          mgISO(I)=0
141          mCURISO(I)=0
142          PmCIST(I)=0
143          PmgIST(I)=0
144          PRIST(I)=0
145      8      CONTINUE
146      DO 9 I=1,15
147          SLNBCT(I)=0
148          SLNmCT(I)=0
149          SLNmGT(I)=0
150          SLNREAT(I)=0
151          SLNTV(I)=0
152          COSTSLN(I)=0
153          KgT(I)=0
154          UDSGSLN(I)=0
155          PmCSLNT(I)=0
156          PmgSLNT(I)=0
157          PRSLNT(I)=0
158          PUDSSLNT(I)=0
159          PBCSLNT(I)=0
160          PCOSTSLNT(I)=0
161          PVOLSLNT(I)=0
162      DO 10 J=1,8
163          SLNmC(I,J)=0
164          SLNmG(I,J)=0
165          SLNREA(I,J)=0
166          PmCSLN(I,J)=0
167          PRSLN(I,J)=0
168          PmgSLN(I,J)=0
169          PJSL(I,J)=0
170          PTmCSL(I,J)=0
171          PTmgSL(I,J)=0
172          PTmRSL(I,J)=0
173      10      CONTINUE
174      DO 11 J=1,2
175          KgSLN(I,J)=0
176      11      CONTINUE
177      DO 12 J=1,4

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178          CNVRSNDT(I,J)=0
179 12        CONTINUE
180 9         CONTINUE
181          TOTmC=0
182          TOTR=0
183          TOTmg=0
184          TOTV=0
185          TOTV2=0
186          TOTB=0
187          TOTCOST=0
188          TOTCKg=0
189          UDSGT=0
190          NWS=0
191 C         TOTV= THE VOL OF SAMPLED FLUSHES
192 C         TOTV2= THE TOTAL VOL
193 C
194          DO 13 I=1,15
195              READ (3@I,100,END=14) (CNVRSNDT(I,J), J=1,4,1)
196 13        CONTINUE
197 C
198 14        DO 15 J=2,9
199            DO 16 I=1,11,1
200                LOGN=RAWDATA(I,1)
201                IF (RAWDATA(I,1).EQ.0) GOTO 16
202                IF (LOGN.EQ.1 .AND. EST.LE.2) GOTO 16
203                DPSISO(J-1)=DPSISO(J-1)+RAWDATA(I,J)*RAWDATA(I,10)
204                *
205                REA(I,J-1)=RAWDATA(I,J)*RAWDATA(I,10)*1000*CNVRSN
206                *
207                DT(J-1,1)
208                mgEA(I,J-1)=RAWDATA(I,J)*RAWDATA(I,10)*CNVRSNDT(J-1,2)
209                mCUREA(I,J-1)=(RAWDATA(I,J)*RAWDATA(I,10)*1000)/3.7E7
210 16        CONTINUE
211 15        CONTINUE
212          DO 17 I=1,11
213              TOTV2=TOTV2+RAWDATA(I,10)
214              IF (RAWDATA(I,1).EQ.0) GOTO 17
215              DO 18 J=2,9,1
216                  DPSFLSH(I)=DPSFLSH(I)+RAWDATA(I,J)*RAWDATA(I,10)*1000
217                  RFLSH(I)=RFLSH(I)+REA(I,J-1)
218                  mgFLSH(I)=mgFLSH(I)+mgEA(I,J-1)
219 18        CONTINUE
220              BCFL(I)=(RAWDATA(I,12)*RAWDATA(I,10)*1000/(60*3.7E07))
221              mCURFLSH(I)=DPSFLSH(I)/3.7E7
222              TOTmC=TOTmC+mCURFLSH(I)
223              TOTR=TOTR+RFLSH(I)
224              TOTV=TOTV+RAWDATA(I,10)
225 17        CONTINUE
226          DO 19 I=1,8
227              mCURISO(I)=DPSISO(I)/3.7E7
228              RISO(I)=DPSISO(I)*CNVRSNDT(I,1)
229              mgISO(I)=DPSISO(I)*CNVRSNDT(I,2)
230 19        CONTINUE
231          DO 20 I=1,11
232              IF (RAWDATA(I,1).EQ.0) GOTO 20
233              TOTB=TOTB+BCFL(I)
234              mgFLSH(I)=1000*mgFLSH(I)
235              TOTmg=TOTmg+mgFLSH(I)
236              DO 21 J=1,8,1
237                  mgEA(I,J)=1000*mgEA(I,J)

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238 20 CONTINUE
239 DO 22 I=1,II
240     LOGN=RAWDATA(I,1)
241     IF (LOGN.GT.1) NWS=NWS+1
242     IF (LOGN.EQ.1 .AND. EST.LE.2) RAWDATA(I,12)=0
243 C     IF (LOGN.EQ.0) GOTO 22
244     K= RAWDATA(I,11)
245     UDSGFL(I)= RAWDATA(I,10)*RAWDATA(I,13)
246     UDSGSLN(K)= UDSGSLN(K)+UDSGFL(I)
247     UDSGT= UDSGT+UDSGFL(I)
248     SLNTV(K)= SLNTV(K)+RAWDATA(I,10)
249     SLNBCT(K)= SLNBCT(K)+BCFL(I)
250     KgFL(I,1)= RAWDATA(I,10)*RAWDATA(I,14)/100
251     COSTFL(I)= KgFL(I,1)*CNVRSNDT(K,3)
252     KgSLN(K,1)= KgSLN(K,1)+KgFL(I,1)
253     COSTSLN(K)= KgSLN(K,1)*CNVRSNDT(K,3)
254     IF (K.EQ.3 .OR. K.EQ.6 .OR. K.EQ.7) GOTO 23
255     IF (K.EQ.11 .OR. K.EQ.13 .OR. K.EQ.15) GOTO 23
256     GOTO 24
257 23     KgFL(I,2)= RAWDATA(I,10)*RAWDATA(I,15)/100
258     COSTFL(I)= COSTFL(I)+KgFL(I,2)*CNVRSNDT(K,4)
259     KgSLN(K,2)= KgSLN(K,2)+KgFL(I,2)
260     COSTSLN(K)= COSTSLN(K)+KgSLN(K,2)*CNVRSNDT(K,4)
261 24     DO 25 J=1,8
262         SLNmC(K,J)= SLNmC(K,J)+mCUREA(I,J)
263         SLNmG(K,J)= SLNmG(K,J)+mgEA(I,J)
264         SLNREA(K,J)= SLNREA(K,J)+REA(I,J)
265         PmCIST(J)= mCURISO(J)*100/TOTmC
266         PmgIST(J)= mgISO(J)*100/TOTmg
267         PRIST(J)= RISO(J)*100/TOTR
268         PTmCIS(I,J)=mCUREA(I,J)*100/TOTmC
269         PTmgIS(I,J)=mgEA(I,J)*100/TOTmg
270         PTmRIS(I,J)=REA(I,J)*100/TOTR
271         IF (mCURISO(J).EQ.0) GOTO 26
272         PJ(I,J)=mCUREA(I,J)*100/mCURISO(J)
273 28     IF (mCURFLSH(I).EQ.0) GOTO 27
274         PmCISFL(I,J)= mCUREA(I,J)*100/mCURFLSH(I)
275         PmgISFL(I,J)= mgEA(I,J)*100/mgFLSH(I)
276         PRISFL(I,J)= REA(I,J)*100/RFLSH(I)
277     GOTO 25
278 26     PJ(I,J)=0
279     GOTO 28
280 27     PmCISFL(I,J)=0
281     PRISFL(I,J)=0
282     PmgISFL(I,J)=0
283 25     CONTINUE
284     PBCFLT(I)= BCFL(I)*100/TOTB
285     PVOLFLT(I)= RAWDATA(I,10)*100/TOTV
286     TOTCOST= TOTCOST+COSTFL(I)
287     PmCISFLT(I)= mCURFLSH(I)*100/TOTmC
288     PmgFLT(I)= mgFLSH(I)*100/TOTmg
289     PRFLT(I)= RFLSH(I)*100/TOTR
290 22 CONTINUE
291 DO 29 I=1,II
292     IF (RAWDATA(I,1).EQ.0) GOTO 29
293     PCOSTFLT(I)= COSTFL(I)*100/TOTCOST
294     IF (UDSGT .EQ.0) GOTO 29
295     PUDSFLT(I)= UDSGFL(I)*100/UDSGT
296 29 CONTINUE
297 DO 30 I=1,15

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```

298      DO 31 J=1,8
299          SLNmCT(I)=SLNmCT(I)+SLNmC(I,J)
300          SLNmGT(I)=SLNmGT(I)+SLNmG(I,J)
301          SLNREAT(I)=SLNREAT(I)+SLNREA(I,J)
302      31      CONTINUE
303      30      CONTINUE
304      DO 32 I=1,15
305          V=SLNTV(I)
306          IF (V.EQ.0) GOTO 32
307          PBCSLNT(I)= SLNBCT(I)*100/TOTB
308          PCOSTSLNT(I)= COSTSLN(I)*100/TOTCOST
309          PVOLSLNT(I)= SLNTV(I)*100/TOTV
310          PmCSLNT(I)= SLNmCT(I)*100/TOTmC
311          PmgSLNT(I)= SLNmGT(I)*100/TOTmg
312          PRSLNT(I)= SLNREAT(I)*100/TOTR
313          IF (UDSGT .EQ. 0) GOTO 33
314          PUDSSLNT(I)= UDSGLN(I)*100/UDSGT
315      33      DO 34 J=1,8
316          PTmCSL(I,J)=SLNmC(I,J)*100/TOTmC
317          PTmgSL(I,J)=SLNmG(I,J)*100/TOTmg
318          PTmRSL(I,J)=SLNREA(I,J)*100/TOTR
319          IF (mCURISO(J).EQ.0) GOTO 35
320          PJSL(I,J)=SLNmC(I,J)*100/mCURISO(J)
321      37      IF (SLNmCT(I).EQ.0) GOTO 36
322          PmCSL(I,J)= SLNmC(I,J)*100/SLNmCT(I)
323          PRSLN(I,J)= SLNREA(I,J)*100/SLNREAT(I)
324          PmgSLN(I,J)= SLNmG(I,J)*100/SLNmGT(I)
325          GOTO 34
326      35      PJSL(I,J)=0
327          GOTO 37
328      36      PmCSL(I,J)=0
329          PRSLN(I,J)=0
330          PmgSLN(I,J)=0
331      34      CONTINUE
332      32      CONTINUE
333      DO 38 I=1,15
334          DO 39 J=1,2
335              KgT(I)=KgT(I)+KgSLN(I,J)
336      39      CONTINUE
337          TOTCKg=TOTCKg+KgT(I)
338      38      CONTINUE
339      C
340      C
341      TH=1000
342      TmoleNa=0
343      TmoleK=0
344      PEWV=0
345      CALV=0
346      moleNaC=0
347      moleKC=0
348      T=1.01E7
349      DO 40 I=1,11
350          MK=0
351          MNa=0
352          IF (RAWDATA(I,11) .EQ. 5) MK=RAWDATA(I,14)*.1463
353          IF (MK .GE. 1) GOTO 41
354          IF (RAWDATA(I,11) .EQ. 7) MNa=RAWDATA(I,15)/4
355          IF (RAWDATA(I,11) .EQ.13) MNa=RAWDATA(I,15)/4
356          IF (RAWDATA(I,11) .EQ.14) MNa=RAWDATA(I,14)/4
357          IF (MNa .GE. 1) GOTO 72

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358      IF (RAWDATA(I,11) .EQ. 3) MK=RAWDATA(I,14)/15.8
359      IF (MK .GE. 1) GOTO 73
360      IF (RAWDATA(I,12) .GT. T) GOTO 74
361      PEWV=PEWV+RAWDATA(I,10)
362      GOTO 40
363  41      moleKC=MK*RAWDATA(I,10)
364      TmoleK=TmoleK+moleKC
365      GOTO 74
366  72      moleNaC=MNA*RAWDATA(I,10)
367      TmoleNa=TmoleNa+moleNaC
368      GOTO 74
369  73      moleKC=MK*RAWDATA(I,10)
370      TmoleK=TmoleK+ moleKC
371  74      CALV=CALV+RAWDATA(I,10)
372  40      CONTINUE
373  C
374      H2O = KgSLN(1,1)
375      HNO3 Kg = KgSLN(2,1) + KgSLN(3,2) + KgSLN(11,2)+ KgSLN(15,2)
376      HNO3 L = (KgSLN(2,1) )*(1000./(63.*13.))
377      KA KMnO4 = KgSLN(3,1)
378      KA MnO4 = KgSLN(3,1)*(119.0/158.0)
379      KA K = KgSLN(3,1)*(39.0/158.0)
380      KA HNO3 Kg = KgSLN(3,2)
381      KA HNO3 L = KgSLN(3,2)*(1000./(63.*13))
382      S4521 = KgSLN(4,1)
383      S4521 CIT A = KgSLN(4,1) * .05
384      S4521 OX A = KgSLN(4,1) * .15
385      NH4OXALATE = KgSLN(4,1) * .80
386      S4502 = KgSLN(5,1)
387      S4502 KMnO4 = KgSLN(5,1) * .20
388      S4502 MnO4 = S4502 KMnO4 * (119.0/158.0)
389      S4502 KK = S4502 KMnO4 * (39.0/158.0)
390      S4502 KOH = KgSLN(5,1) * .77
391      KOH = KgSLN(5,1) * .77
392      S4502 Na = KgSLN(5,1) * (0.03*46.0/162.0)
393      S4502 KB = S4502 KOH * (39.0/56.0)
394      S4502 OH = S4502 KOH * (17.0/56.0)
395      CITROX = KgSLN(6,1) + KgSLN(6,2)
396      CITROX CIT A = KgSLN(6,1)
397      CITROX OX A = KgSLN(6,2)
398      TARTARIC NaOH = KgSLN(7,2)
399      TARTARIC Na = KgSLN(7,2) * 23.0/40.0
400      TARTARIC A = KgSLN(7,1)
401      S4324 = KgSLN(8,1)
402      S4324 Na = S4324 * 0.113
403      OXALIC = KgSLN(9,1)
404      KMnO4 = KA KMnO4 + S4502 KMnO4
405      MnO4 = (KMnO4 + S4502 KMnO4) * (119.0/158.0)
406      K1 = (KMnO4 + S4502 KMnO4)*(39.0/158.0)+S4502 KOH *(39.0/56.0)
407      CIT A =KgSLN(10,1)
408      OXALHNO = KgSLN(11,1)
409      NHOH = KgSLN(12,1)
410      EDTA = KgSLN(13,1)
411      EDTANaOH = KgSLN(13,2)
412      EDTA Na = (EDTANaOH*23.0/40.0) + (EDTA*46.0/372.24)
413      ARRNAOH = KgSLN(14,1)
414      ARRNA = ARRNAOH * 0.412
414.2      HF = KgSLN(15,1)
415      NaOH = KgSLN(7,2) + EDTANaOH + ARRNAOH
416      OH = 17.0*(S4502 KOH/56.0 + NaOH/40.0 + NHOH/35)

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417      Na = TARTARIC Na + EDTA Na + ARRNA + S4502 Na + S4324 Na
418      CITRIC A = CITROX CIT A + S4521 CIT A + CIT A
419      OXALIC A = CITROX OX A + S4521 OX A + OXALIC + OXALHNO
420      TV=TOTV
421      C
422      C
423      IF (EST.NE.0) WRITE (1,105)
424      CALL COUNT(C)
425      WRITE (1,110) FILE,(LABEL(I),I=1,17)
426      WRITE (1,120) ((RAWDATA(I,J), J=1,17,1), I=1,11,1)
427      CALL COUNT(C)
428      WRITE (1,130)
429      DO 42 I=1,15
430          WRITE (1,140) (CNVRSNDT(I,J),J=1,4),I,SOLN(I)
431      42  CONTINUE
432      WRITE (1,150) FILE
433      C
434      SKIP=1
435      TV=TOTV
436      Z=5
437      ZN=1
438      CALL SB1 (II,RAWDATA,mCUREA,mCURFLSH,BCFL,Z,ZN,mCURISO,TOTmC,ISO
439      * ,SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
440      Z=6
441      CALL SB1 (II,RAWDATA,mgEA,mgFLSH,BCFL,Z,ZN,mgISO,TOTmg,ISO,SOLN,
442      * TOTB,C,TOTV,SKIP,ANSPROC)
443      Z=7
444      CALL SB1 (II,RAWDATA,REA,RFLSH,BCFL,Z,ZN,RISO,TOTR,ISO,SOLN,
445      * TOTB,C,TOTV,SKIP,ANSPROC)
446      Z=1.0
447      CALL SB1 (II,RAWDATA,mCUREA,mCURFLSH,BCFL,Z,ZN,mCURISO,TOTmC,ISO
448      * ,SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
449      Z=2.0
450      CALL SB1 (II,RAWDATA,mgEA,mgFLSH,BCFL,Z,ZN,mgISO,TOTmg,ISO,SOLN,
451      * TOTB,C,TOTV,SKIP,ANSPROC)
452      Z=3.0
453      CALL SB1 (II,RAWDATA,REA,RFLSH,BCFL,Z,ZN,RISO,TOTR,ISO,SOLN,
454      * TOTB,C,TOTV,SKIP,ANSPROC)
455      C
456      WRITE (1,160)
457      SKIP=7
458      Z=1
459      ZN=2.0
460      CALL SB1 (II,RAWDATA,PmCISFL,PmCISFLT,PBCFLT,Z,ZN,PmCIST,TOTmC,
461      * ISO,SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
462      Z=2
463      WRITE (1,170)
464      CALL SB1 (II,RAWDATA,PmgISFL,PmgFLT,PBCFLT,Z,ZN,PmgIST,TOTmg,
465      * ISO,SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
466      Z=3
467      WRITE (1,170)
468      CALL SB1 (II,RAWDATA,PRISFL,PRFLT,PBCFLT,Z,ZN,PRIST,TOTR,ISO,
469      * SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
470      C
471      SKIP=1
472      Z=4
473      CALL SB1 (II,RAWDATA,PJ,PmCISFLT,PBCFLT,Z,ZN,PmCIST,
474      * TOTmC,ISO,SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
475      Z=1
476      WRITE (1,180)

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477      CALL SB1 (II,RAWDATA,PTmCIS,PmCISFLT,PBCFLT,Z,ZN,PmCIST,
478      * TOTmC,ISO,SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
479      Z=2
480      CALL SB1 (II,RAWDATA,PTmgIS,PmgFLT,PBCFLT,Z,ZN,PmgIST,TOTmg,
481      * ISO,SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
482      Z=3
483      CALL SB1 (II,RAWDATA,PTmRIS,PRFLT,PBCFLT,Z,ZN,PRIST,TOTR,
484      * ISO,SOLN,TOTB,C,TOTV,SKIP,ANSPROC)
485      C
486      CALL COUNT (C)
487      WRITE (1,200)
488      Z=1
489      CALL SUB3 (ISO,mCURISO,mgISO,RISO,TOTmC,TOTmg,TOTR,Z,TV)
490      WRITE (1,205) TOTB/1000
491      CALL COUNT (C)
492      WRITE (1,210)
493      Z=2
494      CALL SUB3 (ISO,PmCIST,PmgIST,PRIST,TOTmC,TOTmg,TOTR,Z,TV)
495      CALL COUNT(C)
496      WRITE (1,230)
497      Z=1
498      CALL SUB2 (ISO,SLNmC,SLNmCT,SLNTV,SOLN,Z,TV)
499      CALL COUNT(C)
500      WRITE (1,240)
501      CALL SUB2 (ISO,SLNmG,SLNmGT,SLNTV,SOLN,Z,TV)
502      CALL COUNT(C)
503      WRITE (1,250)
504      CALL SUB2 (ISO,SLNREA,SLNREAT,SLNTV,SOLN,Z,TV)
505      CALL COUNT(C)
506      WRITE (1,260)
507      Z=2
508      CALL SUB2 (ISO,PmCSLN,PmCSLNT,PVOLSLNT,SOLN,Z,TV)
509      CALL COUNT(C)
510      WRITE (1,270)
511      CALL SUB2 (ISO,PmgSLN,PmgSLNT,PVOLSLNT,SOLN,Z,TV)
512      CALL COUNT(C)
513      WRITE (1,280)
514      CALL SUB2 (ISO,PRSLN,PRSLNT,PVOLSLNT,SOLN,Z,TV)
515      Z=3
516      CALL COUNT(C)
517      WRITE (1,290)
518      CALL SUB2 (ISO, PJSL,PmCSLNT,PVOLSLNT,SOLN,Z,TV)
519      CALL COUNT(C)
520      WRITE (1,300)
521      Z=2
522      CALL SUB2 (ISO,PTmCSL,PmCSLNT,PVOLSLNT,SOLN,Z,TV)
523      WRITE (1,310) (PmCIST(I),I=1,8)
524      CALL COUNT(C)
525      WRITE (1,320)
526      CALL SUB2 (ISO, PTmgSL,PmgSLNT,PVOLSLNT,SOLN,Z,TV)
527      WRITE (1,310) (PmgIST(I),I=1,8)
528      CALL COUNT(C)
529      WRITE (1,330)
530      CALL SUB2 (ISO, PTmRSL,PRSLNT,PVOLSLNT,SOLN,Z,TV)
531      WRITE (1,310) (PRIST(I),I=1,8)
532      CALL COUNT(C)
533      WRITE (1,340)
534      WRITE (1,350)
535      WRITE (1,360)
536      DO 43 I=1,II,1

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537      K= RAWDATA(I,11)
538      WRITE (1,370) RAWDATA(I,1),RFLSH(I),mgFLSH(I),UDSGFL(I),
539      *      mCURFLSH(I),BCFL(I),COSTFL(I),RAWDATA(I,17),SOLN(K),
540      *      RAWDATA(I,10)
541  43      CONTINUE
542      WRITE (1,360)
543      WRITE (1,380) TOTR,TOTmg,UDSGT,TOTmC,TOTB,TOTCOST,TOTV2
544      WRITE (1,360)
545      CALL COUNT(C)
546  781    WRITE (1,390)
547      WRITE (1,480)
548      WRITE (1,447)
549      DO 44 I=1,II,1
550          IF (RAWDATA(I,1).EQ.0) GOTO 44
551          K= RAWDATA(I,11)
552          V= RAWDATA(I,10)
553          IF (mCURFLSH(I).EQ.0) A=0
554          IF (mCURFLSH(I).EQ.0) GOTO 57
555          AB=BCFL(I)/mCURFLSH(I)
556  57      WRITE (1,405) RAWDATA(I,1),RFLSH(I)/V,mgFLSH(I)/V,
557      *      UDSGFL(I)/V,mCURFLSH(I)/V,BCFL(I)/V,AB,
558      *      COSTFL(I)/V,RAWDATA(I,17),SOLN(K),V
559  44      CONTINUE
560      WRITE (1,447)
561      WRITE (1,407) TOTR/TV,TOTmg/TV,UDSGT/TV,TOTmC/TV,TOTB/TV,
562      *      TOTC/TOTmC,TOTCOST/TV,TV
563      WRITE (1,447)
564      CALL COUNT(C)
565      WRITE (1,410)
566      WRITE (1,350)
567      WRITE (1,360)
568      PROC=RAWDATA(1,17)
569      DO 45 I=1,II,1
570          IF (ANSPROC.EQ."N") GOTO 52
571          IF (PROC.EQ.RAWDATA(I,17)) GOTO 52
572  55      WRITE (1,402)
573          WRITE (1,404) (Pr(J),J=1,6),PROC,Pr(7)
574          DO 56 J=1,8
575              Pr(J)=0
576  56      CONTINUE
577          IF (I.EQ.II) GOTO 45
578          WRITE (1,402)
579          PROC=RAWDATA(I,17)
580  C
581  52      IF (RAWDATA(I,1).EQ.0) GOTO 45
582          K=RAWDATA(I,11)
583          WRITE (1,400) RAWDATA(I,1),PRFLT(I),PmgFLT(I),PUDSFLT(I),
584      *      PmCISFLT(I),PBCFLT(I),PCOSTFLT(I),RAWDATA(I,17),SOLN(K),
585      *      RAWDATA(I,10)
586  C
587          IF (ANSPROC.EQ."N") GOTO 45
588          IF (RAWDATA(I,17).EQ.RAWDATA(1,17) .AND. I.EQ.II) GOTO 45
589          Pr(1)=Pr(1)+PRFLT(I)
590          Pr(2)=Pr(2)+PmgFLT(I)
591          Pr(3)=Pr(3)+PUDSFLT(I)
592          Pr(4)=Pr(4)+PmCISFLT(I)
593          Pr(5)=Pr(5)+PBCFLT(I)
594          Pr(6)=Pr(6)+PCOSTFLT(I)
595          Pr(7)=Pr(7)+RAWDATA(I,10)
596          IF (I.EQ.II) GOTO 55

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597 45 CONTINUE
598 WRITE (1,360)
599 CALL COUNT(C)
600 WRITE (1,420)
601 WRITE (1,430)
602 WRITE (1,440)
603 DO 46 I=1,15
604 IF (SLNTV(I).EQ. 0.0) GOTO 46
605 WRITE (1,450) SLNREAT(I)/TH,SLNmgT(I)/TH,UDSGSLN(I)/TH,
606 * SLNmCT(I)/TH,SLNBCT(I)/TH,COSTSLN(I),SOLN(I),SLNTV(I)
607 46 CONTINUE
608 WRITE (1,440)
609 WRITE (1,380) TOTR/TH,TOTmg/TH,UDSGT/TH,TOTmC/TH,TOTB/TH,
610 * TOTCOST,TOTV
611 WRITE (1,440)
612 CALL COUNT(C)
613 WRITE (1,460)
614 WRITE (1,430)
615 WRITE (1,440)
616 DO 47 I=1,15
617 IF (SLNTV(I).EQ.0) GOTO 47
618 WRITE (1,470) PRSLNT(I),PmgSLNT(I),PUDSSLNT(I),PmCSLNT(I),
619 * PBCSLNT(I),PCOSTSLNT(I),SOLN(I),PVOLSLNT(I)
620 47 CONTINUE
621 WRITE (1,440)
622 CALL COUNT(C)
623 WRITE (1,475)
624 WRITE (1,485)
625 WRITE (1,445)
626 DO 48 I=1,15
627 V = SLNTV(I)
628 IF (V.EQ.0.0) GOTO 48
629 C IF (SLNmCT(I).EQ.0) A=0
630 C IF (SLNmCT(I).EQ.0) GOTO 58
631 C AB=SLNBCT(I)/SLNmCT(I)
632 58 WRITE (1,490) SLNREAT(I)/V,SLNmgT(I)/V,UDSGSLN(I)/V,
633 * SLNmCT(I)/V,SLNBCT(I)/V,SLNBCT(I)/V,COSTSLN(I)/V,
634 * SOLN(I),SLNTV(I)
635 48 CONTINUE
636 C
637 WRITE (1,445)
638 WRITE (1,492) TOTR/TV,TOTmg/TV,UDSGT/TV,TOTmC/TV,TOTB/TV,
639 * TOTCOST/TV,TV
640 WRITE (1,445)
641 CALL COUNT(C)
642 WRITE (1,500)
643 WRITE (1,510)
644 WRITE (1,440)
645 DO 49 I=1,15
646 Y=COSTSLN(I)
647 IF (SLNTV(I).EQ.0) GOTO 49
648 SR = SLNREAT(I)
649 Smg = SLNmgT(I)
650 UDS = UDSGSLN(I)
651 SmC = SLNmCT(I)
652 SBC = SLNBCT(I)
653 IF (Y.EQ.0) Y=1E30
654 WRITE (1,520) SR/Y,Smg/Y,UDS/Y,
655 * SmC/Y,SBC/Y,COSTSLN(I),SOLN(I),SLNTV(I)
656 49 CONTINUE

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657      TC=TOTCOST
658      WRITE (1,440)
659      WRITE (1,380) TOTR/TC,TOTmg/TC,UDSGT/TC,TOTmC/TC,TOTB/TC,
660      * TC,TV
661      WRITE (1,440)
662      CALL COUNT(C)
663
664      C
665      888  WRITE (1,540)
666          TV2=TOTV2
667          WRITE (1,550) TOTV2,(TOTV2/3.785)
668          CALC=(TOTV2/3.785)*5
669          WRITE (1,570) (TOTCKg-HNO3 Kg),((TOTCKg-HNO3 Kg)*2.2)
670          SMOLE=(Na/23.)*1000
671          WRITE (1,575) SMOLE ,SMOLE/TV2
672          MOLEK = ((KA K + S4502 KK + S4502 KB)/39.1)*1000
673          WRITE (1,580) MOLEK,MOLEK/TV2
674          RMOLE= (MOLEK + SMOLE)/TV2
675          WRITE (1,582) MOLEK+SMOLE,RMOLE
676          WRITE (1,586) TOTCOST
677          WRITE (1,584)
678          WRITE (1,660)
679          WRITE (1,775)
680          IF (SLNTV(1) .GT. 1)
681          &  WRITE (1,663) SLNTV(1)
682          WRITE (1,775)
683          IF (SLNTV(2) .GT. 1)
684          &  WRITE (1,666) KgSLN(2,1),SLNTV(2)
685          WRITE (1,775)
686          IF (SLNTV(3) .GT. 1)
687          &  WRITE (1,670) (KA KMnO4,KA K,KA KMnO4+KgSLN(3,2),SLNTV(3))
688          WRITE (1,775)
689          IF (SLNTV(4) .GT. 1)
690          &  WRITE (1,680) (S4521 CIT A,S4521 OX A,NH4OXALATE,S4521,SLNTV(4))
691          WRITE (1,775)
692          IF (SLNTV(5) .GT. 1)
693          &  WRITE (1,690) (S4502 KMnO4,S4502 KK,S4502 KB,S4502 Na,
694          *      S4502,SLNTV(5))
695          WRITE (1,775)
696          IF (SLNTV(6) .GT. 1)
697          &  WRITE (1,700) (CITROX CIT A,CITROX OX A,CITROX,SLNTV(6))
698          WRITE (1,775)
699          IF (SLNTV(7) .GT. 1)
700          &  WRITE (1,710) (TARTARIC A,(TARTARIC NAOH*23.0/40.0),
701          &  (TARTARIC A + TARTARIC NAOH),SLNTV(7) )
702          WRITE (1,775)
703          IF (SLNTV(8) .GT. 1)
704          &  WRITE (1,720) S4324 Na,S4324,SLNTV(8)
705          WRITE (1,775)
706          IF (SLNTV(9) .GT. 1)
707          &  WRITE (1,730) OXALIC,OXALIC,SLNTV(9)
708          WRITE (1,775)
709          IF (SLNTV(10) .GT. 1)
710          &  WRITE (1,735) CIT A,CIT A,SLNTV(10)
711          WRITE (1,775)
712          IF (SLNTV(11) .GT. 1)
713          &  WRITE (1,721) OXALHNO,OXALHNO+KgSLN(11,2),SLNTV(11)
714          WRITE (1,775)
715          IF (SLNTV(12) .GT. 1)
716          &  WRITE (1,722) NHOH,NHOH,SLNTV(12)
717          WRITE (1,775)

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717      IF (SLNTV(13) .GT. 1)
718      & WRITE (1,723) EDTA,EDTA Na,EDTA + EDTANaOH,SLNTV(13)
719      WRITE (1,775)
720      IF (SLNTV(14) .GT. 1)
721      & WRITE (1,724) ARNa,KgSLN(14,1),SLNTV(14)
722      WRITE (1,775)
722.1    IF (SLNTV(15) .GT. 1)
722.2    & Write (1,725) HF,HF+KgSLN(15,2),SLNTV(15)
722.3    Write (1,775)
723      WRITE (1,737) KMnO4,CITRIC A,OXALIC A,
724      * NH4OXALATE,TARTARIC A,(KA K + S4502 KK),S4502 KB,
725      * Na,(TOTCKg-HNO3 Kg),TV2
726      WRITE (1,775)
727      TMOLE=(HNO3 Kg*1000./63.)-OH*1000/17.
728      IF (TMOLE.LT.0) GOTO 59
729      IF (TMOLE.EQ.0) GOTO 60
730      PH=-ALOG10(TMOLE/TOTV2)
731      WRITE (1,770) PH
732      GOTO 60
733      59  POH=-ALOG10((TMOLE*(-1))/TV2)
734      PH= 14-POH
735      WRITE (1,770) PH
736      C
737      60  WRITE (1,790) K2
738      WRITE (1,792) NWS
739      C   Cal waste, 1 all to pew, 2 all to tankfarm, 3 mixed
740      IF (A .EQ. 1) GOTO 63
741      IF (A .EQ. 2) GOTO 64
742      IF (A .EQ. 3) GOTO 65
743      63  WASTE=750*TV2/14000
744      C   For each 14000 L deeptank there was approx 750 L acid added
745      PEWCOST=(TV2 + WASTE)/3.785
746      NaKWASTE=((SMOLE + MOLEK)/2.5)/3.785
747      NaWASTE=(SMOLE/2.5)/3.785
748      C   Cal vol of waste if boiled down to 2.5 M Na or Na + K
749      PEWCALNa=PEWCOST + 5*NaWASTE
750      PEWCALNaK=PEWCOST + 5*NaKWASTE
751      TOTCNa=PEWCALNa + TOTCOST
752      TOTCNaK=PEWCALNaK + TOTCOST
753      WRITE (1,605)
754      WRITE (1,603) NaWASTE,NaKWASTE
755      WRITE (1,601) PEWCALNa,PEWCALNaK
756      WRITE (1,602) TOTCNa,TOTCNaK
757      C   Assumes all solns go to PEW
758      IF (A .EQ. 1) STOP
759      64  WRITE (1,606)
760      WRITE (1,600) CALC
761      WRITE (1,583) (TOTCOST+CALC)
762      C   Assumes all solution goes to calciner and includes chem cost
763      C   Assuming calcination cost is approximately $5 per gallon feed
764      IF (A .EQ. 2) STOP
765      65  BL=TOTB/TOTV2
766      MPEW=(MOLEK+SMOLE-TmoleNa-TmoleK)/PEWV
767      MOLENAK=MPEW*PEWV
768      PEWVNAK=MOLENAK/2.5
769      IF (CALV.NE.0) GOTO 61
770      MCALC=0
771      GOTO 62
772      61  MCALC=(TmoleNa+TmoleK)/CALV
773      62  BLENDV=(MPEW*PEWV/.2)-PEWV/10

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774      TDV=CALV+PEWVNAK
775      CST=TOTCOST+PEWV*1.0/3.785+TDV*5/3.785
776      WRITE (1,607)
777      WRITE (1,589) PEWV,PEWVNAK,PEWVNAK/3.785,CALV,MCALC,
778      & CALV/3.785,TDV,(MOLEK+SMOLE)/TDV,TDV/3.785,CST
779 589  FORMAT (T6,"Waste vol to PEW",9X,I7,1X,"L",
780      & T43,"Reduced to",1X,I7,1X,"L",2X,"2.5 M Na K",
781      & 3X,I7,1X,"gal",/,
782      & T6,"Waste vol bypassing PEW",2X,I7,1X,"L",2X,F4.2,1X,"M Na K",
783      & T54,I7,1X,"gal",/,
784      & T6,"Total tank farm vol",6X,I7,1X,"L",2X,F4.2,1X,"M Na K",
785      & T54,I7,1X,"gal",/,
786      & T6,"Cost w/o labor",T31,I7,1X,"$",T44,"PEW $/gal",
787      & T59,"Calcine $ 5/gal")
788  C    Includes chem cost
789  C    PEW limits are 4.5 mCi Beta/L or 1E+7 beta/min*ml
790 540  FORMAT (//,T2,"Waste Analysis")
791 550  FORMAT (/,T10,"Unprocessed",/,T12,"Volume of Waste",T45,I7,1X,
792      & "L",6X,I6,1X,"gal")
793 585  FORMAT (T15,61("-"))
794 570  FORMAT (T12,"Wt of chemicals w/o HNO3",T45,I7,1X,"Kg",5X,
795      * I6,1X,"lbs",)
796 575  FORMAT (T12,"Moles of Na+ ; Molarity",T44,I8,1X,"moles",T59,
797      & F7.2,1X,"M")
798 580  FORMAT (T12,"Moles of K+ ; Molarity",T44,I8,1X,"moles",T59,
799      & F7.2,1X,"M")
800 582  FORMAT (T12,"Moles Na+ plus K+ ; Molarity",T44,I8,1X,"moles",
801      & T59,F7.2,1X,"M")
802 586  FORMAT (T12,"Chemical cost 1982 $",T44,I8,1X,"$")
803 600  FORMAT (T12,"Calcine cost $ 5/gal",T44,I8,1X,"$")
804 583  FORMAT (T12,"Decon cost w/o labor",T44,I8,1X,"$")
805 601  FORMAT (T12,"PEW + Calcine ($1 & $5/gal)",T44,I8,1X,"$ Na",
806      * T59,I8,1X,"$ Na + K")
807 602  FORMAT (T12,"Decon cost w/o labor",T44,I8,1X,"$ Na",T59,
808      * I8,1X,"$ Na + K")
809 603  FORMAT (T12,"Vol of 2.5 M waste",T44,I8,1X,"gal Na",T59,
810      * I8,1X,"gal Na + K")
811 605  FORMAT (/,T4,"Processed waste - assumed all went to PEW")
812 606  FORMAT (/,T4,"Processed waste - assumed all bypassed PEW")
813 607  FORMAT (/,T4,"Processed waste - mixed PEW & tankfarm, assumed",
814      & 1X,"decision point was at cell")
815 660  FORMAT (/,T61,"KMnO4",T68,"KOH",T74,"NaOH",/,T20,"KMnO4",
816      * T27,"Citric",T35,"Oxalic",T43,"NH Oxal",T52,"Tart A",T63,
817      * "K+",T69,"K+",T74,"Na+",T82,"Kg",T90,"L")
818 663  FORMAT (T4,"H2O",T85,I8)
819 666  FORMAT (T4,"HNO3 ",T79,I5,T85,I8)
820 670  FORMAT (T4,"KMnO4/HNO3",T19,I5,T59,I5,T79,I5,T85,I8)
821 680  FORMAT (T4,"4521",T26,I5,T34,I5,T44,I5,T79,I5,T85,I8)
822 690  FORMAT (T4,"4502",T19,I5,T59,I5,T66,I5,T73,I5,T79,I5,T85,I8)
823 700  FORMAT (T4,"Citrox",T26,I5,T34,I5,T79,I5,T85,I8)
824 710  FORMAT (T4,"Tart A/NaOH",T52,I5,T73,I5,T79,I5,T85,I8)
825 584  FORMAT (//,T2,"Chemical Analysis (Kg)")
826 720  FORMAT (T4,"4324",T73,I5,T79,I5,T85,I8)
827 721  FORMAT (T4,"Oxalic/HNO3",T34,I5,T79,I5,T85,I8)
828 722  FORMAT (T4,"NH4OH",T13,I5,T79,I5,T85,I8)
829 723  FORMAT (T4,"EDTA/NaOH",T13,I5,T73,I5,T79,I5,T85,I8)
830 724  FORMAT (T4,"ARR",T73,I5,T79,I5,T85,I8)
830.2 725  Format (T4,"HF/HNO3",T13,I5,T79,I5,T85,I8)
831 730  FORMAT (T4,"Oxalic A",T34,I5,T79,I5,T85,I8)
832 735  FORMAT (T4,"Citric A",T26,I5,T79,I5,T85,I8)

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833 737 FORMAT (T4,"Totals",T19,I5,T26,I5,T34,I5,T44,I5,T52,I5,
834 * T59,I5,T66,I5,T73,I5,T79,I6,T86,I7)
835 770 FORMAT (/T4,"Approx. pH of waste",T24,F6.1)
836 775 FORMAT (T4,90("-"))
837 790 FORMAT (T4,"Number of flushes",T26,I4)
838 792 FORMAT (T4,"Samples taken",T26,I4)
839 587 FORMAT (T6,"Waste Volume after PEW",T29,I7,1X,"L",T47,I7,1X,
840 & "gal")
841 70 IF (EST.EQ.0) GOTO 50
842 GOTO 99
843 50 DISPLAY " Do you want estimates. Y/N "
844 ANS="Y"
845 ACCEPT ANS
846 IF (ANS.EQ."N") GOTO 99
847 IF (ANS.NE."Y" .AND. ANS.NE."N") GOTO 50
848 51 CALL SUB5 (I1,RAWDATA,RAWDATA)
849 WRITE (1,115) FILE
850 EST=5
851 GOTO 75
852 C
853 100 FORMAT (E9.3,E12.3,F10.2,F10.2)
854 105 FORMAT (//,T32,"ESTIMATED VALUES BASED ON AVERAGES",//)
855 110 FORMAT (/T20,A20,1X,"FILE AS READ IN",//,T4,A6,T11,A6,T19,A6,
856 * T27,A6,T35,A6,T43,A6,T51,A6,T59,A6,T67,A6,T74,A6,T80,A6,T86,
857 * A6,T94,A6,T99,A6,T106,A6,T114,A6,T121,A6,/,T11,"dps/ml",T20,
858 * "dps",T28,"dps",T36,"dps",T44,"dps",T52,"dps",T60,"dps",T68,
859 * "dps",T76,"L",T85,"dpm/ml",T94,"g/L",T100,"% wt",T107,"% wt",
860 * T114,"mR/hr",T122,"#",/)
861 115 FORMAT (//,T20,A20,/)
862 120 FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,
863 * 1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,2X,
864 * E7.2,1X,F5.1,2X,F5.2,2X,F5.2,1X,I6,4X,I3)
865 130 FORMAT (//,T20,"NM FILE AS READ IN",//,T28,"chm 1",T38,
866 * "chm 2",/,T2,"mR/hr*dps",T15,"ug/dps",T28,"$/Kg",T38,"$/Kg",
867 * T48,"Soln",/)
868 140 FORMAT (E9.3,E12.3,F10.2,F10.2,5X,I2,2X,A13)
869 150 FORMAT (//,T2,"DECON INFORMATION ON",1X,A20)
870 160 FORMAT (//,T2,"Percentage Information based on per flush",
871 * 1X,"% direction across rows, -->",/)
872 170 FORMAT (//," ",1X,"% -->")
873 180 FORMAT (//,T2,"Percentage Information based on total.")
874 200 FORMAT (//,T2,"Individual Isotope Information",/)
875 205 FORMAT (T15,"Beta",T23,I8)
876 210 FORMAT (//,T2,"% Isotope Information",/)
877 230 FORMAT (//,T2,"Solution Information - curies",/)
878 240 FORMAT (//,T2,"Solution Information - mg",/)
879 250 FORMAT (//,T2,"Solution Information - R/hr",/)
880 260 FORMAT (//,T2,"% Solution Information curies % -->",/)
881 270 FORMAT (//,T2,"% Solution Information mg % -->",/)
882 280 FORMAT (//,T2,"% Solution Information R/hr % -->",/)
883 290 FORMAT (//,T2,"% Solution Info. curies, mg, R/hr ",
884 * " % down columns",/)
885 300 FORMAT (//,T2,"% Solution Info. curies/tot curies",/)
886 310 FORMAT (T4,"Tot",2X,8(F4.1,4X),/,T4,104("-"))
887 320 FORMAT (//,T2,"% Solution Info. mg/tot mg",/)
888 330 FORMAT (//,T2,"% Solution Info. R/hr/tot R/hr",/
889 * )
890 340 FORMAT (//,T2,"General Solution Information",/)
891 350 FORMAT(T17,"gamma",T27,"gamma",T37,"UDS",T47,"gamma",T57,
892 * "beta",T68,"Cost",/,T5,"Log #",T17,"mR/hr",T28,"ug",T38,"g",

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893      * T47,"mcurie",T56,"mcurie",T69,"$",T74,"Proc",T80,"Soln",
894      * T96,"Vol-L")
895 360  FORMAT (T4,98("-"))
896 370  FORMAT (T5,I6,T13,4(I8,2X),I8,2X,I7,4X,I3,3X,A13,2X,I6)
897 380  FORMAT (T6,"Total",T13,4(I8,2X),I9,2X,I7,3X,I5X,I7)
898 390  FORMAT (//,T2,"x/L",/)
899 400  FORMAT (T5,I6,T15,4(F7.2,3X),F8.2,2X,F6.2,4X,I3,3X,A13,3X,I5)
900 402  FORMAT (T14,63("-"))
901 404  FORMAT (T6,"Pr Total",T15,4(F7.2,3X),F8.2,2X,F6.2,4X,I3,18X,I6)
902 405  FORMAT (T5,I6,T15,4(F7.2,3X),F8.2,2X,F6.1,2X,F6.2,4X,I3,3X,A13,
903      * 4X,I5)
904 407  FORMAT (T6,"Total",T15,4(F7.2,3X),F8.2,2X,F6.1,2X,F6.2,24X,I7)
905 410  FORMAT (//,T2,"General Solution Information %",/)
906 420  FORMAT (//,T2,"Solution Summary",/)
907 430  FORMAT (T17,"gamma",T27,"gamma",T37,"UDS",T47,"gamma",
908      * T57,"beta",T68,"Cost",/,T17,"R/hr",T28,"mg",T38,"g",T47,
909      * "curie",T57,"curie",T69,"$",T80,"Soln",T92,"Vol-L")
910 440  FORMAT (T14,88("-"))
911 445  FORMAT (T14,98("-"))
912 447  FORMAT (T3,109("-"))
913 450  FORMAT (T14,4(I7,3X),I8,2X,I7,3X,A13,3X,I6)
914 460  FORMAT (//,T2,"Solution Summary %",/)
915 470  FORMAT (T14,6(F7.1,3X),A13,3X,F6.1)
916 475  FORMAT (//,T2,"Solution Summary x/L",/)
917 480  FORMAT (T17,"gamma",T27,"gamma",T38,"UDS",T47,"gamma",T58,
918      * "beta",T76,"Cost",/,T5,"Log #",T16,"mR/hr*L",T27,"ug/L",T38,
919      * "g/L",T46,"mcurie/L",T57,"mcurie/L",T68,"B/L",T77,"$/L",T82,
920      * "Proc",T89,"Soln",T102,"Tot Vol-L")
921 485  FORMAT (T18,"gamma",T29,"gamma",T41,"UDS",T50,"gamma",T62,
922      * "beta",T80,"Cost",/,T17,"mR/hr*L",T29,"ug/L",T41,"g/L",
923      * T49,"mcurie/L",T61,"mcurie/L",T72,"B/L",T81,"$/L",T87,"Soln",
924      * T101,"Tot Vol-L")
925 C490  FORMAT (T15,4(F7.1,4X),F8.2,2X,F6.1,2X,F6.2,4X,A13,4X,I7)
926 492  FORMAT (T15,4(F7.1,4X),F8.2,10X,F6.2,21X,I7)
927 C485  FORMAT (T17,"gamma",T27,"gamma",T37,"UDS",T46,"gamma",T58,
928 C      * "beta",T76,"Cost",/,T16,"mR/hr*L",T27,"ug/L",T37,
929 C      * "g/L",T45,"mcurie/L",T57,"mcurie/L",T68,"B/g",T77,"$/L",T87,
930 C      * "Soln",T101,"Tot Vol-L")
931 490  FORMAT (T15,4(F7.1,4X),F8.2,2X,F6.1,2X,F6.2,4X,A13,4X,I7)
932 C495  FORMAT (T6,"Total",T15,4(F7.1,4X),F8.2,2X,F6.1,2X,F6.2,19X,I7)
933 500  FORMAT (//,T2,"Cost Summary x/$",/)
934 510  FORMAT (T17,"gamma",T27,"gamma",T37,"UDS",T47,"gamma",T57,
935      * "beta",T68,"cost",/,T16,"mR/hr/$",T27,"ug/$",T37,"g/$",T46,
936      * "mcurie/$",T56,"mcurie/$",T69,"$",T80,"Soln",T91,"Tot Vol-L"
937      * )
938 520  FORMAT (T15,5(I6,4X),I6,4X,A13,4X,I5)
939 530  FORMAT (//,T6,"Equation for log Ru(dps) vs treatment",T60,
940      * "Equation for log B(dpm) vs treatment",/,T10,"slope",T20,F9.4,
941      * T64,"slope",T74,F9.4,/,T10,"intercept",T20,F9.4,T64,
942      * "intercept",T74,F9.4,/,T10,"r",T20,F9.4,
943      * T64,"r",T74,F9.4)
944 99    STOP
945      END
946 C
947      SUBROUTINE SB1 (I2,RD,X,Y,B,Z2,Z3,S,T,IS,SL,TB,C,TV,SK,AP)
948      DIMENSION RD(100,17),X(100,8),B(100),Pr(12)
949      REAL Y(100),Z2,Z3,S(8),T,TB
950      INTEGER C
951      CHARACTER IS*6(8),AP
952      CHARACTER SL*13(15)

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953      N=0
954      IF (Z2.EQ.1) GOTO 1
955      IF (Z2.EQ.2) GOTO 2
956      IF (Z2.EQ.3) GOTO 3
957      IF (Z2.EQ.4) GOTO 5
958      IF (Z2.EQ.5) GOTO 7
959      IF (Z2.EQ.6) GOTO 8
960      GOTO 9
961  1      CALL COUNT(C)
962          WRITE (1,20)
963          WRITE (1,25) (IS(I),I=1,8,1)
964      GOTO 11
965  2      CALL COUNT(C)
966          WRITE (1,45)
967  4      WRITE (1,50) (IS(I),I=1,8,1)
968      GOTO 11
969  3      CALL COUNT(C)
970          WRITE (1,65)
971      GOTO 4
972  5      CALL COUNT(C)
973          WRITE (1,70)
974          WRITE (1,25) (IS(I),I=1,8)
975          Z2=1
976          N=1
977      GOTO 11
978  7      CALL COUNT (C)
979          WRITE (1,22)
980          WRITE (1,26) (IS(I),I=1,8)
981      GOTO 11
982  8      CALL COUNT (C)
983          WRITE (1,47)
984          WRITE (1,50) (IS(I),I=1,8)
985      GOTO 11
986  9      CALL COUNT (C)
987          WRITE (1,67)
988          WRITE (1,50) (IS(I),I=1,8)
989  11      PROC=RD(1,17)
990          DO 18 I=1,12
991              Pr(I)=0
992  18      CONTINUE
993          DO 12 I=1,12
994              IF (AP.EQ."N" .OR. SK.EQ.7) GOTO 19
995              IF (PROC.EQ.RD(1,17)) GOTO 19
996  128      WRITE (1,129)
997              IF (Z2.EQ.1 .AND. Z3.EQ.1) GOTO 120
998              IF (Z2.EQ.1) GOTO 121
999              IF (Z2.EQ.5) GOTO 122
1000          IF (Z2.GT.5) GOTO 123
1001          IF (Z2.GT.1 .AND. Z3.EQ.1) GOTO 124
1002          IF (Z2.GT.1) GOTO 125
1003  120      WRITE (1,31) (Pr(L),L=1,10),PROC,Pr(11)
1004          GOTO 148
1005  121      WRITE (1,33) (Pr(L),L=1,10),PROC,Pr(11)
1006          GOTO 148
1007  122      WRITE (1,38) (Pr(L)/Pr(11),L=1,10),Pr(10)/Pr(9),PROC,Pr(11)
1008          GOTO 148
1009  123      WRITE (1,61) (Pr(L)/Pr(11),L=1,9),PROC,Pr(11)
1010          GOTO 148
1011  124      WRITE (1,56) (Pr(L),L=1,9),PROC,Pr(11)
1012          GOTO 148

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1013 125      WRITE (1,58) (Pr(L),L=1,9),PROC,Pr(11)
1014 148      IF (1.EQ.12) GOTO 12
1015      DO 130 L=1,12
1016          Pr(L)=0
1017 130      CONTINUE
1018      PROC=RD(1,17)
1019      WRITE (1,129)
1020  C
1021 19      IF (RD(1,1).EQ.0) GOTO 12
1022      K=RD(1,11)
1023      FV= RD(1,10)
1024      IF (B(1) .EQ. 0) YB=0
1025      IF (B(1) .GT. 0) YB=Y(1)/B(1)
1026      gBT=gBT+ YB
1027      IF (Z2.EQ.5) GOTO 14
1028      IF (Z2.GT.5) GOTO 15
1029      IF(Z2.EQ.1 .AND. Z3.EQ.1) WRITE (1,30) RD(1,1),(X(1,J),
1030  *          J=1,8,1),Y(1),B(1),RD(1,17),SL(K)
1031      IF (Z2.EQ.1 .AND. Z3.GT.1) WRITE (1,32) RD(1,1),(X(1,J),
1032  *          J=1,8,1),Y(1),B(1),RD(1,17),SL(K)
1033      IF(Z2.GT.1 .AND.Z3.EQ.1) WRITE (1,55) RD(1,1),(X(1,J),
1034  *          J=1,8,1),Y(1),RD(1,17),SL(K)
1035      IF(Z2.GT.1 .AND. Z3.GT.1) WRITE (1,57) RD(1,1),(X(1,J),
1036  *          J=1,8,1),Y(1),RD(1,17),SL(K)
1037      GOTO 13
1038 14      IF (Y(1).EQ.0) A=0
1039      IF (Y(1).EQ.0) GOTO 10
1040      A=B(1)/Y(1)
1041 10      WRITE (1,34) RD(1,1),(X(1,J)/FV,J=1,8),Y(1)/FV,
1042  *          B(1)/FV,A,RD(1,17),SL(K)
1043      GOTO 13
1044 15      WRITE (1,59) RD(1,1),(X(1,J)/FV,J=1,8),Y(1)/FV,RD(1,17),
1045  *          SL(K)
1046 13      IF (AP.EQ."N") GOTO 12
1047      DO 52 L=1,8
1048          Pr(L)=Pr(L)+X(1,L)
1049 52      CONTINUE
1050          Pr(9)=Pr(9)+Y(1)
1051          Pr(10)=Pr(10)+B(1)
1052          Pr(11)=Pr(11)+FV
1053      IF (RD(1,17).EQ.RD(1,17) .AND. 1.EQ.12) GOTO 12
1054      IF (1.EQ.12 .AND. SK.NE.7) GOTO 128
1055 12      CONTINUE
1056      IF (Z2.EQ.5) GOTO 16
1057      IF (Z2.GT.5) GOTO 17
1058      IF (N.EQ.1) GOTO 6
1059      IF (Z2.EQ.1 .AND. Z3.EQ.1) WRITE (1,35) (S(1),I=1,8,1),T,TB
1060      IF (Z2.EQ.1 .AND. Z3.GT.1) WRITE (1,36) (S(1),I=1,8,1),T,TB
1061 6      IF (Z2.EQ.1) WRITE (1,37)
1062      IF (Z2.GT.1 .AND. Z3.EQ.1) WRITE (1,60) (S(1),I=1,8,1),T
1063      IF (Z2.GT.1 .AND. Z3.GT.1) WRITE (1,62) (S(1),I=1,8,1),T
1064      IF (Z2.GT.1) WRITE (1,40)
1065      GOTO 99
1066 16      WRITE (1,36) (S(1)/TV,I=1,8),T/TV,TB/TV,TB/T
1067      WRITE (1,37)
1068      GOTO 99
1069 17      WRITE (1,62) (S(1)/TV,I=1,8),T/TV
1070      WRITE (1,40)
1071  C
1072 20      FORMAT (//,T2,"mCurie Information",/)

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1073 22  FORMAT (//,T2,"mCi/L",/)
1074 25  FORMAT (4X,"Log #",T14,8(A6,2X),"Total",5X,"mCi Beta",2X,
1075      * "Proc",3X,"Soln",/,T4,112("-"))
1076 26  FORMAT (4X,"Log #",T14,8(A6,2X),"Total",5X,"mCi Beta",3X,
1077      * "B/L",2X,"Proc",4X,"Soln",/,T4,112("-"))
1078 30  FORMAT (T4,I6,2X,9(I7,1X),3X,I8,4X,I3,3X,A13)
1079 32  FORMAT (T4,I6,2X,9(F6.1,2X),3X,F6.1,6X,I3,3X,A13)
1080 34  FORMAT (T4,I6,2X,9(F7.2,1X),4X,F7.2,2X,F5.1,3X,I3,3X,A13)
1081 35  FORMAT (T4,112("-"),/,T5,"Total",T12,9(I7,1X),2X,I9)
1082 36  FORMAT(T4,112("-"),/,T5,"Total",T11,8(F7.1,1X),I7,3X,I9,
1083      * 4X,F4.1)
1084 37  FORMAT (T4,112("-"))
1085 40  FORMAT (T4,98("-"))
1086 45  FORMAT (//,T2,"ug Information",/)
1087 47  FORMAT (//,T2,"ug/L",/)
1088 50  FORMAT (4X,"Log #",T14,8(A6,2X),"Total",2X,"Proc",4X,
1089      * "Soln",/,T4,98("-"))
1090 55  FORMAT (T4,I6,2X,9(I7,1X),2X,I3,3X,A13)
1091 57  FORMAT (T4,I6,2X,9(F6.1,2X),2X,I3,3X,A13)
1092 59  FORMAT (T4,I6,2X,9(F7.2,1X),2X,I3,3X,A13)
1093 60  FORMAT (T4,98("-"),/,T5,"Total",T12,8(I7,1X),I8)
1094 62  FORMAT (T4,98("-"),/,T5,"Total",T11,8(F7.1,1X),I8)
1095 65  FORMAT (//,T2,"mR/hr Information",/)
1096 67  FORMAT (//,T2,"mR/hr*L",/)
1097 70  FORMAT (T2,"% Info mcuries,ug,mR/hr, % direction",
1098      * " down columns",/)
1099 31  FORMAT (T5,"Total",2X,9(I7,1X),3X,I8,4X,I3,2X,I8,1X,"L")
1100 33  FORMAT (T5,"Total",2X,9(F6.1,2X),3X,F6.1,6X,I3,2X,I8,1X,"L")
1101 38  FORMAT (T5,"Total",2X,9(F7.2,1X),5X,F6.2,3X,F4.1,3X,I3,2X,I8,
1102      * 1X,"L")
1103 61  FORMAT (T5,"Total",2X,9(F7.2,1X),2X,I3,2X,I8,1X,"L")
1104 56  FORMAT (T5,"Total",2X,9(I7,1X),2X,I3,2X,I8,1X,"L")
1105 58  FORMAT (T5,"Total",2X,9(F6.1,2X),2X,I3,2X,I8,1X,"L")
1106 129 FORMAT (T12,90("-"))
1107 127 FORMAT (" ")
1108 99  RETURN
1109  END
1110  C
1111  C
1112  C
1113  SUBROUTINE SUB2(IS,X,Y,Z,SL,Z2,TV)
1114  DIMENSION X(15,8),Y(15),Z(15)
1115  CHARACTER SL*13(15),IS*6(8)
1116  T=1000
1117  C  GOTO 9
1118  IF (Z2.EQ.3) GOTO 1
1119  WRITE (1,130) (IS(I),I=1,8,1)
1120  GOTO 2
1121  1  WRITE (1,160) (IS(I),I=1,8)
1122  2  DO 3 I=1,15
1123      IF (Z(I).EQ.0) GOTO 3
1124      IF (Z2.EQ.1) WRITE (1,100) (X(I,J)/T,J=1,8),Y(I)/T,
1125          * SL(I),Z(I)
1126      IF (Z2.EQ.2) WRITE (1,140) (X(I,J),J=1,8),Y(I),SL(I),Z(I)
1127      IF (Z2.EQ.3) WRITE (1,170) (X(I,J),J=1,8),SL(I),Z(I)
1128      IF (Z2.EQ.4) WRITE (1,180) (X(I,J)/Z(I),J=1,8),
1129          * Y(I)/Z(I),SL(I),Z(I)
1130  3  CONTINUE
1131  WRITE (1,120)
1132  GOTO 99

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1133 100 FORMAT (T6,9(I7,1X),5X,A13,T98,I6)
1134 120 FORMAT (" ",T4,104(" "))
1135 130 FORMAT (T8,8(A6,2X),"Total",6X,"Soln",10X,
1136 * "Total Vol",/,," ",T4,104(" "))
1137 140 FORMAT (T6,9(F7.1,1X),5X,A13,T98,F6.1)
1138 160 FORMAT (T8,8(A6,2X),11X,"Soln",10X,"Total Vol",/,," ",T4,
1139 * 104(" "))
1140 170 FORMAT (T6,8(F7.1,1X),13X,A13,T98,F6.1)
1141 180 FORMAT (T6,9(F7.2,1X),5X,A13,T98,I6)
1142 9 WRITE (1,11) (SL(I),I=1,9)
1143 WRITE (1,14)
1144 DO 30 J=1,8
1145 WRITE (1,13) IS(J),(X(I,J),I=1,8)
1146 30 CONTINUE
1147 WRITE (1,14)
1148 WRITE (1,15) (Y(I),I=1,8)
1149 WRITE (1,14)
1150 WRITE (1,16) (Z(I),I=1,8)
1151 11 FORMAT (//,T12,"Soln",T27,A6,T36,A6,T44,A6,T56,A6,T66,A6,T74,
1152 * A6,T84,A6,T96,A6,T104,A6)
1153 13 FORMAT (T12,A6,T20,T22,I8,T32,I8,T42,I8,T52,I8,T62,I8,T72,I8,
1154 * T82,I8,T92,I8,T102,I8)
1155 14 FORMAT (T12,112(" "))
1156 15 FORMAT (T12,"Totals",T22,8(I8,2X))
1157 16 FORMAT (T12,"Tot vol",T22,8(I8,2X))
1158 99 RETURN
1159 END
1160 C
1161 C
1162 C
1163 SUBROUTINE SUB3 (IS,X,Y,Z,TmC,Tmg,TR,Z2,TV)
1164 DIMENSION X(8),Y(8),Z(8)
1165 CHARACTER IS*6(8)
1166 T=1000
1167 IF (Z2.EQ.3) GOTO 5
1168 WRITE (1,100)
1169 WRITE (1,120)
1170 IF (Z2.EQ.2) GOTO 1
1171 C
1172 DO 2 I=1,8
1173 WRITE (1,130) IS(I),X(I)/T,Y(I)/T,Z(I)/T
1174 2 CONTINUE
1175 WRITE (1,120)
1176 WRITE (1,140) TmC/T,Tmg/T,TR/T
1177 WRITE (1,120)
1178 GOTO 99
1179 C
1180 5 WRITE (1,110)
1181 WRITE (1,120)
1182 DO 6 I=1,8
1183 WRITE (1,135) IS(I),X(I)/TV,Y(I)/TV,Z(I)/TV
1184 6 CONTINUE
1185 WRITE (1,120)
1186 WRITE (1,145) TmC/TV,Tmg/TV,TR/TV
1187 WRITE (1,120)
1188 GOTO 99
1189 C
1190 1 DO 3 I=1,8
1191 WRITE (1,190) IS(I),X(I),Y(I),Z(I)
1192 3 CONTINUE

```

```

1193      WRITE (1,120)
1194      C
1195      100  FORMAT (/,T29,"Ci",T38,"mg",T44," R/hr")
1196      110  FORMAT (/,T27,"mCi/L",T36,"ug/L",T43,"mR/hr*L")
1197      130  FORMAT (T15,A6,T24,3(I7,2X))
1198      135  FORMAT (T15,A6,T24,3(F7.1,2X))
1199      140  FORMAT (T15,"Total",T23,3(I8,1X))
1200      145  FORMAT (T15,"Total",T23,3(F8.1,1X))
1201      120  FORMAT (T15,34("-"))
1202      190  FORMAT (T15,A6,T24,3(F7.1,2X))
1203      99   RETURN
1204      END
1205      C
1206      C
1207      SUBROUTINE SUB4 (LB,RAWDATA,K2)
1208      REAL NUM
1209      DIMENSION RAWDATA(100,17)
1210      1     DO 2 I=1,100
1211           DO 3 J=1,17
1212               RAWDATA(I,J)=0
1213      3     CONTINUE
1214      2     CONTINUE
1215           DO 4 I=1,100
1216               READ (901,100,END=5) (RAWDATA(I,J),J=1,17)
1217      4     CONTINUE
1218      5     K=I
1219           K2=K-1
1220           IF (K2.EQ.100) DISPLAY "Only 100 flushes read"
1221      100   FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
1222      * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,1X,E7.2,1X,F5.1,1X,F5.2,1X,
1223      * F5.2,1X,I6,1X,I3)
1224      99   RETURN
1225      END
1226      C
1227      C
1228      SUBROUTINE SUB5 (I2,RD,Z)
1229      DIMENSION RD(100,15),RDSLN(15,13),RDT(13),AVSLRD(15,13),
1230      * AVR(13),COUNT(15),Z(100,15),T(100),KN(15),VOL(15),
1231      * VOLSNG(15)
1232      C
1233      C*****
1234      C      *
1235      C      T(I)      is the sum of the gamma for a flush      *
1236      C      K          is the solution number                  *
1237      C      COUNT(K)   is the # of flushes of soln k w log #    *
1238      C      N          is the # of flushes w/o gamma scan      *
1239      C      KN(K)      is the # of flushes of soln k w/o gamma  *
1240      C      COUNTTOT   is the total # of flushes with log #'s  *
1241      C      VOL(K)     is the volume of soln K w log #s        *
1242      C      VOLT       is the total volume of sampled flushes  *
1243      C      VOLSNG(K)  is the volume of sampled soln k w/o gamma *
1244      C      VOLSNGT    is the total vol of sampled flushes w/o gamma *
1245      C      VOLNST     is the total vol of flushes w/o log #s  *
1246      C      *
1247      C*****
1248      C
1249      COUNTTOT=0
1250      VOLT=0
1251      VOLNST=0
1252      VOLSNGT=0

```



```

1253      N=0
1254      DO 1 I=1,12
1255          T(I)=0
1256      1    CONTINUE
1257      DO 2 I=1,12
1258          DO 3 J=2,9
1259              T(I)=T(I)+RD(I,J)
1260      3    CONTINUE
1261      2    CONTINUE
1262      DO 4 I=1,15
1263          COUNT(I)=0
1264          KN(I)=0
1265          VOL(I)=0
1266          VOLSNG(I)=0
1267          DO 5 J=1,13
1268              RDSLNI(I,J)=0
1269              AVSLRD(I,J)=0
1270      5    CONTINUE
1271      4    CONTINUE
1272      DO 6 I=1,13
1273          RDT(I)=0
1274          AVRDI(I)=0
1275      6    CONTINUE
1276      DO 7 I=1,12
1277          IF (RDI(I,1).EQ.0) VOLNST=VOLNST+RDI(I,10)
1278          IF (RDI(I,1).EQ.0) GOTO 7
1279          K=RDI(I,11)
1280          COUNT(K)=COUNT(K)+1
1281          COUNTTOT=COUNTTOT+1
1282          VOL(K)=VOL(K)+RDI(I,10)
1283          VOLT=VOLT+RDI(I,10)
1284          IF(T(I).EQ.0) GOTO 8
1285      GOTO 9
1286      8    N=N+1
1287          KN(K)=KN(K)+1
1288          VOLSNG(K)=VOLSNG(K)+RDI(I,10)
1289          VOLSNGT=VOLSNGT+RDI(I,10)
1290      9    DO 10 J=2,9
1291              RDSLNI(K,J)=RDSLNI(K,J)+RDI(I,J)*RDI(I,10)
1292              RDT(J)=RDT(J)+RDI(I,J)*RDI(I,10)
1293      10    CONTINUE
1294          DO 11 J=12,13
1295              RDSLNI(K,J)=RDSLNI(K,J)+RDI(I,J)*RDI(I,10)
1296              RDT(J)=RDT(J)+RDI(I,J)*RDI(I,10)
1297      11    CONTINUE
1298      7    CONTINUE
1299      DO 12 K=1,15
1300          IF (COUNT(K).EQ.0) GOTO 12
1301          IF (COUNT(K).EQ.KN(K)) GOTO 15
1302      C      (If there is no soln k .or. # flshs of soln k = #
1303      C      flshs of soln k w/o gamma) goto 12
1304          IF (KN(K).GT.0) GOTO 13
1305      C      (If # flshs of soln K w/o g .GT.0) goto 13
1306      C      Only solns with gamma results go to nest step
1307          DO 14 J=2,9
1308              AVSLRD(K,J)=RDSLNI(K,J)/VOL(K)
1309      14    CONTINUE
1310      GOTO 15
1311      C      13 is ave of sons k w some flshs w/o gamma
1312      C      Vol(K)-Volsng(K)= vol of soln K w gamma

```



```

1313 13      DO 16 J=2,9
1314          AVSLRD(K,J)=RDSLN(K,J)/(VOL(K)-VOLSNG(K))
1315 16      CONTINUE
1316 15      DO 17 J=12,13
1317          AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
1318 17      CONTINUE
1319 12      CONTINUE
1320          DO 18 J=2,9
1321          AVRD(J)=RDT(J)/(VOLT-VOLSNGT)
1322 18      CONTINUE
1323          DO 19 J=12,13
1324          AVRD(J)=RDT(J)/VOLT
1325 19      CONTINUE
1326          DO 20 I=1,12,1
1327          IF (RD(I,1).GT.0 .AND. T(I).GT.0) GOTO 20
1328 C          Solns w log # and w gammas skip to 20
1329          IF (RD(I,1).GT.0) GOTO 21
1330          RD(I,1)=1
1331 21      K=RD(I,11)
1332 C          Working with flushes w/o log #s or no gammas
1333          IF (COUNT(K).EQ.0) GOTO 22
1334          IF (COUNT(K).EQ.KN(K)) GOTO 23
1335          DO 24 J=12,13
1336          IF (RD(I,J).GT. 0) GOTO 24
1337          RD(I,J)=AVSLRD(K,J)
1338 24      CONTINUE
1339          DO 25 J=2,9
1340          RD(I,J)=AVSLRD(K,J)
1341 25      CONTINUE
1342          GOTO 20
1343 C          If soln k has no samples then the ave of all is used
1344 22      DO 26 J=12,13
1345          RD(I,J)=AVRD(J)
1346 26      CONTINUE
1347 23      DO 27 J=2,9
1348          RD(I,J)=AVRD(J)
1349 27      CONTINUE
1350          IF (COUNT(K).EQ.0 .AND. COUNT(K).EQ.KN(K) ) GOTO 20
1351          IF (RD(I,1).EQ.1 .AND. COUNT(K).EQ.KN(K)) GOTO 30
1352          GOTO 20
1353 C          For a flush w/o sample, where there are other solns
1354 C          with beta but with no gamma, use soln ave for beta
1355 30      DO 31 J=12,13
1356          RD(I,J)=AVSLRD(K,J)
1357 31      CONTINUE
1358 20      CONTINUE
1359          DO 28 I=1,12
1360          DO 29 J=1,15
1361          Z(I,J)=RD(I,J)
1362 29      CONTINUE
1363 28      CONTINUE
1364 99      RETURN
1365      END
1366 C
1367 C
1368      SUBROUTINE COUNT(C1)
1369      INTEGER C1
1370      C1=C1+1
1371      WRITE (1,10) C1
1372 10      FORMAT (////,T2,120("-"),T124,"TABLE ",12)

```

```

1373      RETURN
1374      END
1375      C
1376      C
1377      SUBROUTINE DATAFILE
1378      CHARACTER*30 NAME,DATA3,PRNT,STRTSP,A*10,DEVN*5
1379      C
1380      DISPLAY " File name to be accessed"
1381      ACCEPT A
1382      DISPLAY "Printer dev number (local=144,lp=6;default=144)"
1383      DEVN="144"
1384      ACCEPT DEVN
1385      C
1386      NAME[1:11]="FILE FTN09="
1387      NAME[12:10]=A
1388      NAME[22:4]=",OLD"
1389      NAME[26:1]=%15C
1390      DATA3[1:18]="FILE FTN03=ZNM,OLD"
1391      DATA3[19:1]=%15C
1392      PRNT[1:18]="FILE FTN01=LP;DEV="
1393      PRNT[19:4]=DEVN
1394      PRNT[23:1]=%15C
1395      STRTSP[1:14]="STARTSPOOL 144"
1396      STRTSP[15:1]=%15C
1397      C
1398      CALL COMMAND (NAME,11,12)
1399      CALL COMMAND (DATA3,11,12)
1400      CALL COMMAND (PRNT,11,12)
1401      CALL COMMAND (STRTSP,11,12)
1402      RETURN
1403      END

```

```

T ZRD
/L ALL
1  $CONTROL USLINIT,INIT,NOSOURCE
2  C
3  C  ZRD lists data offline
4  C  FTN09=(File name),OLD
5  C  FTN01;DEV=(Device #)
6  C
7      DIMENSION RAWDATA(790,17)
8  C
9      CHARACTER LABEL*6(17),FILE*20,ANS
10 C
11     DATA LABEL/"Log #","Ce144","Cs134","Cs137","Nb 95","Ru103",
12     * "Ru106","Sb125","Zr 95","Vol-L","Soln","Beta","uds",
13     * "% ch 1","% ch 2","mR/hr","Proc"/,Y/"Y"/,N/"N"/
14 C
15 C
16     CALL DATAFILE
17 C
18 C
19     I=16
20     DISPLAY "Print size 16,12,10"
21     ACCEPT I
22     IF (I.EQ.16) WRITE (1,101)
23     IF (I.EQ.12) WRITE (1,102)
24     IF (I.EQ.10) WRITE (1,103)
25     103     FORMAT ("")
26     102     FORMAT ("")
27     101     FORMAT ("")
28 C
29     DISPLAY "Report name"
30     ACCEPT FILE
31 C
32     2     DISPLAY "Do you want to run the program Y/N "
33     ANS="Y"
34     ACCEPT ANS
35     IF (ANS.EQ."N") GOTO 99
36     IF (ANS.NE."Y") GOTO 2
37 C
38     CALL SUB4 (LABEL,RAWDATA,I)
39     WRITE (1,110) FILE,(LABEL(I),I=1,17)
40     WRITE (1,120) ((RAWDATA(I,J), J=1,17,1), I=1,11,1)
41     WRITE (1,130)
42 C
43     110    FORMAT (/,T20,A20,1X,"FILE AS READ IN",//,T4,A6,T11,A6,T19,A6,
44     * T27,A6,T35,A6,T43,A6,T51,A6,T59,A6,T67,A6,T74,A6,T80,A6,T86,
45     * A6,T94,A6,T99,A6,T106,A6,T114,A6,T121,A6,/,T11,"dps/ml",T20,
46     * "dps",T28,"dps",T36,"dps",T44,"dps",T52,"dps",T60,"dps",T68,
47     * "dps",T76,"L",T85,"dpm/ml",T94,"g/L",T100,"% wt",T107,"% wt",
48     * T114,"mR/hr",T122,"#",/)
49     120    FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,
50     * 1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,2X,
51     * 1PE7.1,1X,OPF5.1,2X,F5.2,2X,F5.2,1X,I6,2X,I3)
52     130    FORMAT (//,T4,"Solutions",/,T6,"1. H2O",T24,"6. Citrox",T45,
53     * "11. Oxalic/HNO3",/,T6,"2. HNO3",T24,"7. Tartaric/NaOH",T45,
54     * "12. NH4OH",/,T6,"3. KMnO4/HNO3",T24,"8. 4324",T45,
55     * "13. EDTA/NaOH",/,T6,"4. 4521",T24,"9. Oxalic",T45,
56     * "14. ARR",/,T6,"5. 4502",T23,"10. Citric A",T45,"15. HF/HNO3")
57     99     STOP
58     END

```

```

59 C
60 C
61 C
62 SUBROUTINE SUB4 (LB,RAWDATA,K2)
63 REAL NUM
64 DIMENSION RAWDATA(790,17)
65 CHARACTER LB*6(17),ANS
66 1 DO 2 I=1,790
67 DO 3 J=1,17
68 RAWDATA(I,J)=0
69 3 CONTINUE
70 2 CONTINUE
71 DO 4 I=1,790
72 READ (9@I,100,END=5) (RAWDATA(I,J),J=1,17)
73 4 CONTINUE
74 5 K2=I-1
75 100 FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
76 * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,1X,E7.2,1X,F5.1,1X,F5.2,1X,
77 * F5.2,1X,I6,1X,I3)
78 99 RETURN
79 END
80 C
81 C
82 SUBROUTINE DATAFILE
83 CHARACTER*30 NAME,PRNT,STRTSP,A*10,DEVN*5
84 C
85 DISPLAY " File name to be accessed"
86 ACCEPT A
87 DISPLAY "Printer dev number (local=144,lp=6;default=144)"
88 DEVN="144"
89 ACCEPT DEVN
90 C
91 NAME[1:11]="FILE FTM09="
92 NAME[12:10]=A
93 NAME[22:4]=",OLD"
94 NAME[26:1]=%15C
95 PRNT[1:18]="FILE FTM01=LP;DEV="
96 PRNT[19:4]=DEVN
97 PRNT[23:1]=%15C
98 STRTSP[1:14]="STARTSPOOL 144"
99 STRTSP[15:1]=%15C
100 C
101 CALL COMMAND (NAME,I1,I2)
102 CALL COMMAND (PRNT,I1,I2)
103 CALL COMMAND (STRTSP,I1,I2)
104 RETURN
105 END

```

T ZSUMEA

/L ALL

```
1 $CONTROL USLINIT,INIT,NOSOURCE
2 $INTEGER*4
3 C
4 C NAME PROGRAM SHORT FORM (ZSUMEA)
5 C FILE FTN03=ZNM,OLD
6 C FILE FTN09=(FILE TO BE ACCESSED),OLD
7 C FILE FTN01;DEV=LP;CCTL
8 C
9 DIMENSION RAWDATA(790,16),CNVRSNDT(15,4),
10 * RISO(8),DPSISO(8),
11 * SLNTV(15),COSTSLN(15),SLNNO(15)
12 C
13 REAL mgISO(8),mCURISO(8),TOTmC,KgSLN(15,2),KgT(15),Z,
14 * TOTmg,TOTR,LOGN,PmCIST(8),PmgIST(8),PRIST(8),MPEW,MCALC
15 C
16 CHARACTER ISO*6(8),ANS,LABEL*6(16),FILE*30
17 C
18 DATA ISO/"Ce144","Cs134","Cs137","Nb 95","Ru103","Ru106",
19 * "Sb125","Zr 95"/
20 C
21 C
22 CALL DATAFILE
23 C
24 I=16
25 DISPLAY "Print size 16,12,10"
26 ACCEPT I
27 IF (I.EQ.16) WRITE (1,101)
28 IF (I.EQ.12) WRITE (1,102)
29 IF (I.EQ.10) WRITE (1,103)
30 103 FORMAT ("")
31 102 FORMAT ("")
32 101 FORMAT ("")
33 C
34 DISPLAY " Report name"
35 ACCEPT FILE
36 DO 804 I=1,790
37 READ (901,800,END=805) (RAWDATA(I,J),J=1,16)
38 804 CONTINUE
39 805 K=I
40 K2=K-1
41 C=0
42 C
43 II=K2
44 1 DISPLAY K2,"flushes "
45 C
46 98 DISPLAY "Do you want to run the program Y/N "
47 ANS="Y"
48 ACCEPT ANS
49 IF (ANS.EQ."N") STOP
50 IF (ANS.NE."Y") GOTO 98
51 C
52 2 DISPLAY "Estimates only Y/N"
53 ANS="Y"
54 ACCEPT ANS
55 IF (ANS.EQ."Y") GOTO 51
56 IF (ANS.NE."N") GOTO 2
57 EST=2
58 C
```

```

59 3  DISPLAY "Include averaged data Y/N"
60     ANS="Y"
61     ACCEPT ANS
62     IF (ANS.EQ."N") GOTO 4
63     IF (ANS.NE."Y") GOTO 3
64     EST=3
65 C
66 4   DISPLAY "1. All went to PEW"
67     DISPLAY "2. All went to Tankfarm"
68     DISPLAY "3. Mixed, PEW & Tankfarm"
69     DISPLAY "4. Calc. all the above Processes"
70     DISPLAY "Waste Processing default = 4 "
71     A=4
72     ACCEPT A
73     IF (A.EQ.1 .OR. A.EQ.2 .OR. A.EQ.3) GOTO 6
74     IF (A.NE.4) GOTO 4
75 C
76 6   WRITE (1,115) FILE
77     DO 8 I=1,8,1
78         RISO(I)=0
79         DPSISO(I)=0
80         mgISO(I)=0
81         mCURISO(I)=0
82         PmgIST(I)=0
83         PmCIST(I)=0
84         PRIST(I)=0
85 8   CONTINUE
86     DO 9 I=1,15,1
87         SLNTV(I)=0
88         SLNNO(I)=0
89         COSTSLN(I)=0
90         KgT(I)=0
91         DO 11 J=1,2,1
92             KgSLN(I,J)=0
93 11   CONTINUE
94         DO 12 J=1,4
95             CNVRSNDT(I,J)=0
96 12   CONTINUE
97 9   CONTINUE
98     TOTmC=0
99     TOTR=0
100    TOTmg=0
101    TOTB=0
102    TOTV=0
103    TOTCOST=0
104    TOTCKg=0
105    NWS=0
106 C
107    DO 13 I=1,15
108        READ (3@I,100,END=14) (CNVRSNDT(I,J), J=1,4,1)
109 13   CONTINUE
110 C
111 14   DO 15 J=2,9
112        DO 16 I=1,11
113            LOGN=RAWDATA(I,1)
114            IF (LOGN.EQ.0) GOTO 16
115            IF (LOGN.EQ.1 .AND. EST.LE.2) GOTO 16
116            DPSISO(J-1)=DPSISO(J-1)+RAWDATA(I,J)*RAWDATA(I,10)
117            *1000
117.2 C Multiplying by 1000 converts ml to L

```

```

118 16      CONTINUE
119 15      CONTINUE
120        DO 19 I=1,8
121          mCURISO(I)=DPSISO(I)/3.7E7
122          RISO(I)=DPSISO(I)*CNVRSNDT(I,1)
123          mgISO(I)=DPSISO(I)*CNVRSNDT(I,2)
124 19      CONTINUE
125        DO 20 I=1,8
126          TOTmC=TOTmC+mCURISO(I)
127          TOTmg=TOTmg+mgISO(I)
128          TOTR=TOTR+RISO(I)
129 20      CONTINUE
130        DO 22 I=1,11,1
131          LOGN=RAWDATA(I,1)
132          IF (LOGN.GT.1) NWS=NWS+1
133          IF (LOGN.EQ.1 .AND. EST.LE.2) RAWDATA(I,12)=0
134          S1= RAWDATA(I,10)
135          B=S1*RAWDATA(I,12)*1000/(60*3.7E7)
136          K= RAWDATA(I,11)
137          SLNTV(K)=SLNTV(K)+S1
138          SLNNO(K)=SLNNO(K)+1
139          TOTV=TOTV+S1
140          TOTB=TOTB+B
141          KgSLN(K,1)= KgSLN(K,1)+ (S1*RAWDATA(I,14))/100
142          COSTSLN(K)= KgSLN(K,1)*CNVRSNDT(K,3)
143          IF (K.EQ.3 .OR. K.EQ.6 .OR. K.EQ.7) GOTO 23
144          IF (K.EQ.11 .OR. K.EQ.13 .OR. K.EQ.15) GOTO 23
145          GOTO 24
146 23      KgSLN(K,2)= KgSLN(K,2)+S1*RAWDATA(I,15)/100
147          COSTSLN(K)= COSTSLN(K)+KgSLN(K,2)*CNVRSNDT(K,4)
148  C      IF (RAWDATA(I,1).EQ.0) GOTO 22
149 24      DO 25 J=1,8,1
150          T1=RAWDATA(I,J+1)*S1
151          PmCIST(J)=mCURISO(J)*100/TOTmC
152          PmgIST(J)=mgISO(J)*100/TOTmg
153          PRIST(J)=RISO(J)*100/TOTR
154 25      CONTINUE
155 22      CONTINUE
156        DO 30 I=1,15,1
157          TOTCOST=TOTCOST+COSTSLN(I)
158 30      CONTINUE
159        DO 38 I=1,15,1
160          DO 39 J=1,2,1
161            KgT(I)=KgT(I)+KgSLN(I,J)
162 39      CONTINUE
163          TOTCKg=TOTCKg+KgT(I)
164 38      CONTINUE
165  C
166          TmoleNa=0
167          TmoleK=0
168          PEWV=0
169          CALV=0
170          moleNaC=0
171          moleKC=0
172          T=1.01E7
173          DO 40 I=1,11
174            MK=0
175            MNa=0
176            IF (RAWDATA(I,11) .EQ. 5) MK=RAWDATA(I,14)*.1463
177            IF (MK .GE. 1) GOTO 41

```

```

178      IF (RAWDATA(I,11) .EQ. 7) MNa=RAWDATA(I,15)/4
179      IF (RAWDATA(I,11) .EQ.13) MNa=RAWDATA(I,15)/4
180      IF (RAWDATA(I,11) .EQ.14) MNa=RAWDATA(I,14)/4
181      IF (MNa .GE. 1) GOTO 42
182      IF (RAWDATA(I,11) .EQ. 3) MK=RAWDATA(I,14)/15.8
183      IF (MK .GE. 1) GOTO 43
184      IF (RAWDATA(I,12) .GT. T) GOTO 44
185      PEWV=PEWV+RAWDATA(I,10)
186      GOTO 40
187  41      moleKC=MK*RAWDATA(I,10)
188      TmoleK=TmoleK+moleKC
189      GOTO 44
190  42      moleNaC=MNa*RAWDATA(I,10)
191      TmoleNa=TmoleNa+moleNaC
192      GOTO 44
193  43      moleKC=MK*RAWDATA(I,10)
194      TmoleK=TmoleK+ moleKC
195  44      CALV=CALV+RAWDATA(I,10)
196  40      CONTINUE
197      H2O = KgSLN(1,1)
198      HNO3 Kg = KgSLN(2,1) + KgSLN(3,2) + KgSLN(11,2)+KgSLN(15,2)
199      HNO3 L = (KgSLN(2,1) )*(1000./(63.*13.))
200      KA KMnO4 = KgSLN(3,1)
201      KA MnO4 = KgSLN(3,1)*(119.0/158.0)
202      KA K = KgSLN(3,1)*(39.0/158.0)
203      KA HNO3 Kg = KgSLN(3,2)
204      KA HNO3 L = KgSLN(3,2)*(1000./(63.*13))
205      S4521 = KgSLN(4,1)
206      S4521 CIT A = KgSLN(4,1) * .05
207      S4521 OX A = KgSLN(4,1) * .15
208      NH4OXALATE = KgSLN(4,1) * .80
209      S4502 = KgSLN(5,1)
210      S4502 KMnO4 = KgSLN(5,1) * .20
211      S4502 MnO4 = S4502 KMnO4 * (119.0/158.0)
212      S4502 KK = S4502 KMnO4 * (39.0/158.0)
213      S4502 KOH = KgSLN(5,1) * .77
214      KOH = KgSLN(5,1) * .77
215      S4502 KB = S4502 KOH * (39.0/56.0)
216      S4502 OH = S4502 KOH * (17.0/56.0)
217      S4502 Na = KgSLN(5,1) * 0.03*46.0/162.0
218      CITROX = KgSLN(6,1) + KgSLN(6,2)
219      CITROX CIT A = KgSLN(6,1)
220      CITROX OX A = KgSLN(6,2)
221      TARTARIC NaOH = KgSLN(7,2)
222      TARTARIC Na = KgSLN(7,2)*23.0/40.0
223      TARTARIC A = KgSLN(7,1)
224      S4324 = KgSLN(8,1)
225      S4324 Na = KgSLN(8,1) * 0.113
226      OXALIC = KgSLN(9,1)
227      KMnO4 = KA KMnO4 + S4502 KMnO4
228      MnO4 = (KMnO4 + S4502 KMnO4) * (119.0/158.0)
229      K1 = (KMnO4 + S4502 KMnO4)*(39.0/158.0)+S4502 KOH *(39.0/56.0)
230      CIT A =KgSLN(10,1)
231      OXALHNO = KgSLN(11,1)
232      NHOH = KgSLN(12,1)
233      EDTA = KgSLN(13,1)
234      EDTANaOH = KgSLN(13,2)
235      EDTA Na = (EDTANaOH*23.0/40.0) + (EDTA*46/372.24)
236      ARRNAOH = KgSLN(14,1) * 0.69
237      ARRNA = KgSLN(14,1) * 0.412

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237.2      HF = KgSLN(15,1)
238      NaOH = KgSLN(7,2) + EDTANaOH + ARNaOH
239      OH = 17.0*(S4502 KOH /56.0 + NaOH/40.0 + NHOH/35)
240      Na = TARTARIC Na + EDTA Na + ARNa + S4502 Na + S4324 Na
241      CITRIC A = CITROX CIT A + S4521 CIT A + CIT A
242      OXALIC A = CITROX OX A + S4521 OX A + OXALIC + OXALHNO
243      TV=TOTV
244      C
245      C      TOTB is in mCi
246      C
247      888      WRITE (1,540)
248      WRITE (1,550) TOTV,(TOTV/3.785)
249      CALC=(TOTV/3.785)*5
250      WRITE (1,570) (TOTCKg-HNO3 Kg),((TOTCKg-HNO3 Kg)*2.2)
251      SMOLE=(Na/23.)*1000
252      WRITE (1,575) SMOLE ,SMOLE/TV
253      MOLEK = ((KA K + S4502 KK + S4502 KB)/39.1)*1000
254      WRITE (1,580) MOLEK,MOLEK/TV
255      RMOLE= (MOLEK + SMOLE)/TV
256      WRITE (1,582) MOLEK+SMOLE,RMOLE
257      WRITE (1,586) TOTCOST
258      WRITE (1,584)
259      WRITE (1,660)
260      WRITE (1,775)
261      IF (SLNTV(1) .GT. 1) WRITE (1,663) SLNTV(1),SLNNO(1)
262      WRITE (1,775)
263      IF (SLNTV(2) .GT. 1) WRITE (1,666) KgSLN(2,1),SLNTV(2),SLNNO(2)
264      WRITE (1,775)
265      IF (SLNTV(3) .GT. 1) WRITE (1,670) KA KMnO4, KA K,
266      *      KA KMnO4 + KgSLN(3,2), SLNTV(3),SLNNO(3)
267      WRITE (1,775)
268      IF (SLNTV(4) .GT. 1) WRITE (1,680) S4521 CIT A, S4521 OX A,
269      *      NH4OXALATE, S4521, SLNTV(4),SLNNO(4)
270      WRITE (1,775)
271      IF (SLNTV(5) .GT. 1) WRITE (1,690) S4502 KMnO4,(S4502 KK +
272      *      S4502 KB), S4502 Na, S4502, SLNTV(5),SLNNO(5)
273      WRITE (1,775)
274      IF (SLNTV(6) .GT. 1) WRITE (1,700) CITROX CIT A, CITROX OX A,
275      *      CITROX, SLNTV(6),SLNNO(6)
276      WRITE (1,775)
277      IF (SLNTV(7) .GT. 1) WRITE (1,710) TARTARIC A,
278      *      (TARTARIC NaOH * 23.0/40.0),
279      *      (TARTARIC A + TARTARIC NaOH), SLNTV(7),SLNNO(7)
280      WRITE (1,775)
281      IF (SLNTV(8) .GT. 1) WRITE (1,720) S4324 Na, S4324, SLNTV(8),
282      *      SLNNO(8)
283      WRITE (1,775)
284      IF (SLNTV(9) .GT. 1) WRITE(1,730) OXALIC, OXALIC, SLNTV(9),
285      *      SLNNO(9)
286      WRITE (1,775)
287      IF (SLNTV(10) .GT. 1) WRITE (1,735) CIT A, CIT A, SLNTV(10),
288      *      SLNNO(10)
289      WRITE (1,775)
290      IF (SLNTV(11) .GT. 1) WRITE(1,721) OXALHNO,OXALHNO+KgSLN(11,2),
291      *      SLNTV(11),SLNNO(11)
292      WRITE (1,775)
293      IF (SLNTV(12) .GT. 1) WRITE (1,722) NHOH, NHOH, SLNTV(12),
294      *      SLNNO(12)
295      WRITE (1,775)
296      IF (SLNTV(13) .GT. 1) WRITE (1,723) EDTA,

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297      *   (EDTA Na), (EDTA + EDTANaOH), SLNTV(13),
298      *   SLNNO(13)
299      WRITE (1,775)
300      IF (SLNTV(14) .GT. 1) WRITE (1,724) ARRNa, KgSLN(14,1),
301      *   SLNTV(14),SLNNO(14)
302      WRITE (1,775)
302.2    IF (SLNTV(15) .GT. 1) WRITE (1,725) HF, (HF + KgSLN(15,2)),
302.21   *   SLNTV(15),SLNNO(15)
302.3    WRITE (1,775)
303      WRITE (1,737) KMnO4,CITRIC A,OXALIC A,
304      *   NH4OXALATE,TARTARIC A,(KA K + S4502 KK + S4502 KB),
305      *   Na,(TOTCKg-HNO3 Kg),TV,K2
306      WRITE (1,775)
307      TMOLE=(HNO3 KG*1000./63.)-OH*1000/17.
308      IF (TMOLE.LT.0) GOTO 59
309      IF (TMOLE.EQ.0) GOTO 60
310      pH=-ALOG10(TMOLE/TOTV)
311      WRITE (1,770) pH
312      GOTO 60
313      59  pOH=-ALOG10((TMOLE*(-1))/TV)
314      pH= 14-pOH
315      WRITE (1,770) pH
316      C
317      60  WRITE (1,790) K2
318      WRITE (1,792) NWS
319      C   Cal waste, 1 all to pew, 2 all to tankfarm, 3 mixed
320      IF (A .EQ. 1) GOTO 63
321      IF (A .EQ. 2) GOTO 64
322      IF (A .EQ. 3) GOTO 65
323      63  WASTEV=750*TV/14000
324      C   For each 14000 L deeptank there was approx 750 L acid added
325      PEWCOST=(TV + WASTEV)/3.785
326      NaKWASTE=((SMOLE + MOLEK)/2.5)/3.785
327      NaWASTE=(SMOLE/2.5)/3.785
328      C   Cal vol of waste if boiled down to 2.5 M Na or Na + K
329      PEWCALNa=PEWCOST + 5*NaWASTE
330      PEWCALNaK=PEWCOST + 5*NaKWASTE
331      TOTCNa=PEWCALNa + TOTCOST
332      TOTCNaK=PEWCALNaK + TOTCOST
333      WRITE (1,605)
334      WRITE (1,603) NaWASTE,NaKWASTE
335      WRITE (1,601) PEWCALNa,PEWCALNaK
336      WRITE (1,602) TOTCNa,TOTCNaK
337      C   Assumes all solns go to PEW
338      IF (A .EQ. 1) GOTO 588
339      IF (A .EQ. 4) WRITE (1,604)
340      64  WRITE (1,606)
341      WRITE (1,600) CALC
342      WRITE (1,583) (TOTCOST+CALC)
343      C   Assumes all solution goes to calciner and includes chem cost
344      C   Assuming calcination cost is approximately $5 per gallon feed
345      IF (A .EQ. 2) GOTO 588
346      65  BL=TOTB/TOTV
347      MPEW=(MOLEK+SMOLE-TmoleNa-TmoleK)/PEWV
348      MOLENAK=MPEW*PEWV
349      PEWVNAK=MOLENAK/2.5
350      IF (CALV.NE.0) GOTO 61
351      MCALC=0
352      GOTO 62
353      61  MCALC=(TmoleNa+TmoleK)/CALV

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354 62 BLENDV=(MPEW*PEWV/.2)-PEWV/10
355 TDV=CALV+PEWVNAK
356 IF (TDV .EQ. 0.0) GOTO 66
357 MOLARKS = (MOLEK+SMOLE)/TDV
358 GOTO 67
359 66 MOLARKS = 0
360 67 CST=TOTCOST+PEWV*1.0/3.785+TDV*5/3.785
361 WRITE (1,607)
362 WRITE (1,589) PEWV,PEWVNAK,PEWVNAK/3.785,CALV,MCALC,
363 & CALV/3.785,TDV,MOLARKS,TDV/3.785,CST
364 589 FORMAT (T6,"Waste vol to PEW",9X,I7,1X,"L",
365 & T43,"Reduced to",1X,I7,1X,"L",2X,"2.5 M Na K",
366 & 3X,I7,1X,"gal",/,
367 & T6,"Waste vol bypassing PEW",2X,I7,1X,"L",2X,F4.2,1X,"M Na K",
368 & T54,I7,1X,"gal",/,
369 & T6,"Total tank farm vol",6X,I7,1X,"L",2X,F4.2,1X,"M Na K",
370 & T54,I7,1X,"gal",/,
371 & T6,"Cost w/o labor",T31,I7,1X,"$",T44,"PEW $/gal",
372 & T59,"Calcine $ 5/gal")
373 C Includes chem cost
374 C PEW limits are 4.5 mCi Beta/L or 1E+7 beta/min*ml
375 588 IF (A .NE. 4) WRITE (1,604)
376 IF (A .NE. 4) WRITE (1,115) FILE
377 WRITE (1,200)
378 Z=1
379 CALL SUB3 (ISO,mCURISO,mgISO,RISO,TOTmC,TOTmg,TOTR,Z,TOTV)
380 WRITE (1,202) TOTB/1000
381 Z=3
382 WRITE (1,205)
383 CALL SUB3 (ISO,mCURISO,mgISO,RISO,TOTmC,TOTmg,TOTR,Z,TOTV)
384 WRITE (1,207) TOTB/TOTV,(TOTB*2.22E6/TOTV)
385 WRITE (1,210)
386 83 Z=2
387 CALL SUB3 (ISO,PmCIST,PmgIST,PRIST,TOTmC,TOTmg,TOTR,Z,TOTV)
388 GOTO 99
389 51 CALL SUB5 (I1,RAWDATA,RAWDATA)
390 C WRITE (1,115) FILE
391 EST=5
392 GOTO 4
393 C
394 100 FORMAT (E9.3,E12.3,F10.2,F10.2)
395 115 FORMAT (/,T20,A30)
396 C116 FORMAT (///// ,T20,A30)
397 200 FORMAT (//,T2,"Individual Isotope Information")
398 202 FORMAT (T15,"Beta",T26,I8)
399 205 FORMAT (//,T2,"X/L Isotope Information")
400 207 FORMAT (T15,"Beta",T26,F8.1,T40,"B/min/ml=",T51,1PE7.1)
401 210 FORMAT (//,T2,"% Isotope Information")
402 540 FORMAT (/,T2,"Waste Analysis")
403 550 FORMAT (T10,"Unprocessed",/,T12,"Volume of Waste",T45,I7,1X,
404 & "L",6X,I6,1X,"gal")
405 585 FORMAT (T15,61("-"))
406 570 FORMAT (T12,"Wt of chemicals w/o HNO3",T45,I7,1X,"Kg",5X,
407 * I6,1X,"lbs",)
408 575 FORMAT (T12,"Moles of Na+ ; Molarity",T44,I8,1X,"moles",T59,
409 & F7.2,1X,"M")
410 580 FORMAT (T12,"Moles of K+ ; Molarity",T44,I8,1X,"moles",T59,
411 & F7.2,1X,"M")
412 582 FORMAT (T12,"Moles Na+ plus K+ ; Molarity",T44,I8,1X,"moles",
413 & T59,F7.2,1X,"M")

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414 586 FORMAT (T12,"Chemical cost 1982 $",T44,I8,1X,"$")
415 600 FORMAT (T12,"Calcine cost $ 5/gal",T44,I8,1X,"$")
416 583 FORMAT (T12,"Decon cost w/o labor",T44,I8,1X,"$")
417 601 FORMAT (T12,"PEW + Calcine ($1 & $5/gal)",T44,I8,1X,"$ Na",
418 * T59,I8,1X,"$ Na + K")
419 602 FORMAT (T12,"Decon cost w/o labor",T44,I8,1X,"$ Na",T59,
420 * I8,1X,"$ Na + K")
421 603 FORMAT (T12,"Vol of 2.5 M waste",T44,I8,1X,"gal Na",T59,
422 * I8,1X,"gal Na + K")
423 C FORMAT 604 HAS AN ESC&11V escape sequence, don't screen!
424 584 FORMAT (/ ,T2, "Chemical Analysis (Kg)")
425 604 FORMAT ("")
426 605 FORMAT (/ ,T4,"Processed waste - assumed all went to PEW")
427 606 FORMAT (/ ,T4,"Processed waste - assumed all bypassed PEW")
428 607 FORMAT (/ ,T4,"Processed waste - mixed PEW & tankfarm, assumed",
429 & 1X,"decision point was at cell")
430 C660 FORMAT (T61,"KMnO4",T68,"KOH",T74,"NaOH",T96,"# of",/,
431 660 FORMAT (T91,"# of",/,
432 * T20,"KMnO4",T27,"Citric",T35,"Oxalic",T43,"NH Oxal",T52,
433 * "Tart A",T62,"K+",T69,"Na+",T76,"Kg",T85,"L",T90,
434 * "Flushes")
435 663 FORMAT (T4,"H2O",T80,I8,T92,I3)
436 666 FORMAT (T4,"HNO3 ",T74,I5,T80,I8,T92,I3)
437 670 FORMAT (T4,"KMnO4/HNO3",T19,I5,T59,I5,T74,I5,T80,I8,T92,I3)
438 680 FORMAT (T4,"4521",T26,I5,T34,I5,T44,I5,T74,I5,T80,I8,T92,I3)
439 690 FORMAT (T4,"4502",T19,I5,T59,I5,T66,I5,T74,I5,T80,I8,
440 * T92,I3)
441 700 FORMAT (T4,"Citrox",T26,I5,T34,I5,T74,I5,T80,I8,T92,I3)
442 710 FORMAT (T4,"Tart A/NaOH",T52,I5,T66,I5,T74,I5,T80,I8,T92,I3)
443 720 FORMAT (T4,"4324",T66,I5,T74,I5,T80,I8,T92,I3)
444 721 FORMAT (T4,"Oxalic/HNO3",T34,I5,T74,I5,T80,I8,T92,I3)
445 722 FORMAT (T4,"NH4OH",T13,I5,T74,I5,T80,I8,T92,I3)
446 723 FORMAT (T4,"EDTA/NaOH",T13,I5,T66,I5,T74,I5,T80,I8,T92,I3)
447 724 FORMAT (T4,"ARR",T66,I5,T74,I5,T80,I8,T92,I3)
447.2 725 FORMAT (T4,"HF/HNO3",T13,I5,T74,I5,T80,I8,T92,I3)
448 730 FORMAT (T4,"Oxalic A",T34,I5,T74,I5,T80,I8,T92,I3)
449 735 FORMAT (T4,"Citric A",T26,I5,T74,I5,T80,I8,T92,I3)
450 737 FORMAT (T4,"Totals",T19,I5,T26,I5,T34,I5,T44,I5,T52,I5,
451 * T59,I5,T66,I5,T73,I6,T80,I8,T92,I3)
452 770 FORMAT (/ ,T4,"Approx. pH of waste",T24,F6.1)
453 775 FORMAT (T4,93(" "))
454 790 FORMAT (T4,"Number of flushes",T26,I4)
455 792 FORMAT (T4,"Samples taken",T26,I4)
456 587 FORMAT (T6,"Waste Volume after PEW",T29,I7,1X,"L",T47,I7,1X,
457 & "gal")
458 794 FORMAT (/ ,T4,"mCi gamma/Kg waste",T25,I5)
459 795 FORMAT (/ ,T4,"Cost per flush",T22,"$",T24,I4)
460 796 FORMAT (/ ,T4,"Cost per L",T22,"$",T24,F4.2)
461 800 FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
462 * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,1X,E7.2,1X,F5.1,1X,F5.2,1X,
463 * F5.2,1X,I6)
464 99 STOP
465 END
466 C
467 SUBROUTINE SUB5 (I2,RD,Z)
468 DIMENSION RD(790,15),RDSLW(15,13),RDT(13),AVSLRD(15,13),
469 * AVR(13),COUNT(15),Z(790,15),T(790),KN(15),VOL(15),
470 * VOLSNG(15)
471 C
472 C*****

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473 C
474 C      T(I)      is the sum of the gamma for a flush      *
475 C      K        is the solution number                    *
476 C      COUNT(K) is the # of flushes of soln k w log #      *
477 C      N        is the # of flushes w/o gamma scan         *
478 C      KN(K)    is the # of flushes of soln k w/o gamma     *
479 C      COUNTTOT is the total # of flushes with log #'s      *
480 C      VOL(K)   is the volume of soln K w log #s            *
481 C      VOLT     is the total volume of sampled flushes      *
482 C      VOLSNG(K) is the volume of sampled soln k w/o gamma   *
483 C      VOLSNGT  is the total vol of sampled flushes w/o gamma *
484 C      VOLNST   is the total vol of flushes w/o log #s      *
485 C
486 C*****
487 C
488      COUNTTOT=0
489      VOLT=0
490      VOLNST=0
491      VOLSNGT=0
492      N=0
493      DO 1 I=1,12
494          T(I)=0
495      1      CONTINUE
496      DO 2 I=1,12
497          DO 3 J=2,9
498              T(I)=T(I)+RD(I,J)
499      3      CONTINUE
500      2      CONTINUE
501      DO 4 I=1,15
502          COUNT(I)=0
503          KN(I)=0
504          VOL(I)=0
505          VOLSNG(I)=0
506          DO 5 J=1,13
507              RDSLNI(I,J)=0
508              AVSLRD(I,J)=0
509      5      CONTINUE
510      4      CONTINUE
511      DO 6 I=1,13
512          RDT(I)=0
513          AVRDI(I)=0
514      6      CONTINUE
515      DO 7 I=1,12
516          IF (RD(I,1).EQ.0) VOLNST=VOLNST+RD(I,10)
517          IF (RD(I,1).EQ.0) GOTO 7
518          K=RD(I,11)
519          COUNT(K)=COUNT(K)+1
520          COUNTTOT=COUNTTOT+1
521          VOL(K)=VOL(K)+RD(I,10)
522          VOLT=VOLT+RD(I,10)
523          IF (T(I).EQ.0) GOTO 8
524          GOTO 9
525      8      N=N+1
526              KN(K)=KN(K)+1
527              VOLSNG(K)=VOLSNG(K)+RD(I,10)
528              VOLSNGT=VOLSNGT+RD(I,10)
529      9      DO 10 J=2,9
530                  RDSLNI(K,J)=RDSLNI(K,J)+RD(I,J)*RD(I,10)
531                  RDT(J)=RDT(J)+RD(I,J)*RD(I,10)
532      10     CONTINUE

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533          DO 11 J=12,13
534              RDSLN(K,J)=RDSLN(K,J)+RD(I,J)*RD(I,10)
535              RDT(J)=RDT(J)+RD(I,J)*RD(I,10)
536 11          CONTINUE
537 7          CONTINUE
538          DO 12 K=1,15
539              IF (COUNT(K).EQ.0) GOTO 12
540              IF (COUNT(K).EQ.KN(K)) GOTO 15
541  C          (If there is no soln k .or. # flshs of soln k= #
542  C          flshs of soln k w/o gamma) goto 12
543              IF (KN(K).GT.0) GOTO 13
544  C          (If # flshs of soln K w/o g .GT.0) goto 13
545  C          Only solns with gamma results go to nest step
546              DO 14 J=2,9
547                  AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
548 14          CONTINUE
549              GOTO 15
550  C          13 is ave of sons k w some flshs w/o gamma
551  C          Vol(K)-Volsng(K)= vol of soln K w gamma
552 13          DO 16 J=2,9
553              AVSLRD(K,J)=RDSLN(K,J)/(VOL(K)-VOLSNG(K))
554 16          CONTINUE
555 15          DO 17 J=12,13
556              AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
557 17          CONTINUE
558 12          CONTINUE
559              DO 18 J=2,9
560                  AVR(D(J))=RDT(J)/(VOLT-VOLSNGT)
561 18          CONTINUE
562              DO 19 J=12,13
563                  AVR(D(J))=RDT(J)/VOLT
564 19          CONTINUE
565          DO 20 I=1,12,1
566              IF (RD(I,1).GT.0 .AND. T(I).GT.0) GOTO 20
567  C          Solns w log # and w gammas skip to 20
568              IF (RD(I,1).GT.0) GOTO 21
569              RD(I,1)=1
570 21          K=RD(I,11)
571  C          Working with flushes w/o log #s or no gammas
572              IF (COUNT(K).EQ.0) GOTO 22
573              IF (COUNT(K).EQ.KN(K)) GOTO 23
574              DO 24 J=12,13
575                  IF (RD(I,J) .GT. 0) GOTO 24
576                  RD(I,J)=AVSLRD(K,J)
577 24          CONTINUE
578              DO 25 J=2,9
579                  RD(I,J)=AVSLRD(K,J)
580 25          CONTINUE
581              GOTO 20
582  C          If soln k has no samples then the ave of all is used
583 22          DO 26 J=12,13
584              RD(I,J)=AVRD(J)
585 26          CONTINUE
586 23          DO 27 J=2,9
587              RD(I,J)=AVRD(J)
588 27          CONTINUE
589              IF (COUNT(K).EQ.0 .AND. COUNT(K).EQ.KN(K) ) GOTO 20
590              IF (RD(I,1).EQ.1 .AND. COUNT(K).EQ.KN(K)) GOTO 30
591              GOTO 20
592  C          For a flush w/o sample, where there are other solns

```

```

593      C          with beta but with no gamma, use soln ave for beta
594      30          DO 31 J=12,13
595                  RD(I,J)=AVSLRD(K,J)
596      31          CONTINUE
597      20          CONTINUE
598                  DO 28 I=1,12
599                      DO 29 J=1,15
600                          Z(I,J)=RD(I,J)
601      29          CONTINUE
602      28          CONTINUE
603      99          RETURN
604                  END
605      C
606          SUBROUTINE SUB3 (IS,X,Y,Z,TmC,Tmg,TR,ZZ,TV)
607          DIMENSION X(8),Y(8),Z(8),XX(8),YY(8),ZZ(8)
608          CHARACTER IS*6(8),IS2*9(8)
609          DATA IS2/"Zr 95","Nb 95","Ru103","Ru106","Sb125","Cs134",
610              * "Cs137","Ce144"/
611      C
612          DO 12 I=4,7
613              XX(I-2)=X(I)
614              YY(I-2)=Y(I)
615              ZZ(I-2)=Z(I)
616      12          CONTINUE
617              XX(1)=X(8)
618              XX(6)=X(2)
619              XX(7)=X(3)
620              XX(8)=X(1)
621              YY(1)=Y(8)
622              YY(6)=Y(2)
623              YY(7)=Y(3)
624              YY(8)=Y(1)
625              ZZ(1)=Z(8)
626              ZZ(6)=Z(2)
627              ZZ(7)=Z(3)
628              ZZ(8)=Z(1)
629      10          T=1000
630                  IF (ZZ.EQ.3) GOTO 5
631                  WRITE (1,100)
632                  WRITE (1,120)
633                  IF (ZZ.EQ.2) GOTO 1
634      C
635          DO 2 I=1,8
636              WRITE (1,130) IS2(I),XX(I)/T,YY(I)/T,ZZ(I)/T
637      2          CONTINUE
638              WRITE (1,120)
639              WRITE (1,140) TmC/T,Tmg/T,TR/T
640              WRITE (1,120)
641              GOTO 99
642      C
643      5          WRITE (1,110)
644              WRITE (1,120)
645                  DO 6 I=1,8
646                      WRITE (1,135) IS2(I),XX(I)/TV,YY(I)/TV,ZZ(I)/TV
647      6          CONTINUE
648              WRITE (1,120)
649              WRITE (1,145) TmC/TV,Tmg/TV,TR/TV
650              WRITE (1,120)
651              GOTO 99
652      C

```

```

653 1      DO 3 I=1,8
654      WRITE (1,190) IS2(I),XX(I),YY(I),ZZ(I)
655 3      CONTINUE
656      WRITE (1,120)
657  C
658 100     FORMAT (T32,"Ci",T41,"mg",T47," R/hr")
659 110     FORMAT (T30,"mCi/L",T39,"ug/L",T46,"mR/hr*L")
660 130     FORMAT (T15,A9,T27,6(I7,2X))
661 135     FORMAT (T15,A9,T27,6(F7.1,2X))
662 140     FORMAT (T15,"Total",T26,3(I8,1X))
663 145     FORMAT (T15,"Total",T26,3(F8.1,1X))
664 120     FORMAT (T15,37("-"))
665 190     FORMAT (T15,A9,T27,6(F7.1,2X))
666 99      RETURN
667      END
668  C
669  C
670  C
671      SUBROUTINE DATAFILE
672      CHARACTER*30 NAME,DATA3,PRNT,STRTSP,A*10,DEVN*5
673  C
674      DISPLAY " File name to be accessed"
675      ACCEPT A
676      DISPLAY "Printer dev number (local=144,lp=6;default=144)"
677      DEVN="144"
678      ACCEPT DEVN
679  C
680      NAME[1:11]="FILE FTN09="
681      NAME[12:10]=A
682      NAME[22:4]=",OLD"
683      NAME[26:1]=%15C
684      DATA3[1:18]="FILE FTN03=ZNM,OLD"
685      DATA3[19:1]=%15C
686      PRNT[1:18]="FILE FTN01=LP;DEV="
687      PRNT[19:4]=DEVN
688      PRNT[23:1]=%15C
689      STRTSP[1:14]="STARTSPOOL 144"
690      STRTSP[15:1]=%15C
691  C
692      CALL COMMAND (NAME,I1,I2)
693      CALL COMMAND (DATA3,I1,I2)
694      CALL COMMAND (PRNT,I1,I2)
695      CALL COMMAND (STRTSP,I1,I2)
696      RETURN
697      END

```


T ZTOTAL

/L ALL

```

1 $CONTROL USLINIT,INIT,NOSOURCE
2 $INTEGER*4
3 C NAME PROGRAM SHORT FORM (ZTOTAL)
4 C FILE FTN03=ZNM,OLD
5 C FILE FTN09=(FILE TO BE ACCESSED),OLD
6 C FILE FTN01;DEV=LP;CCTL
7 C
8 DIMENSION RAWDATA(720,16),CNVRSNDT(15,4),
9 * RISO(8),DPSISO(8),
10 * SLNmC(15,8),SLNmG(15,8),SLNREA(15,8),SLNBCT(15),
11 * SLNmCT(15),SLNmGT(15),SLNREAT(15),SLNTV(15),SLNNO(15),
12 * COSTSLN(15),
13 * UDSGSLN(15),
14 * PmCIST(8),PmgIST(8),PRIST(8),
15 * PmCSLN(15,8),PRSLN(15,8),PmgSLN(15,8),
16 * PmCSLNT(15),PmgSLNT(15),PRSLNT(15),PUDSSLNT(15),PBCSLNT(15),
17 * PCOSTSLNT(15),PVOLSLNT(15),
18 * PJSL(15,8),
19 * PTmgSL(15,8),PTmRSL(15,8),PTmCSL(15,8)
20 C
21 REAL mgISO(8),mCURISO(8),
22 * TOTmC,TOTmg,TOTR,KgSLN(15,2),KgT(15),Z
23 C
24 INTEGER C
25 C
26 CHARACTER ISO*6(8),SOLN*13(15),ANS,LABEL*6(16),FILE*20
27 C
28 DATA ISO/"Ce144","Cs134","Cs137","Nb 95","Ru103",
29 * "Ru106","Sb125","Zr 95"/
30 DATA SOLN/"H2O","HNO3","KMnO4/HNO3","4521","4502","CITROX",
31 * "Tartaric/NaOH","4324","Oxalic","Citric A","Oxalic/HNO3",
32 * "NH4OH","EDTA/NaOH","ARR","HF/HNO3"/
33 DATA LABEL/"Log #","Ce144","Cs134","Cs137","Nb 95","Ru103",
34 * "Ru106","Sb125","Zr 95","Vol-L","Soln","Beta","uds",
35 * "% ch 1","% ch 2","mR/hr"/,"Y/Y"/,"N/N"/
36 C
37 C
38 CALL DATAFILE
39 C
40 I=16
41 DISPLAY "Print size 16,12,10"
42 ACCEPT I
43 IF (I.EQ.16) WRITE (1,101)
44 IF (I.EQ.12) WRITE (1,102)
45 IF (I.EQ.10) WRITE (1,103)
46 102 FORMAT ("")
47 103 FORMAT ("")
48 101 FORMAT ("")
49 C
50 C
51 DISPLAY " Report name"
52 ACCEPT FILE
53 DO 804 I=1,720
54 READ (9@I,800,END=805) (RAWDATA(I,J),J=1,16)
55 804 CONTINUE
56 805 K=1
57 K2=K-1
58 EST =0

```

```

59      C=0
60      C
61      II=K2
62      1  DISPLAY " How many flushes ", K2
63      ACCEPT II
64      C
65      98 DISPLAY "Do you want to run the program Y/N "
66      ANS="Y"
67      ACCEPT ANS
68      IF (ANS.EQ."N") STOP
69      IF (ANS.NE."Y") GOTO 98
70      C
71      2  DISPLAY "Estimates only Y/N"
72      ANS="Y"
73      ACCEPT ANS
74      IF (ANS.EQ."Y") GOTO 51
75      IF (ANS.NE."N") GOTO 2
76      EST=2
77      C
78      3  DISPLAY "Include averaged data Y/N"
79      ANS="Y"
80      ACCEPT ANS
81      IF (ANS.EQ."N") GOTO 4
82      IF (ANS.NE."Y") GOTO 3
83      EST=3
84      C
85      4  DO 8 I=1,8,1
86          RISO(I)=0
87          DPSISO(I)=0
88          mgISO(I)=0
89          mCURISO(I)=0
90          PRIST(I)=0
91      8  CONTINUE
92      DO 9 I=1,15
93          SLNBCT(I)=0
94          SLNmCT(I)=0
95          SLNmGT(I)=0
96          SLNREAT(I)=0
97          SLNTV(I)=0
98          SLNNO(I)=0
99          COSTSLN(I)=0
100         KgT(I)=0
101         UDSGSLN(I)=0
102         PmCSLNT(I)=0
103         PmgSLNT(I)=0
104         PRSLNT(I)=0
105         PUDSSLNT(I)=0
106         PBCSLNT(I)=0
107         PCOSTSLNT(I)=0
108         PVOLSLNT(I)=0
109         DO 10 J=1,8
110             SLNmC(I,J)=0
111             SLNmG(I,J)=0
112             SLNREA(I,J)=0
113             PmCSLN(I,J)=0
114             PRSLN(I,J)=0
115             PmgSLN(I,J)=0
116             PJSL(I,J)=0
117             PTmCSL(I,J)=0
118             PTmgSL(I,J)=0

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```

119          PTmRSL(I,J)=0
120 10        CONTINUE
121          DO 11 J=1,2
122            KgSLN(I,J)=0
123 11        CONTINUE
124          DO 12 J=1,4
125            CNVRSNDT(I,J)=0
126 12        CONTINUE
127 9         CONTINUE
128          T=1000
129          TOTmC=0
130          TOTR=0
131          TOTmg=0
132          TOTV=0
133          TOTB=0
134          TOTCOST=0
135          TOTCKg=0
136          UDSGT=0
137          NWS=0
138 C
139          DO 13 I=1,15
140            READ (3@I,100,END=14) (CNVRSNDT(I,J), J=1,4,1)
141 13        CONTINUE
142 C
143 C Multiply by 1000 to covert ml to L
144 14        DO 15 J=2,9
145          DO 16 I=1,II
146            IF (RAWDATA(I,1).EQ.0) GOTO 16
147            DPSISO(J-1)=DPSISO(J-1)+RAWDATA(I,J)*RAWDATA(I,10)
148            *1000
149 16        CONTINUE
150 15        CONTINUE
151          DO 19 I=1,8
152            mCURISO(I)=DPSISO(I)/3.7E7
153            RISO(I)=DPSISO(I)*CNVRSNDT(I,1)
154            mgISO(I)=DPSISO(I)*CNVRSNDT(I,2)
155 19        CONTINUE
156          DO 20 I=1,8
157            TOTmC=TOTmC+mCURISO(I)
158            TOTmg=TOTmg+mgISO(I)
159            TOTR=TOTR+RISO(I)
160 20        CONTINUE
161          DO 22 I=1,II
162            IF (RAWDATA(I,1).GT.1) NWS=NWS+1
163            IF (RAWDATA(I,1).EQ.0) GOTO 22
164            S1= RAWDATA(I,10)
165            B=S1*RAWDATA(I,12)*1000/(60*3.7E7)
166            K= RAWDATA(I,11)
167            TOTV=TOTV+S1
168            TOTB=TOTB+B
169            UDSGSLN(K)= UDSGSLN(K)+S1*RAWDATA(I,13)
170            SLNTV(K)= SLNTV(K)+S1
171            SLNNO(K)= SLNNO(K)+1
172            SLNBCT(K)= SLNBCT(K)+B
173            KgSLN(K,1)= KgSLN(K,1)+S1*RAWDATA(I,14)/100
174            COSTSLN(K)= KgSLN(K,1)*CNVRSNDT(K,3)
175            IF (K.EQ.3 .OR. K.EQ.6 .OR. K.EQ.7) GOTO 23
176            IF (K.EQ.11 .OR. K.EQ.13 .OR. K.EQ.15) GOTO 23
177            GOTO 24
178 23        KgSLN(K,2)= KgSLN(K,2)+S1*RAWDATA(I,15)/100

```

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179      COSTSLN(K)= COSTSLN(K)+KgSLN(K,2)*CNVRSNDT(K,4)
180  24      DO 25 J=1,8,1
181          T1=RAWDATA(I,J+1)*S1
182          SLNmC(K,J)= SLNmC(K,J)+(T1*1000)/3.7E7
183          SLNmG(K,J)= SLNmG(K,J)+T1*CNVRSNDT(J,2)*1000
184          SLNREA(K,J)= SLNREA(K,J)+T1*1000*CNVRSNDT(J,1)
185          PmCIST(J)= mCURISO(J)*100/TOTmC
186          PmgIST(J)= mgISO(J)*100/TOTmg
187          PRIST(J)= RISO(J)*100/TOTR
188  25      CONTINUE
189  22      CONTINUE
190      DO 30 I=1,15
191          DO 31 J=1,8
192              SLNmCT(I)=SLNmCT(I)+SLNmC(I,J)
193              SLNmGT(I)=SLNmGT(I)+SLNmG(I,J)
194              SLNREAT(I)=SLNREAT(I)+SLNREA(I,J)
195  31      CONTINUE
196          TOTCOST=TOTCOST+COSTSLN(I)
197          UDSGT=UDSGT+UDSGSLN(I)
198  30      CONTINUE
199      DO 32 I=1,15
200          V=SLNTV(I)
201          IF (V.EQ.0) GOTO 32
202          PBCSLNT(I)= SLNBCT(I)*100/TOTB
203          PCOSTSLNT(I)= COSTSLN(I)*100/TOTCOST
204          PVOLSLNT(I)= SLNTV(I)*100/TOTV
205          PmCSLNT(I)= SLNmCT(I)*100/TOTmC
206          PmgSLNT(I)= SLNmGT(I)*100/TOTmg
207          PRSLNT(I)= SLNREAT(I)*100/TOTR
208          IF (UDSGT .EQ. 0) GOTO 33
209          PUDSSLNT(I)= UDSGSLN(I)*100/UDSGT
210  33      DO 34 J=1,8
211          PTmCSL(I,J)=SLNmC(I,J)*100/TOTmC
212          PTmgSL(I,J)=SLNmG(I,J)*100/TOTmg
213          PTmRSL(I,J)=SLNREA(I,J)*100/TOTR
214          IF (mCURISO(J).EQ.0) GOTO 35
215          PJSL(I,J)=SLNmC(I,J)*100/mCURISO(J)
216  37      IF (SLNmCT(I).EQ.0) GOTO 36
217          PmCSLN(I,J)= SLNmC(I,J)*100/SLNmCT(I)
218          PRSLN(I,J)= SLNREA(I,J)*100/SLNREAT(I)
219          PmgSLN(I,J)= SLNmG(I,J)*100/SLNmGT(I)
220          GOTO 34
221  35      PJSL(I,J)=0
222          GOTO 37
223  36      PmCSLN(I,J)=0
224          PRSLN(I,J)=0
225          PmgSLN(I,J)=0
226  34      CONTINUE
227  32      CONTINUE
228      DO 38 I=1,15
229          DO 39 J=1,2
230              KgT(I)=KgT(I)+KgSLN(I,J)
231  39      CONTINUE
232          TOTCKg=TOTCKg+KgT(I)
233  38      CONTINUE
234  C
235      H2O = KgSLN(1,1)
236      HNO3 Kg = KgSLN(2,1) + KgSLN(3,2) + KgSLN(11,2)+ KgSLN(15,2)
237      HNO3 L = (KgSLN(2,1) )*(1000./(63.*13.))
238      KA KMnO4 = KgSLN(3,1)

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239      KA MnO4 = KgSLN(3,1)*(119.0/158.0)
240      KA K = KgSLN(3,1)*(39.0/158.0)
241      KA HNO3 Kg = KgSLN(3,2)
242      KA HNO3 L = KgSLN(3,2)*(1000./(63.*13))
243      S4521 = KgSLN(4,1)
244      S4521 CIT A = KgSLN(4,1) * .05
245      S4521 OX A = KgSLN(4,1) * .15
246      NH4OXALATE = KgSLN(4,1) * .80
247      S4502 = KgSLN(5,1)
248      S4502 KMnO4 = KgSLN(5,1) * .20
249      S4502 MnO4 = S4502 KMnO4 * (119.0/158.0)
250      S4502 KK = S4502 KMnO4 * (39.0/158.0)
251      S4502 KOH = KgSLN(5,1) * .77
252      KOH = KgSLN(5,1) * .77
253      S4502 Na = KgSLN(5,1) * 0.03*46.0/162.0
254      S4502 KB = S4502 KOH * (39.0/56.0)
255      S4502 OH = S4502 KOH * (17.0/56.0)
256      CITROX = KgSLN(6,1) + KgSLN(6,2)
257      CITROX CIT A = KgSLN(6,1)
258      CITROX OX A = KgSLN(6,2)
259      TARTARIC NaOH = KgSLN(7,2)
260      TARTARIC Na = KgSLN(7,2)*23.0/40.0
261      TARTARIC A = KgSLN(7,1)
262      S4324 = KgSLN(8,1)
263      S4324 Na = S4324 * 0.113
264      OXALIC = KgSLN(9,1)
265      KMnO4 = KA KMnO4 + S4502 KMnO4
266      MnO4 = (KMnO4 + S4502 KMnO4) * (119.0/158.0)
267      K1 = (KMnO4 + S4502 KMnO4)*(39.0/158.0)+S4502 KOH *(39.0/56.0)
268      CIT A =KgSLN(10,1)
269      OXALHNO = KgSLN(11,1)
270      NHOH = KgSLN(12,1)
271      EDTA = KgSLN(13,1)
272      EDTANaOH = KgSLN(13,2)
273      EDTA Na = (EDTANaOH*23.0/40.0) + (EDTA*46/372.24)
274      ARRNAOH = KgSLN(14,1)
275      ARRNA = ARRNAOH * 0.412
276      NaOH = KgSLN(7,2) + EDTANaOH + ARRNAOH
277      HF = KgSLN(15,1)
278      OH = 17.0*(S4502 KOH/56.0 + NaOH/40.0 + NHOH/35)
279      Na = TARTARIC Na + EDTA Na + ARRNA + S4502 Na + S4324 Na
280      CITRIC A = CITROX CIT A + S4521 CIT A + CIT A
281      OXALIC A = CITROX OX A + S4521 OX A + OXALIC + OXALHNO
282      TV=TOTV
283      C
284      C
285      IF (EST.NE.0) WRITE (1,105)
286      WRITE (1,150) FILE
287      C
288      CALL COUNT (C)
289      WRITE (1,200)
290      Z=1
291      CALL SUB3 (ISO,mCURISO,mgISO,RISO,TOTmC,TOTmg,TOTR,Z,TOTV)
292      WRITE (1,202) TOTB/1000.
293      CALL COUNT (C)
294      Z=3
295      WRITE (1,205)
296      CALL SUB3 (ISO,mCURISO,mgISO,RISO,TOTmC,TOTmg,TOTR,Z,TOTV)
297      WRITE (1,207) TOTB/TOTV,(TOTB*2.22E6/TOTV)
298      CALL COUNT (C)

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299      WRITE (1,210)
300      Z=2
301      CALL SUB3 (ISO,PmCIST,PmgIST,PRIST,TOTmC,TOTmg,TOTR,Z,TOTV)
302      CALL COUNT(C)
303      WRITE (1,235)
304      Z=4
305      CALL SUB2(ISO,SLNmC,SLNmCT,SLNTV,SOLN,Z,TOTV)
306      WRITE (1,315) (mCURISO(I)/TOTV,I=1,8),TOTmC/TOTV,TOTV
307      CALL COUNT(C)
308      WRITE (1,245)
309      CALL SUB2(ISO,SLNmG,SLNmGT,SLNTV,SOLN,Z,TOTV)
310      WRITE (1,315) ((mgISO(I)/TOTV),I=1,8),TOTmg/TOTV,TOTV
311      CALL COUNT(C)
312      WRITE (1,255)
313      CALL SUB2(ISO,SLNREA,SLNREAT,SLNTV,SOLN,Z,TOTV)
314      WRITE (1,315) ((RISO(I)/TOTV),I=1,8),TOTR/TOTV,TOTV
315      CALL COUNT(C)
316      Z=1
317      WRITE (1,230)
318      CALL SUB2 (ISO,SLNmC,SLNmCT,SLNTV,SOLN,Z,TOTV)
319      CALL COUNT(C)
320      WRITE (1,240)
321      CALL SUB2 (ISO,SLNmG,SLNmGT,SLNTV,SOLN,Z,TOTV)
322      CALL COUNT(C)
323      WRITE (1,250)
324      CALL SUB2 (ISO,SLNREA,SLNREAT,SLNTV,SOLN,Z,TOTV)
325      CALL COUNT(C)
326      WRITE (1,260)
327      Z=2
328      CALL SUB2 (ISO,PmCSLN,PmCSLNT,PVOLSLNT,SOLN,Z,TOTV)
329      CALL COUNT(C)
330      WRITE (1,270)
331      CALL SUB2 (ISO,PmgSLN,PmgSLNT,PVOLSLNT,SOLN,Z,TOTV)
332      CALL COUNT(C)
333      WRITE (1,280)
334      CALL SUB2 (ISO,PRSLN,PRSLNT,PVOLSLNT,SOLN,Z,TOTV)
335      Z=3
336      CALL COUNT(C)
337      WRITE (1,290)
338      CALL SUB2 (ISO, PJSL,PmCSLNT,PVOLSLNT,SOLN,Z,TOTV)
339      CALL COUNT(C)
340      WRITE (1,300)
341      Z=2
342      CALL SUB2 (ISO,PTmCSL,PmCSLNT,PVOLSLNT,SOLN,Z,TOTV)
343      WRITE (1,310) (PmCIST(I),I=1,8)
344      CALL COUNT(C)
345      WRITE (1,320)
346      CALL SUB2 (ISO, PTmgSL,PmgSLNT,PVOLSLNT,SOLN,Z,TOTV)
347      WRITE (1,310) (PmgIST(I),I=1,8)
348      CALL COUNT(C)
349      WRITE (1,330)
350      CALL SUB2 (ISO, PTmRSL,PRSLNT,PVOLSLNT,SOLN,Z,TOTV)
351      WRITE (1,310) (PRIST(I),I=1,8)
352      CALL COUNT(C)
353      WRITE (1,420)
354      WRITE (1,430)
355      WRITE (1,440)
356      DO 46 I=1,15
357          IF (SLNTV(I) .EQ. 0.0) GOTO 46
358          WRITE (1,450) SLNREAT(I)/T,SLNmGT(I)/T,UDSGSLN(I)/T,

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359      *      SLNmCT(I)/T,SLNBCT(I)/T,COSTSLN(I),SOLN(I),SLNTV(I)
360  46      CONTINUE
361      WRITE (1,440)
362      WRITE (1,380) TOTR/T,TOTmg/T,UDSGT/T,TOTmC/T,TOTB/T,TOTCOST,TOTV
363      WRITE (1,440)
364      CALL COUNT(C)
365      WRITE (1,460)
366      WRITE (1,430)
367      WRITE (1,440)
368      DO 47 I=1,15
369          IF (SLNTV(I).EQ.0) GOTO 47
370          WRITE (1,470) PRSLNT(I),PmgSLNT(I),PUDSSLNT(I),PmCSLNT(I),
371      *      PBCSLNT(I),PCOSTSLNT(I),SOLN(I),PVOLSLNT(I)
372  47      CONTINUE
373      WRITE (1,440)
374      CALL COUNT(C)
375      WRITE (1,475)
376      WRITE (1,480)
377      WRITE (1,445)
378      DO 48 I=1,15
379          V = SLNTV(I)
380          IF (V.EQ.0.0) GOTO 48
381          WRITE (1,490) SLNREAT(I)/V,SLNmgT(I)/V,UDSGSLN(I)/V,
382      *      SLNmCT(I)/V,SLNBCT(I)/V,SLNBCT(I)/V,COSTSLN(I)/V,
383      *      SOLN(I),SLNTV(I)
384  48      CONTINUE
385  C
386      WRITE (1,445)
387      TC=TOTCOST
388      TV=TOTV
389      WRITE (1,492) TOTR/TV,TOTmg/TV,UDSGT/TV,TOTmC/TV,TOTB/TV,TC/TV,
390      *      TV
391      WRITE (1,445)
392      CALL COUNT(C)
393      WRITE (1,500)
394      WRITE (1,510)
395      WRITE (1,440)
396      DO 49 I=1,15
397          Y=COSTSLN(I)
398          IF (SLNTV(I).EQ.0) GOTO 49
399          SR = SLNREAT(I)
400          Smg = SLNmgT(I)
401          UDS = UDSGSLN(I)
402          SmC = SLNmCT(I)
403          SBC = SLNBCT(I)
404          IF (Y.EQ.0) Y=1E50
405          WRITE (1,520) SR/Y,Smg/Y,UDS/Y,
406      *      SmC/Y,SBC/Y,COSTSLN(I),SOLN(I),SLNTV(I)
407  49      CONTINUE
408      WRITE (1,440)
409      WRITE (1,386) TOTR/TC,TOTmg/TC,UDSGT/TC,TOTmC/TC,TOTB/TC,TC/TC,
410      *      TV/TC
411      WRITE (1,440)
412      CALL COUNT(C)
413      WRITE (1,540)
414  C      WRITE (1,550) TOTV
415  C      CALC=(TOTV/3.785)*5.5
416  C      WRITE (1,560) TOTCKg,(TOTCKg-HNO3 Kg),TOTCOST,
417  C      *      CALC,(TOTCOST+CALC)
418      WRITE (1,550) TOTV,(TOTV/3.785)

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419      CALC=(TOTV/3.785)*5
420      WRITE (1,570) (TOTCKg-HNO3 Kg),((TOTCKg-HNO3 Kg)*2.2)
421      SMOLE=(Na/23.)*1000
422      WRITE (1,575) SMOLE ,SMOLE/TV
423      MOLEK = ((KA K + S4502 KK + S4502 KB)/39.1)*1000
424      WRITE (1,580) MOLEK,MOLEK/TV
425      RMOLE= (MOLEK + SMOLE)/TV
426      WRITE (1,582) MOLEK+SMOLE,RMOLE
427      WRITE (1,584) TOTCOST
428      WRITE (1,585)
429  C
430      WRITE (1,660)
431      WRITE (1,775)
432      IF (SLNTV(1) .GT. 1) WRITE (1,663) SLNTV(1),SLNNO(1)
433      WRITE (1,775)
434      IF (SLNTV(2) .GT. 1) WRITE (1,666) KgSLN(2,1),SLNTV(2),SLNNO(2)
435      WRITE (1,775)
436      IF (SLNTV(3) .GT. 1) WRITE (1,670) KA KMnO4, KA K,
437      *   KA KMnO4 + KgSLN(3,2), SLNTV(3),SLNNO(3)
438      WRITE (1,775)
439      IF (SLNTV(4) .GT. 1) WRITE (1,680) S4521 CIT A, S4521 OX A,
440      *   NH4OXALATE, S4521, SLNTV(4),SLNNO(4)
441      WRITE (1,775)
442      IF (SLNTV(5) .GT. 1) WRITE (1,690) S4502 KMnO4,(S4502 KK +
443      *   S4502 KB), S4502 Na, S4502, SLNTV(5),SLNNO(5)
444      WRITE (1,775)
445      IF (SLNTV(6) .GT. 1) WRITE (1,700) CITROX CIT A, CITROX OX A,
446      *   CITROX, SLNTV(6),SLNNO(6)
447      WRITE (1,775)
448      IF (SLNTV(7) .GT. 1) WRITE (1,710) TARTARIC A,
449      *   (TARTARIC NAOH * 23.0/40.0),
450      *   (TARTARIC A + TARTARIC NAOH), SLNTV(7),SLNNO(7)
451      WRITE (1,775)
452      IF (SLNTV(8) .GT. 1) WRITE (1,720) S4324 Na, S4324, SLNTV(8),
453      *   SLNNO(8)
454      WRITE (1,775)
455      IF (SLNTV(9) .GT. 1) WRITE(1,730) OXALIC, OXALIC, SLNTV(9),
456      *   SLNNO(9)
457      WRITE (1,775)
458      IF (SLNTV(10) .GT. 1) WRITE (1,735) CIT A, CIT A, SLNTV(10),
459      *   SLNNO(10)
460      WRITE (1,775)
461      IF (SLNTV(11) .GT. 1) WRITE(1,721) OXALHNO,OXALHNO+KgSLN(11,2),
462      *   SLNTV(11),SLNNO(11)
463      WRITE (1,775)
464      IF (SLNTV(12) .GT. 1) WRITE (1,722) NHOH, NHOH, SLNTV(12),
465      *   SLNNO(12)
466      WRITE (1,775)
467      IF (SLNTV(13) .GT. 1) WRITE (1,723) EDTA,
468      *   (EDTA Na), (EDTA + EDTANaOH), SLNTV(13),
469      *   SLNNO(13)
470      WRITE (1,775)
471      IF (SLNTV(14) .GT. 1) WRITE (1,724) ARNa, KgSLN(14,1),
472      *   SLNTV(14),SLNNO(14)
473      WRITE (1,775)
474      IF (SLNTV(15) .GT. 1) WRITE (1,725) HF, (HF + KgSLN(15,2)),
475      *   SLNTV(15),SLNNO(15)
476      WRITE (1,775)
477      WRITE (1,737) KMnO4,CITRIC A,OXALIC A,
478      *   NH4OXALATE,TARTARIC A,(KA K + S4502 KK + S4502 KB),

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479      * Na,(TOTCKg-HNO3 Kg),TV,K2
480      WRITE (1,775)
481      TMOLE=(HNO3 KG*1000./63.)-(OH*1000./17.)
482      IF (TMOLE.LT.0) GOTO 50
483      IF (TMOLE.EQ.0) GOTO 60
484      pH=-ALOG10(TMOLE/TOTV)
485      WRITE (1,770) pH
486      GOTO 60
487  50    pOH = -ALOG10 ((TMOLE*(-1))/TV)
488      pH= 14-pOH
489      WRITE (1,770) pH
490  60    WRITE (1,790) K2
491      WRITE (1,792) NWS
492      C
493      C
494      STOP
495  51    CALL SUB5 (II,RAWDATA,RAWDATA)
496      EST=5
497      GOTO 4
498      C
499      C
500  100   FORMAT (E9.3,E12.3,F10.2,F10.2)
501  105   FORMAT (//,T32,"ESTIMATED VALUES BASED ON AVERAGES")
502  110   FORMAT (/ ,T20,A20,1X,"FILE AS READ IN",//," ",T4,A6,T11,A6,
503      *T19,A6,T27,A6,T35,A6,T43,A6,T51,A6,T59,A6,T67,A6,T74,A6,T80,A6,
504      * T86,A6,T94,A6,T99,A6,T106,A6,T115,A6,/, " ",T11,"dps/ml",T20,
505      * "dps",T28,"dps",T36,"dps",T44,"dps",T52,"dps",T60,"dps",T68,
506      * "dps",T76,"L",T85,"dpm/ml",T94,"g/L",T100,"% wt",T107,"% wt",
507      * T116,"mR/hr",/)
508  115   FORMAT (//,T20,A10,/)
509  120   FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
510      * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,2X,E7.2,1X,F5.1,2X,F5.2,2X,
511      * F5.2,1X,I6)
512  130   FORMAT (//," ",T20,"NM FILE AS READ IN",//," ",T28,"chm 1",T38,
513      * "chm 2",/,T2,"mR/hr*dps",T15,"ug/dps",T28,"$/Kg",T38,"$/Kg",
514      * T48,"Soln",/)
515  140   FORMAT (E9.3,E12.3,F10.2,F10.2,5X,I2,2X,A13)
516  150   FORMAT (//,T2,"DECON INFORMATION ON",1X,A20)
517  200   FORMAT (//," ",T2,"Individual Isotope Information",/)
518  202   FORMAT (T15,"Beta",T23,I8)
519  205   FORMAT (//,T2,"X/L Isotope Information",/)
520  207   FORMAT (T15,"Beta",T23,F8.1,T36,"Beta/min/ml="T49,1PE7.1)
521  210   FORMAT (//," ",T2,"% Isotope Information",/)
522  230   FORMAT (//,T2,"Solution Information - curies",/)
523  235   FORMAT (//,T2,"Solution Information - mCi/L",/)
524  240   FORMAT (//,T2,"Solution Information - mg",/)
525  245   FORMAT (//,T2,"Solution Information - ug/L",/)
526  250   FORMAT (//,T2,"Solution Information - R/hr",/)
527  255   FORMAT (//,T2,"Solution Information - mR/hr*L",/)
528  260   FORMAT (//,T2,"% Solution Information curies % -->",/)
529  270   FORMAT (//,T2,"% Solution Information mg % -->",/)
530  280   FORMAT (//,T2,"% Solution Information R/hr % -->",/)
531  290   FORMAT (//,T2,"% Solution Info. curies,mg,R/hr ",
532      * " % down columns",/)
533  300   FORMAT (//,T2,"% Solution Info. curies/tot curies",/)
534  310   FORMAT (" ",T4,"Tot",2X,8(F4.1,4X),/, " ",T4,104("-"))
535  315   FORMAT ( ,T3,"Tot",,9(F7.2,1X),T97,I7,/,T4,104("-"))
536  320   FORMAT (//,T2,"% Solution Info. mg/tot mg",/)
537  330   FORMAT (//,T2,"% Solution Info. R/hr/tot R",/
538      * )

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539 380 FORMAT (T6,"Total",T14,4(17,3X),18,2X,17,3X,15X,17)
540 385 FORMAT (T6,"Total",T12,4(17,3X),1X,18,11X,F7.2,21X,17)
541 386 FORMAT (T6,"Total",T16,4(17,3X),17,1X,F7.2,21X,F7.2)
542 420 FORMAT (//,T2,"Solution Summary",/)
543 430 FORMAT (T17,"gamma",T27,"gamma",T37,"UDS",T47,"gamma",
544 * T57,"beta",T68,"Cost",/,T17," R/hr",T28,"mg",T38,"g",T47,
545 * " curie",T56," curie",T69,"$",T80,"Soln",T92,"Vol-L")
546 440 FORMAT (T14,88("-"))
547 445 FORMAT (T14,98("-"))
548 450 FORMAT (T14,4(17,3X),18,2X,17,3X,A13,3X,17)
549 460 FORMAT (//,T2,"Solution Summary %",/)
550 470 FORMAT (T14,6(F7.1,3X),A13,3X,F6.1)
551 475 FORMAT (//,T2,"Solution Summary x/L",/)
552 480 FORMAT (T18,"gamma",T29,"gamma",T41,"UDS",T50,"gamma",T62,
553 * "beta",T80,"Cost",/,T17,"mR/hr*L",T29,"ug/L",T41,"g/L",
554 * T49,"mcurie/L",T61,"mcurie/L",T72,"B/L",T81,"$/L",T87,"Soln",
555 * T101,"Tot Vol-L")
556 490 FORMAT (T15,4(F7.1,4X),F8.2,2X,F6.1,2X,F6.2,4X,A13,4X,17)
557 492 FORMAT (T15,4(F7.1,4X),F8.2,10X,F6.2,21X,17)
558 500 FORMAT (//,T2,"Cost Summary x/$",/)
559 510 FORMAT (T17,"gamma",T27,"gamma",T37,"UDS",T47,"gamma",T57,
560 * "beta",T68,"cost",/,T16,"mR/hr/$",T27,"ug/$",T37,"g/$",T46
561 * "mcurie/$",T56,"mcurie/$",T69,"$",T80,"Soln",T91,"Tot Vol-L")
562 520 FORMAT (T15,5(18,2X),16,4X,A13,4X,17)
563 540 FORMAT (//,T2,"Waste Analysis")
564 550 FORMAT (/ ,T12,"Volume of Waste",T45,17,1X,"L",5X,16,1X,"gal")
565 570 FORMAT (T12,"Wt of chemicals w/o HNO3",T45,17,1X,"Kg",4X,
566 * 16,1X,"lbs",)
567 575 FORMAT (T12,"Moles of Na+ ; Molarity",T44,18,1X,"moles",T58,
568 & F7.2,1X,"M")
569 580 FORMAT (T12,"Moles of K+ ; Molarity",T44,18,1X,"moles",T58,
570 & F7.2,1X,"M")
571 582 FORMAT (T12,"Moles Na+ plus K+ ; Molarity",T44,18,1X,"moles",
572 & T58,F7.2,1X,"M")
573 584 FORMAT (T12,"Chemical cost 1982 $",T44,18,1X,"$")
574 585 FORMAT (///,T4,"Chemical Analysis (Kg)",/)
575 660 FORMAT (T91,"# of",/,
576 * T20,"KMnO4",T27,"Citric",T35,"Oxalic",T43,"NH Oxal",T52,
577 * "Tart A",T62,"K+",T69,"Na+",T76,"Kg",T85,"L",T90,
578 * "Flushes")
579 663 FORMAT (T4,"H2O",T80,18,T92,13)
580 666 FORMAT (T4,"HNO3 ",T74,15,T80,18,T92,13)
581 670 FORMAT (T4,"KMnO4/HNO3",T19,15,T59,15,T74,15,T80,18,T92,13)
582 680 FORMAT (T4,"4521",T26,15,T34,15,T44,15,T74,15,T80,18,T92,13)
583 690 FORMAT (T4,"4502",T19,15,T59,15,T66,15,T74,15,T80,18,
584 * T92,13)
585 700 FORMAT (T4,"Citrox",T26,15,T34,15,T74,15,T80,18,T92,13)
586 710 FORMAT (T4,"Tart A/NaOH",T52,15,T66,15,T74,15,T80,18,T92,13)
587 720 FORMAT (T4,"4324",T66,15,T74,15,T80,18,T92,13)
588 721 FORMAT (T4,"Oxalic/HNO3",T34,15,T74,15,T80,18,T92,13)
589 722 FORMAT (T4,"NH4OH",T13,15,T74,15,T80,18,T92,13)
590 723 FORMAT (T4,"EDTA/NaOH",T13,15,T66,15,T74,15,T80,18,T92,13)
591 724 FORMAT (T4,"ARR",T66,15,T74,15,T80,18,T92,13)
592 725 FORMAT (T4,"HF/HNO3",T13,15,T74,15,T80,18,T92,13)
593 730 FORMAT (T4,"Oxalic A",T34,15,T74,15,T80,18,T92,13)
594 735 FORMAT (T4,"Citric A",T26,15,T74,15,T80,18,T92,13)
595 737 FORMAT (T4,"Totals",T19,15,T26,15,T34,15,T44,15,T52,15,
596 * T59,15,T66,15,T73,16,T80,18,T92,13)
597 770 FORMAT (/ ,T20,"Approx. pH",T40,F6.1)
598 775 FORMAT (T4,93("-"))

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599 C780 FORMAT (/,T20,"Moles OH",T40,I6)
600 C785 FORMAT (/,T20,"M OH",T40,F6.1)
601 790 FORMAT (T20,"Number of flushes",T40,I4)
602 792 FORMAT (T20,"Samples taken",T40,I4)
603 C795 FORMAT (/,T20,"Cost per flush",T38,"$",T40,I4)
604 C796 FORMAT (/,T20,"Cost per L",T38,"$",T40,F4.2)
605 800 FORMAT (" ",1X,I6,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,E7.2,1X,
606 * E7.2,1X,E7.2,1X,E7.2,1X,I5,1X,I2,1X,E7.2,1X,F5.1;1X,F5.2,1X,
607 * F5.2,1X,I6)
608 99 STOP
609 END
610 C
611 C
612 C
613 SUBROUTINE SUB2(IS,X,Y,Z,SL,Z2,TV)
614 DIMENSION X(15,8),Y(15),Z(15)
615 CHARACTER SL*13(15),IS*6(8)
616 T=1000
617 C GOTO 9
618 IF (Z2.EQ.3) GOTO 1
619 WRITE (1,130) (IS(I),I=1,8,1)
620 GOTO 2
621 1 WRITE (1,160) (IS(I),I=1,8)
622 2 DO 3 I=1,15
623 IF (Z(I).EQ.0) GOTO 3
624 IF (Z2.EQ.1) WRITE (1,100) (X(I,J)/T,J=1,8),Y(I)/T,
625 * SL(I),Z(I)
626 IF (Z2.EQ.2) WRITE (1,140) (X(I,J),J=1,8),Y(I),SL(I),Z(I)
627 IF (Z2.EQ.3) WRITE (1,170) (X(I,J),J=1,8),SL(I),Z(I)
628 IF (Z2.EQ.4) WRITE (1,180) (X(I,J)/Z(I),J=1,8),
629 * Y(I)/Z(I),SL(I),Z(I)
630 3 CONTINUE
631 WRITE (1,120)
632 GOTO 99
633 100 FORMAT (T6,9(I7,1X),5X,A13,T98,I6)
634 120 FORMAT (" ",T4,104("-"))
635 130 FORMAT (T8,8(A6,2X),"Total",6X,"Soln",10X,
636 * "Total Vol",/, " ",T4,104("-"))
637 140 FORMAT (T6,9(F7.1,1X),5X,A13,T98,F6.1)
638 160 FORMAT (T8,8(A6,2X),11X,"Soln",10X,"Total Vol",/, " ",T4,
639 * 104("-"))
640 170 FORMAT (T6,8(F7.1,1X),13X,A13,T98,F6.1)
641 180 FORMAT (T6,9(F7.2,1X),5X,A13,T98,I6)
642 9 WRITE (1,11) (SL(I),I=1,9)
643 WRITE (1,14)
644 DO 30 J=1,8
645 WRITE (1,13) IS(J),(X(I,J),I=1,8)
646 30 CONTINUE
647 WRITE (1,14)
648 WRITE (1,15) (Y(I),I=1,8)
649 WRITE (1,14)
650 WRITE (1,16) (Z(I),I=1,8)
651 11 FORMAT (//,T12,"Soln",T27,A6,T36,A6,T44,A6,T56,A6,T66,A6,T74,
652 * A6,T84,A6,T96,A6,T104,A6)
653 13 FORMAT (T12,A6,T20,T22,I8,T32,I8,T42,I8,T52,I8,T62,I8,T72,I8,
654 * T82,I8,T92,I8,T102,I8)
655 14 FORMAT (T12,112("-"))
656 15 FORMAT (T12,"Totals",T22,8(I8,2X))
657 16 FORMAT (T12,"Tot vol",T22,8(I8,2X))
658 99 RETURN

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659      END
660      C
661      C
661.1    SUBROUTINE SUB3 (IS,X,Y,Z,TmC,Tmg,TR,ZZ,TV)
661.2    DIMENSION X(8),Y(8),Z(8),XX(8),YY(8),ZZ(8)
661.3    CHARACTER IS*6(8),IS2*9(8)
661.4    DATA IS2/"Zr 95","Nb 95","Ru103","Ru106","Sb125","Cs134",
661.5    * "Cs137","Ce144"/
661.6    C
661.7    DO 12 I=4,7
661.8        XX(I-2)=X(I)
661.9        YY(I-2)=Y(I)
662        ZZ(I-2)=Z(I)
662.1    12  CONTINUE
662.2    XX(1)=X(8)
662.3    XX(6)=X(2)
662.4    XX(7)=X(3)
662.5    XX(8)=X(1)
662.6    YY(1)=Y(8)
662.7    YY(6)=Y(2)
662.8    YY(7)=Y(3)
662.9    YY(8)=Y(1)
663    ZZ(1)=Z(8)
663.1    ZZ(6)=Z(2)
663.2    ZZ(7)=Z(3)
663.3    ZZ(8)=Z(1)
663.4    10  T=1000
663.5        IF (ZZ.EQ.3) GOTO 5
663.6    WRITE (1,100)
663.7    WRITE (1,120)
663.8        IF (ZZ.EQ.2) GOTO 1
663.9    C
664        DO 2 I=1,8
664.1        WRITE (1,130) IS2(I),XX(I)/T,YY(I)/T,ZZ(I)/T
664.2    2  CONTINUE
664.3    WRITE (1,120)
664.4    WRITE (1,140) TmC/T,Tmg/T,TR/T
664.5    WRITE (1,120)
664.6    GOTO 99
664.7    C
664.8    5  WRITE (1,110)
664.9    WRITE (1,120)
665        DO 6 I=1,8
665.1        WRITE (1,135) IS2(I),XX(I)/TV,YY(I)/TV,ZZ(I)/TV
665.2    6  CONTINUE
665.3    WRITE (1,120)
665.4    WRITE (1,145) TmC/TV,Tmg/TV,TR/TV
665.5    WRITE (1,120)
665.6    GOTO 99
665.7    C
665.8    1  DO 3 I=1,8
665.9        WRITE (1,190) IS2(I),XX(I),YY(I),ZZ(I)
666    3  CONTINUE
666.1    WRITE (1,120)
666.2    C
666.3    100  FORMAT (T32,"Ci",T41,"mg",T47," R/hr")
666.4    110  FORMAT (T30,"mCi/L",T39,"ug/L",T46,"mR/hr*L")
666.5    130  FORMAT (T15,A9,T27,6(I7,2X))
666.6    135  FORMAT (T15,A9,T27,6(F7.1,2X))
666.7    140  FORMAT (T15,"Total",T26,3(I8,1X))

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666.8 145 FORMAT (T15,"Total",T26,3(F8.1,1X))
666.9 120 FORMAT (T15,37("-"))
667 190 FORMAT (T15,A9,T27,6(F7.1,2X))
667.1 99 RETURN
667.2 END
667.3 C
705 C
706 C
707 C
708 SUBROUTINE SUB5 (I2,RD,Z)
709 DIMENSION RD(720,15),RDSLN(15,13),RDT(13),AVSLRD(15,13),
710 * AVR(13),COUNT(15),Z(720,15),T(720),KN(15),VOL(15),
711 * VOLSNG(15)
712 C
713 C*****
714 C
715 C T(I) is the sum of the gamma for a flush *
716 C K is the solution number *
717 C COUNT(K) is the # of flushes of soln k w log # *
718 C N is the # of flushes w/o gamma scan *
719 C KN(K) is the # of flushes of soln k w/o gamma *
720 C COUNTTOT is the total # of flushes with log #'s *
721 C VOL(K) is the volume of soln K w log #s *
722 C VOLT is the total volume of sampled flushes *
723 C VOLSNG(K) is the volume of sampled soln k w/o gamma *
724 C VOLSNGT is the total vol of sampled flushes w/o gamma *
725 C VOLNST is the total vol of flushes w/o log #s *
726 C
727 C*****
728 C
729 COUNTTOT=0
730 VOLT=0
731 VOLNST=0
732 VOLSNGT=0
733 N=0
734 DO 1 I=1,12
735 T(I)=0
736 1 CONTINUE
737 DO 2 I=1,12
738 DO 3 J=2,9
739 T(I)=T(I)+RD(I,J)
740 3 CONTINUE
741 2 CONTINUE
742 DO 4 I=1,15
743 COUNT(I)=0
744 KN(I)=0
745 VOL(I)=0
746 VOLSNG(I)=0
747 DO 5 J=1,13
748 RDSLN(I,J)=0
749 AVSLRD(I,J)=0
750 5 CONTINUE
751 4 CONTINUE
752 DO 6 I=1,13
753 RDT(I)=0
754 AVR(I)=0
755 6 CONTINUE
756 DO 7 I=1,12
757 IF (RD(I,1).EQ.0) VOLNST=VOLNST+RD(I,10)
758 IF (RD(I,1).EQ.0) GOTO 7

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759      K=RD(I,11)
760      COUNT(K)=COUNT(K)+1
761      COUNTTOT=COUNTTOT+1
762      VOL(K)=VOL(K)+RD(I,10)
763      VOLT=VOLT+RD(I,10)
764      IF(T(I).EQ.0) GOTO 8
765      GOTO 9
766  8      N=N+1
767          KN(K)=KN(K)+1
768          VOLSNG(K)=VOLSNG(K)+RD(I,10)
769          VOLSNGT=VOLSNGT+RD(I,10)
770  9      DO 10 J=2,9
771          RDSLN(K,J)=RDSLN(K,J)+RD(I,J)*RD(I,10)
772          RDT(J)=RDT(J)+RD(I,J)*RD(I,10)
773  10     CONTINUE
774         DO 11 J=12,13
775         RDSLN(K,J)=RDSLN(K,J)+RD(I,J)*RD(I,10)
776         RDT(J)=RDT(J)+RD(I,J)*RD(I,10)
777  11     CONTINUE
778  7      CONTINUE
779      DO 12 K=1,15
780          IF (COUNT(K).EQ.0) GOTO 12
781          IF (COUNT(K).EQ.KN(K)) GOTO 15
782  C      (If there is no soln k .or. # flshs of soln k = #
783  C      flshs of soln k w/o gamma) goto 12
784          IF (KN(K).GT.0) GOTO 13
785  C      (If # flshs of soln K w/o g .GT.0) goto 13
786  C      Only solns with gamma results go to nest step
787          DO 14 J=2,9
788          AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
789  14     CONTINUE
790      GOTO 15
791  C      13 is ave of sons k w some flshs w/o gamma
792  C      Vol(K)-Volsng(K)= vol of soln K w gamma
793  13     DO 16 J=2,9
794          AVSLRD(K,J)=RDSLN(K,J)/(VOL(K)-VOLSNG(K))
795  16     CONTINUE
796  15     DO 17 J=12,13
797          AVSLRD(K,J)=RDSLN(K,J)/VOL(K)
798  17     CONTINUE
799  12     CONTINUE
800          DO 18 J=2,9
801          AVR(D,J)=RDT(J)/(VOLT-VOLSNGT)
802  18     CONTINUE
803          DO 19 J=12,13
804          AVR(D,J)=RDT(J)/VOLT
805  19     CONTINUE
806      DO 20 I=1,12,1
807          IF (RD(I,1).GT.0 .AND. T(I).GT.0) GOTO 20
808  C      Solns w log # and w gammas skip to 20
809          IF (RD(I,1).GT.0) GOTO 21
810          RD(I,1)=1
811  21     K=RD(I,11)
812  C      Working with flushes w/o log #s or no gammas
813          IF (COUNT(K).EQ.0) GOTO 22
814          IF (COUNT(K).EQ.KN(K)) GOTO 23
815          DO 24 J=12,13
816          IF (RD(I,J) .GT. 0) GOTO 24
817          RD(I,J)=AVSLRD(K,J)
818  24     CONTINUE

```

```

819          DO 25 J=2,9
820              RD(I,J)=AVSLRD(K,J)
821      25      CONTINUE
822          GOTO 20
823      C          If soln k has no samples then the ave of all is used
824      22      DO 26 J=12,13
825              RD(I,J)=AVRD(J)
826      26      CONTINUE
827      23      DO 27 J=2,9
828              RD(I,J)=AVRD(J)
829      27      CONTINUE
830          IF (COUNT(K).EQ.0 .AND. COUNT(K).EQ.KN(K) ) GOTO 20
831          IF (RD(I,1).EQ.1 .AND. COUNT(K).EQ.KN(K)) GOTO 30
832          GOTO 20
833      C          For a flush w/o sample, where there are other solns
834      C          with beta but with no gamma, use soln ave for beta
835      30      DO 31 J=12,13
836              RD(I,J)=AVSLRD(K,J)
837      31      CONTINUE
838      20      CONTINUE
839          DO 28 I=1,12
840              DO 29 J=1,15
841                  Z(I,J)=RD(I,J)
842      29      CONTINUE
843      28      CONTINUE
844      99      RETURN
845      END
846      C
847      C
848      SUBROUTINE COUNT(C1)
849          INTEGER C1
850          C1=C1+1
851          WRITE (1,10) C1
852      10      FORMAT (////,T2,120("-"),T124,"TABLE ",12)
853          RETURN
854      END
855      C
856      C
857      C
858      SUBROUTINE DATAFILE
859          CHARACTER*30 NAME,DATA3,PRNT,STRTSP,A*10,DEVN*5
860      C
861          DISPLAY " File name to be accessed"
862          ACCEPT A
863          DISPLAY "Printer dev number (local=144,lp=6;default=144)"
864          DEVN="144"
865          ACCEPT DEVN
866      C
867          NAME[1:11]="FILE FTM09="
868          NAME[12:10]=A
869          NAME[22:4]=",OLD"
870          NAME[26:1]=%15C
871          DATA3[1:18]="FILE FTM03=ZNM,OLD"
872          DATA3[19:1]=%15C
873          PRNT[1:18]="FILE FTM01=LP;DEV="
874          PRNT[19:4]=DEVN
875          PRNT[23:1]=%15C
876          STRTSP[1:14]="STARTSPOOL 144"
877          STRTSP[15:1]=%15C
878      C

```

```
879      CALL COMMAND (NAME,I1,I2)
880      CALL COMMAND (DATA3,I1,I2)
881      CALL COMMAND (PRNT,I1,I2)
882      CALL COMMAND (STRISP,I1,I2)
883      RETURN
884      END
```