EXECUTIVE SUMMARY

I. INTRODUCTION

This report has been prepared to summarize the findings of the Y-12 National Security Complex (Y-12 Complex) Mass Balance Project and to support preparation of associated U. S. Department of Energy (DOE) site reports. The project was conducted in support of DOE efforts to assess the potential for health and environmental issues resulting from the presence of transuranic (TRU) elements and fission products in recycled uranium (RU) processed by DOE and its predecessor agencies. The United States government used uranium in fission reactors to produce plutonium and tritium for nuclear weapons production. Because uranium was considered scarce relative to demand when these operations began almost 50 years ago, the spent fuel from U.S. fission reactors was processed to recover uranium for recycling.

Uranium that has been irradiated in reactors contains TRU elements [e.g., plutonium (Pu) and neptunium-237 (Np)], fission products [e.g., technetium-99 (Tc)], and reactor-generated uranium products [e.g., uranium-236 (^{236}U)]. Following chemical processing to extract various isotopes of Pu and tritium, as well as to recover uranium for reuse, trace quantities of Pu, Np, Tc, and ^{236}U remain in the RU stream. These constituents make the RU stream more radioactive than natural uranium. Thus, the processing and re-enrichment of RU may present an increased potential for personnel and environmental exposure greater than that normally associated with the processing of unirradiated uranium.

In response to these concerns, DOE initiated an effort to identify all situations in which the processing of RU by DOE and its predecessor agencies could have created an increased potential for exposure of workers and/or significant increased environmental exposure. The first step in this process involves the "mass balance review."

The Y-12 Complex Mass Balance Project represents an effort to collect, verify, analyze, and interpret available data to provide an overall accounting, or site mass balance, for Y-12 Complex RU streams. In addition, data on related Y-12 Complex processes and activities and data on Pu, Np, Tc, and ^{236}U —the primary constituents of concern in the RU streams—have also been collected, analyzed, and interpreted. Based on available Y-12 Complex records and information about processes and methods of operation and maintenance, the Project Team has identified essentially all those plant activities that (1) created a likelihood of Y-12 Complex workers coming into contact with significant levels of RU constituents through direct physical contact or via airborne dust and/or (2) caused reportable environmental releases of concentrated RU constituents.

The Project Team analyzed data on receipts, shipments, inventories, product, releases, and other categories—along with available analytical data—in the context of documented historical information on Y-12 Complex processes and activities. Understanding of processes known to concentrate Pu, Np, and Tc and of activities known to create potential for exposure to these RU constituents provided additional context for analysis. By correlating mass balance data, analytical data, and historical information on Y-12 Complex processes, the team was able to identify specific processes, locations, and time periods of importance for potential worker exposure or environmental releases. These processes, locations, and time periods became the focus of additional assessment to determine the situations that had the potential to create exposure hazards for workers and/or significant environmental release.

II. CHARACTERIZATION OF RU STREAMS RECEIVED AT THE Y-12 COMPLEX

Uranium streams received at the Y-12 Complex that contained or may have contained RU constituents included:

- highly enriched RU material in the form of uranyl nitrate (UN) solutions or uranium oxide (UO_3) received from the Savannah River Site (SRS) and the Idaho Chemical Processing Plant (ICPP) and
- slightly depleted RU[1] oxide (including ash and scrap) from the Oak Ridge Gaseous Diffusion Plant (ORGDP), Hanford, and the Paducah Gaseous Diffusion Plant (PGDP.

In accordance with the methodology prescribed by the DOE Project Plan, calculations were performed to estimate for these streams the additional dose presented by constituents in irradiated uranium over that of unirradiated uranium. A fractional dose calculation with a result of <0.1 indicates that the additional dose presented by the RU constituents is less than 10% of the dose expected from doing similar work with uncontaminated weapons-grade uranium. RU streams characterized by a dose fraction of <0.1 were deemed *de minimis* in accordance with the definition established by DOE for the Recycled Uranium Mass Balance Project. For those streams, the radiation-protection measures in place for the presence of uranium are considered adequate for worker protection.

The highly enriched RU from Savannah River and Idaho in the form of uranyl nitrate and uranium oxide was processed at the Y-12 Complex and shipped to Savannah River as highly enriched uranium (HEU) metal for fabrication of production reactor fuel. The primary focus of this document is on the facilities and processes that had the potential for concentrating the RU constituents, relative to the uranium flow, and so presented the greatest potential for increased worker exposure.

Five shipments of slightly enriched RU (0.74% ^{235}U) were received from SRS; however, they were transferred to Fernald within one day to one month of receipt. Since the material was not repackaged, it is not considered to contribute to an increase in personnel exposure.

Slightly depleted RU oxide was received by the Y-12 Complex from ORGDP, Hanford, and PGDP (including fluorination tower ash from PGDP). Documentation and discussion with many individuals who worked at the Y-12 Complex from the 1950s onward indicated that the plant did not have the need for nor the capability of chemically processing this material. Therefore, it is assumed this material was sent to the plant for storage prior to burial or further disposition to other Oak Ridge Operations sites; most of the ash was returned to ORGDP and PDGP. Since these materials were apparently not processed or handled directly at the Y-12 Complex, they are not at this time considered to be potential sources of increased personnel exposure or significant environmental release. Further analysis may be warranted in the future if these materials are determined to have been processed at the Y-12 Complex.

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[1] Slightly depleted RU recovered from production reactor spent fuel is generally in the range of 0.6 to 0.71% enrichment.

Depleted uranium metal primarily from Fernald, produced from gaseous diffusion plant tails, has been used extensively in weapons and defense programs at Idaho, Rocky Flats, the Y-12 Complex, and other sites. Identical material received at Idaho was analyzed in the Report on Mass Balance at the Specific Manufacturing Capability Project where it was determined that the fractional dose resulting from the RU constituents is less than 10% of that of the uranium itself. The ORGDP Mass Balance Report also confirms very low levels of transuranics and Tc in the tails streams. Processing of this material in a manner that concentrated the RU constituents was not performed at the Y-12 Complex; rather, the material was fabricated as is into an end-use form. For this reason, and in accordance with the DOE Project Plan, this depleted uranium metal stream was excluded from further consideration.

III. RECYCLED URANIUM AT THE Y-12 COMPLEX

For purposes of the DOE recycled uranium mass balance project, RU has been defined as any uranium that has been irradiated in a reactor and, as a result, contains TRU material (e.g., Pu and Np), fission products (e.g., Tc), and reactor-generated uranium products (^{236}U). The methodology applied in this Y-12 Complex project for identifying the flow of RU materials includes the criteria of (1) the source site, (2) the isotopic constituents, and (3) the wt-% assays of the material. Sites identified as RU source sites are the U.S. government facilities that operated production reactors and/or used chemical separation processes to extract uranium from irradiated fuel. Primary source sites are SRS, ICPP, and Hanford. The majority of Y-12 Complex transfers with SRS and ICPP have involved RU (although significant quantities of fresh fuel and sweetener[2] were also shipped to Savannah River). Secondary source sites providing RU materials to the Y-12 Complex are ORGDP and PGDP. The project identified and reviewed RU streams at the Y-12 Complex from the initial introduction of RU into the plant in 1953 until March 31, 1999.

Receipts

RU was received at the Y-12 Complex from three primary source sites:

- ***receipts of 125,161 kg of highly enriched RU*** as UN solution or U-Al ingots from SRS; this material was processed in the plant's 9212 and/or 9206 facilities,
- ***receipts of 25,696 kg of highly enriched RU*** as UN solution or oxide from ICPP; this material was processed in the plant's 9212 and/or 9206 facilities.
- ***receipts of 1,502 kg of slightly depleted RU*** as oxide from Hanford; the assay associated with this material indicates that it was slightly depleted uranium (DU); this material is believed to have been disposed of on the Oak Ridge Reservation without any processing in Y-12 Complex facilities.

The Y-12 Complex also received RU from the following secondary sites:

[2] HEU used to blend with recycled uranium fuel feed to increase its enrichment is referred to as "sweetener."

- ***receipts of 192,836 kg of slightly depleted RU*** from ORGDP; this material is believed to have been stored at the Y-12 Complex temporarily and returned to ORGDP and
- ***receipts of 38,423 kg of slightly depleted RU*** as fluorination tower ash from PGDP; this material is believed to have been disposed of on the Oak Ridge Reservation or returned to PGDP without any processing in Y-12 Complex facilities.

Shipments

RU streams exited the Y-12 Complex via:

- ***shipments of 120,384 kg of highly enriched RU*** as metal product to SRS,
- ***shipments of 29,614 kg of RU*** as slightly depleted fluorination tower ash to PGDP (this material was apparently the ash that had been shipped from PGDP to the Y-12 Complex and stored at the plant), and
- ***shipments of 192,836 kg of slightly depleted RU*** to ORGDP (these represent the return of material to ORGDP).

Inventory

As of March 31, 1999, approximately 13 MT of highly enriched RU remained in the Y-12 Complex inventory.

Summary

The estimated mass balance for highly enriched RU, which is of most concern for worker exposure and is the primary focus of this project, is summarized in Table ES-1. A discrepancy in the mass balance between receipts and shipments (plus inventory and waste) reflects an inability to precisely distinguish between RU and non-RU shipments and receipts involving the Y-12 Complex and Savannah River. Shipments of fresh fuel (non-RU) and sweetener (also non-RU) were made from the Y-12 Complex to Savannah River along with RU shipments. The only way to distinguish between these RU and non-RU streams using available records is by enrichment level. Shipments of ≤90% enrichment were assumed to be RU. Shipments of >90% enrichment were assumed to be non-RU fresh fuel or sweetener. This methodology using enrichment level to distinguish between RU and non-RU results in good estimates of RU flows that are reasonably consistent with Savannah River estimates. Although this is the best available means of distinguishing RU streams, this method does leave a difference of approximately 17.3 MTU between receipts and shipments.

Slightly depleted RU streams received by the Y-12 Complex from ORGDP and PGDP are believed to have been returned to the shipping site or disposed of as waste on the Oak Ridge Reservation. No evidence of Y-12 Complex processing of this material was identified in the historical records reviewed by the Project Team.

Table ES-1 Estimated Mass Balance for Highly Enriched RU

	RU Received kg U	RU Shipped kg U
Savannah River	125,161	120,384
ICPP	25,696	0
TOTAL	**150,857**	**120,384**
Total RU Shipped		120,384
RU Inventory (as of 3/31/99)		13,082
Estimated RU Waste		~100
TOTAL	**150,857**	**133,566**
Difference*		~17,300

** This difference is due to the inability to precisely distinguish between RU and non-RU shipments.*

IV. CONSTITUENTS (PU, NP, AND TC) IN RU

The overall mass balance for highly enriched RU and constituent flow through the Y-12 Complex is summarized in Table ES-2. This table compiles quantities of each constituent based upon the estimating logic presented in Chapter 5.

Table ES-2 Overall Mass Balance for Y-12 Complex Highly Enriched RU

	Receipts	Shipments	Inventory	Waste	Difference
RU (kg U)	150,857	120,384	13,082	~100	~17,300
Pu (g)	0.051	0.033	0.002	~0.01	~0
Np (g)	3,666	1,073	121	270	2,200 (-300)*
Tc (g)	14,499	12,279	1,365	3,200	-2,345 (335)†

** The Np difference is –300 g if it is assumed that the reported 1.75 Ci (2,500 g) Np was buried in the Bear Creek Burial Grounds as solid waste or shipped off site to another DOE facility.*
† The Tc difference is 340 g if it is assumed that most Tc found in the southeast S-3 Pond came from ORGDP and that Tc is not included in receipts.

Based upon Y-12 Complex records of highly enriched RU receipts and shipments, material remaining in inventory, and determinations regarding quantities in disposal, there remain no more than trace quantities of Pu not accounted for.

In contrast, the overall mass balance cannot account for 2,200 g of Np. In the historical plant record, reference is made to discharge of 2,500 g (1.75 Ci) of Np to the S-3 Ponds. However, the amount of Np that can be accounted for by sampling and analysis of pond sludge is only 145 g. A similar quantity was found in the WETF sludge. It is known by a few individuals in the plant that an ion exchange column was installed in the uranyl nitrate feed stream to specifically remove Np from the incoming SRS RU for use in another program. The spent or loaded ion exchange columns were removed from the feed line and sent off-site for Np recovery. Since there was little residual uranium contained on the ion exchange resin, this transaction was not listed as an RU transfer and was not placed in the plant uranium accountability record. Assuming that the 2,500 g of Np identified in the waste management record was indeed separated from the RU stream as suspected and either sent off-site for use elsewhere or buried as a solid waste in the Bear Creek Burial Grounds, the overall mass balance shows 300 g more Np than can be accounted for.

The overall Y-12 Complex mass balance shows 2,345 grams more Tc on the plant site than can be accounted for, based on the mass difference between the uranium feed, product, and waste streams. It should be noted that the normal flow of acid waste from the 9212 and 9206 HEU operations to the S-3 Ponds went first into the NE basin. The flow was then routed by overflow pipe to the NW basin, then to the SW basin, and finally into the SE basin. Under this normal design flow pattern, one would expect to find the greatest concentration of Tc in the NE basin and the least in the SE basin. Sludge analysis, however, shows 179 g of Tc in the NE basin, 184 g in the NW, 89 g in the SW, and 2,680 g in the SE. The apparent discrepancy was explained by a former S-3 Pond manager, who stated that on several occasions Tc liquid waste was discharged directly to the SE basin from 5-gal waste drums received from ORGDP. These Tc residues were removed from the gaseous diffusion cascade from time to time during certain maintenance activities. If it is assumed that essentially all of the Tc in the SE basin came from ORGDP and was not included in the Y-12 Complex RU database, the mass balance difference is 340 g Tc, or 2% of the estimated total receipt.

V. POTENTIAL FLOW PATHS OF RU WITHIN THE Y-12 COMPLEX

The processing of RU at the Y-12 Complex impacted a number of facilities and locations at the plant site. The primary facilities with significant involvement in processing RU were:

- Building 9212, a large uranium processing complex that performed uranium recovery operations on RU materials and produced RU metal product,
- Building 9206, a large uranium processing facility that also performed uranium recovery operations on RU materials and produced RU metal product,
- Building 9720-5, the Y-12 Complex "warehouse," which received, stored, and shipped uranium materials, including RU,
- S-3 Ponds, four holding ponds for liquid and sludge wastes resulting from processes involving uranium, including both unirradiated and recycled uranium (prior to WETF operation beginning in 1986),
- West End Treatment Facility (WETF), a group of nine tanks/bioreactors for holding and treating Y-12 Complex aqueous nitrate wastes (after the S-3 Ponds were taken out of service) plus four sludge storage tanks, and
- New Hope Pond, a large surface water impoundment designed to capture and retain coal fines and other entrained solids from rainwater and plant secondary wastewaters.

Building 9212 Complex Processes

Building 9212 complex processes involved the following pathways:

- receiving UN solution from ICPP (in safe bottles) and from SRS (in tanker trucks)
- weighing SRS tanker trucks (at Building 9929-1)
- sampling UN solution
- pouring UN solution from ICPP safe bottles into "pour-up" stations for transfer to intermediate storage tanks
- pumping UN solution from SRS tanker trucks to 9212
- UN evaporated and concentrated
- manual filling and loading of UN into safe bottles for transfer to 9206 (in the period after 9206 assumed responsibility for certain recovery operations from 9212)
- ICPP UO_3 received and dissolved to produce UN (in the period after ICPP began sending UO_3 instead of UN)
- purification of UN via solvent extraction (primary and secondary extraction)
- pumping of solvent extraction raffinate to S-3 Ponds
- feeding of solvent extraction raffinate to 9212 bioreactor
- transporting of solvent extraction raffinate to WETF
- denitration of uranyl nitrate hexahydrate (UNH) to UO_3
- maintenance on denitrator or fluid beds
- conversion of UO_3 to uranium tetrafluoride (UF_4) in converted lab muffle furnaces
- removal of dry UF_4 from process
- "bomb" reduction of UF_4 to uranium metal
- sampling, fracturing, and packaging of uranium metal buttons
- salvage operations for uranium-aluminum (U-Al) alloy from SRS
- metal product shipped from Building 9720-5

Building 9206 Processes

Building 9206 processes involved the following pathways:

- UN solution "poured-up" into safe tanks
- U-Al ingots received from SRS at Building 9720-5
- dross and sweepings received
- U-Al ingots (or dross/sweepings) dissolved in NaOH to remove Al; sodium diuranate produced
- sodium diuranate dissolved in nitric acid to produce UN
- UO_3 received and dissolved to form UN
- purification of UN via solvent extraction (primary and secondary extraction)
- isolation and transport of raffinate to 9212
- denitration of UNH to UO_3
- maintenance on denitrator or fluid beds
- conversion of UO_3 to UF_4

- removal of dry UF_4 from process
- "bomb" reduction of UF_4 to uranium metal

Processes Associated with Other Y-12 Complex Facilities

- capping and closure of S-3 Ponds and sludge removal and closure of New Hope Pond
- treatment of nitrate waste at WETF
- storage of RU materials at Building 9720-5

VI. EVALUATION OF ACTIVITIES THAT INVOLVED POTENTIAL WORKER EXPOSURE TO RU CONSTITUENTS

Prior to and during the processing of RU, the Y-12 Complex also operated as a uranium-processing facility. Careful consideration for worker protection was given to the introduction of RU for processing. A criterion for acceptance was based upon DOE/OR-859,[3] which in turn was derived from an informal agreement between the Y-12 Complex and SRS. The intent of this criterion was to maintain the relative hazard potential of all non-uranium alpha emitters to less than 7% of the relative hazard potential of uranium.[4] With this limitation, it was expected that RU could be safely managed by the measures already in place for processing uranium.

The Project Team carefully analyzed and evaluated 36 activities identified as involving potential for worker exposure. The team assigned the following Occupational Exposure Potential (OEP) scores:

- No Significant OEP — 8 activities
- Low OEP — 1 activity
- Moderate OEP — 27 activities

Most of the potential exposure activities at the Y-12 Complex were found to have a "Moderate" OEP rating as a result of the combined product of a constituent level value of 3 for Savannah River RU or a value of 2 for Idaho RU with a value of 1 or 2 for airborne potential and exposure duration. Certain maintenance activities involving equipment that contained finely divided RU solids were assigned a value of 3 for airborne potential. However, because these types of maintenance activities were not performed very often, the overall OEP was rated "Moderate," with a cumulative score of 9.

In no instance did any identified activity involve a combination of airborne potential, constituent level, and exposure duration that produced an OEP score in the "High" range. Although some activities presented moderate OEP scores, the average derived air concentrations (DAC) for the areas associated with RU was on the order of only 3% of the plant action level (PAL).

The methodology established for the DOE Mass Balance Project considered ^{236}U an unmonitored isotope, along with Pu, Np, and Tc. In fact, ^{236}U is generally indistinguishable from other uranium isotopes; it has the same chemical behavior and the same dose

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[3] Egli, D. et al., *The Report of the Joint Task Force on Uranium Recycle Materials Processing*, 1985.
[4] Vath and Duerksen, *Criteria for Acceptance and Technical Assessment for Acceptance of Enriched Uranium at the Y-12 Plant,* April 25, 1996.

consequences as can be seen by comparing uranium DAC values. Monitoring, both in the field and through bioassay, accounts for its presence and correctly assigns dose or risk. Other constituents, such as plutonium, are fundamentally different in that they do not have the same chemical behavior or risk. Their presence could alter the intrinsic risk of handling recycled uranium. Because ^{236}U was monitored at the Y-12 Complex, the analysis presented here, which used the DOE Mass Balance Project *de minimis* calculation methodology, estimates the Occupational Exposure Potential (the implied hazard) to be higher than it actually is. A calculation that considers the non-uranium, potentially unmonitored component would at times lead to the conclusion of "No Significant Occupational Exposure Potential" when ^{236}U is more appropriately considered.

VII. EVALUATION OF PROCESSES OR FACILITIES THAT INVOLVED POTENTIAL ENVIRONMENTAL RELEASES

Various sources that documented the potential environmental impact of RU components from the Y-12 Complex and the Oak Ridge Reservation were identified and reviewed by the Project Team. These reports are summarized in Chapter 2.

Solvent raffinate streams from Building 9212 and 9206 extraction systems—as well as condensed acid streams from the various UN solution evaporators and denitrators—were ultimately discharged to the unlined S-3 Ponds. Chemical analysis of the S-3 Pond sludge indicated the presence of 3,140 g of Tc, 145 g of Np, and <0.1 g of Pu. The S-3 Ponds were capped in 1986, with the sludge left in place under EPA oversight. Uranium has been detected in groundwater monitoring wells around the S-3 Ponds. Therefore, one can infer that RU constituents also leached into the nearby environment from the ponds. Data from other locations, such as the WETF and New Hope Pond, were analyzed and indicated these sites have no significant potential for environmental releases.

VIII. CONCLUSIONS

Potential Personnel Exposure

Although the Project Team identified 36 activities as having potential for worker exposure, in no instance did any identified activity produce an OEP score in the "High" range. As a result, the potential for worker exposure to TRU elements and fission products at the Y-12 Complex is considered low to moderate.

Early in its existence, the Y-12 Complex implemented a worker protection program that included worker radiological protection (see Section 2.7). This program incorporated such elements as personnel protective equipment, personnel monitoring, environmental monitoring, work location surveys, work-time limits on jobs with penetrating radiation, excretion rate limits, periodic examinations of personnel, and Plant Action Level limits. The inhalation of radioactive materials was recognized as the most important source of possible exposure at the Y-12 Complex. Consequently, administrative controls were primarily designed to guard against associated hazards.

Worker protection measures in place at the Y-12 Complex likely provided substantial mitigation to the risks introduced by the activities rated as moderate to low in OEP.

However, dose assessment studies may be warranted as a follow-on activity to provide a more detailed assessment of worker exposure.

Potential Environmental Releases

Soil and groundwater around the Y-12 Complex is contaminated with various radionuclides as a direct result of the nature of the Y-12 Complex work and past disposal practices. However, the quantities of RU constituents in and around the plant are very small and pose no threat to the immediate environment or the surrounding communities. A clear understanding of the contamination exists, and ongoing environmental programs continue to verify this conclusion. The report of the joint task force assembled by DOE in 1985 to study past and (then) current practices related to the processing of RU reflected similar conclusions. The task force did not disclose any instance at the Y-12 Complex in which the environment was jeopardized or compromised.

An Oak Ridge Dose Reconstruction Project was initiated in 1994 as follow-up to the Oak Ridge Dose Reconstruction Feasibility Study, which recommended a closer examination of past uranium emissions and potential resulting exposures. The Task 6 component of the project involved further evaluation of Oak Ridge uranium operations and effluent monitoring records to determine if uranium releases from the Oak Ridge Reservation likely resulted in off-site doses that warranted further study. The results were documented in the July 1999 Task 6 report. The Task 6 team concluded that earlier estimates of uranium releases had been underestimated. However, based on the decision guidelines from the Oak Ridge Health Agreement Steering Panel, the Task 6 team concluded that while Y-12 Complex uranium releases are candidates for further study, they are not high-priority candidates.

The Task 7 component of the project involved performing qualitative and quantitative screening of various materials of concern at the Y-12 Complex and the other DOE Oak Ridge sites. Materials screened included Np and Tc. Results were reported in the Task 7 report. Based on the analysis of data, the Task 7 team determined that Np did not warrant further study. Although Tc was identified as one of the potential candidates for further study, it was not determined to be a high-priority candidate.

These analyses, along with other information on environmental consequences from Y-12 Complex operations, identify candidate environmental issues for additional study. However, candidate issues related to the processing of RU have not been determined to be high-priority candidates for further study.

APPENDIX B

OCCUPATIONAL EXPOSURE POTENTIAL METHODOLOGY

The Occupational Exposure Potential (OEP), shown in Table 2.6, is a score derived from the product of three parameters qualitatively assigned by the Project Team. The parameters are airborne potential, constituent level, and exposure duration. Each parameter is assigned a numeric value according to prescribed criteria.

Airborne Potential

This parameter is a subjective assignment of the likelihood of the contaminant to become airborne or concentrated in air. The judgment is largely based upon the form of the material and the nature of the particular operation. An associated numeric value is based on the following criteria:

Value	Likelihood
0	No likelihood of being airborne
1	Low airborne potential
2	Moderate airborne potential
3	High airborne potential

Constituent Level

Calculations for each of the various product streams were performed to estimate the additional dose presented by constituents present in irradiated uranium over that of the uranium alone. The DOE EH-3 team provided a standardized tool, in the form of an electronic spreadsheet, to perform the dose fraction calculations. The calculation and its technical basis are described in detail in the *Historical Generation and Flow of Recycled Uranium in the DOE Complex Project Plan*. To use the tool, the following information about the process stream being considered was determined and entered in the spreadsheet:

- chemical form
- level of enrichment in the ^{235}U isotope
- mass fraction of the constituents ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{237}Np, ^{241}Am, ^{236}U, and ^{99}Tc

The required information was determined by assuming estimates based on available analytical data, process knowledge, and engineering judgment, and calculations were performed for the streams of interest. Assumptions for the calculations and the results are summarized in the accompanying tables.

The calculated fractional dose was then compared against criteria for assignment of a respective numeric value:

Value	Likelihood
0	Sum of constituents clearly below *de minimis* levels (clearly less than 10% additional dose)
1	Sum of constituents likely to cause up to 20% total dose
2	Sum of constituents likely to cause more than 20% but less than 50% total dose
3	Sum of constituents likely to cause 50% or more of total dose

Exposure Duration

This parameter considers the time of worker exposure on the job. As such, it considers whether or not a particular activity was conducted infrequently or was carried out on a daily basis. Exposure duration was also based upon a set of criteria to arrive at a numeric value:

Value	Likelihood
1	50 hours per year or less
2	More than 50 hours per year but less than 500 hours per year
3	500 or more hours per year

OEP Ratings

Multiplying the three values for airborne potential, constituent level, and exposure duration produces an overall value that falls within a range that determines the OEP score:

Score	Product Range	Likelihood
0	0	"No significant" occupational exposure potential
1	1	"Low" occupational exposure potential
2	2-9	"Moderate" occupational exposure potential
3	>10	"High" occupational exposure potential

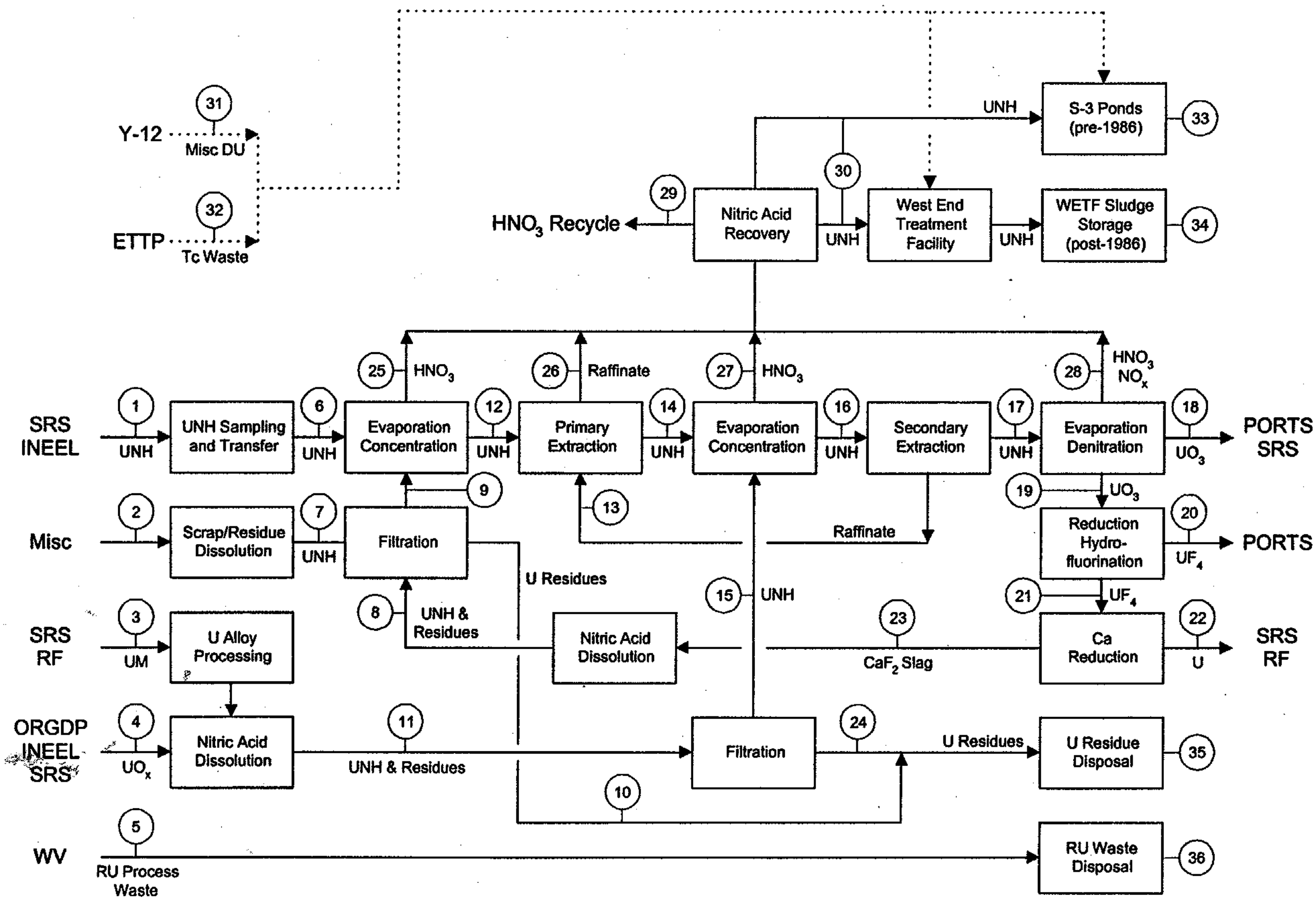
The results of this rating system for Y-12 Complex activities are presented in the following charts and tables, which were used to provide the OEP ratings presented in Table 2.6.

RU Occupational Exposure Potential at the Y-12 Complex

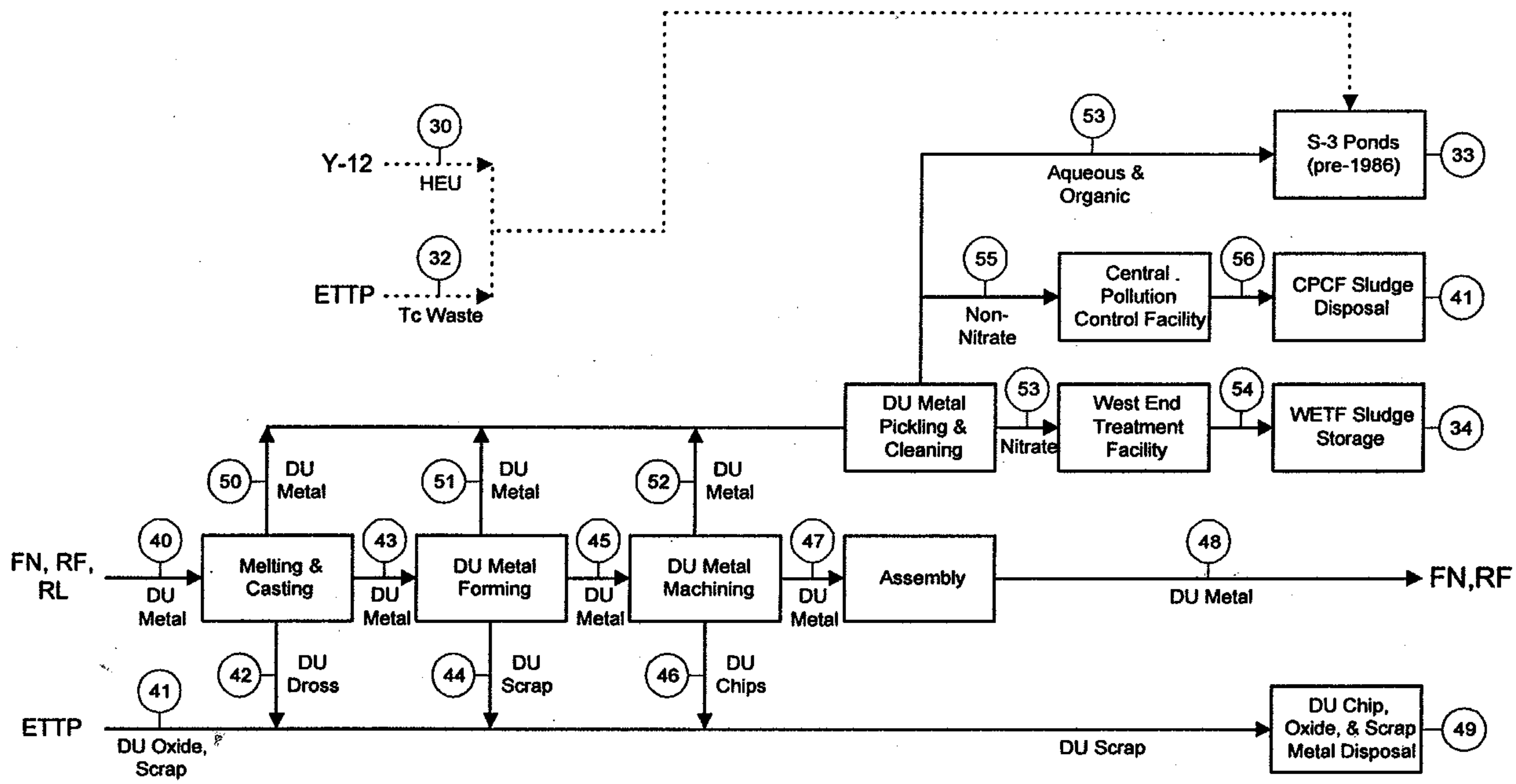
Y-12 HEU Activity	Stream Composition, U Basis				Exposure Potential			
	Pu ppb	Np ppm	Tc ppm	^{236}U %	Constit. Level	Airborne Potential	Exposure Duration	Occ. Exposure
Activities with Bldg 9212								
1A. ICPP UN soln received in safe bottles	0.11	4.7	0.13	10	2	0	1	no sig
1B. SR tanker truck weighed	0.36	28.8	82	27.8	3	0	1	no sig
1C. SR material sampled	0.36	28.8	82	27.8	3	0	1	no sig
1D. ICPP UN soln poured	0.11	4.7	0.13	10	2	1	1	low
1E. SR UN soln pumped to 9212	0.36	28.8	82	27.8	3	0	1	no sig
1F. SR/ICPP UN evaporated	0.36	28.8	82	27.8	3	1	2	mod
1G. Manual fill and load of UN in safe bottles	0.36	28.8	82	27.8	3	1	2	mod
1H. ICPP UO_3 received, dissolved to UN	0.11	4.7	0.13	10	2	2	1	mod
1I. Purification of UN via solvent extraction	4.5	346	211	27.8	3	1	3	mod
1J. Discard of raffinate to S-3 Ponds	62	2980	641	27.8	3	1	1	mod
1K. Feeding of raffinate to bioreactor	62	2980	641	27.8	3	1	1	mod
1L. Transport raffinate to WETF	62	2980	641	27.8	3	1	1	mod
1M. Denitration of SR/ICPP UN to UO_3	0.24	23.8	85	27.8	3	1	2	mod
1N. Maintenance on denitrator and fluid beds	0.24	23.8	85	27.8	3	3	1	mod
1O. Conversion of material to UF_4	0.24	23.8	85	27.8	2	3	1	mod
1P. Removal of dry UF_4 from process	0.24	23.8	85	27.8	3	3	1	mod
1Q. Bomb reduction to metal	0.24	23.7	72	27.8	3	3	1	mod
1R. Sampling, fracturing, packaging metal	0.24	23.7	72	27.8	3	2	1	mod
1S. SR U-Al salvage operations	0.23	22.5	81	27.8	3	1	1	mod
1T. Metal product shipped	0.23	22.5	81	27.8	3	0	2	no sig

RU Occupational Exposure Potential at the Y-12 Complex

Y-12 HEU Activity	Stream Composition, U Basis				Exposure Potential			
	Pu ppb	Np ppm	Tc ppm	^{236}U %	Constit. Level	Airborne Potential	Exposure Duration	Occ. Exposure
Activities with Bldg 9206								
2A. SRS UN soln poured into safe bottles	0.36	28.8	82	27.8	3	1	1	mod
2B. SRS U-Al ingots received	0.23	22.5	82	27.8	3	0	1	no sig
2C. SRS dross and sweepings received	0.23	22.5	82	27.8	3	0	1	no sig
2D. SRS U-Al dissolved in NaOH	0.23	22.5	82	27.8	3	1	2	mod
2E. SRS sodium diuranate dissolved in acid	0.23	22.5	82	27.8	3	1	2	mod
2F. ICPP UO_3 received, dissolved to UN	0.11	4.7	130	10	2	2	1	mod
2G. Purification of UN	4.5	346	211	27.8	3	1	3	mod
2H. Isolating, trucking, piping raff to 9212	62.4	2980	641	27.8	3	1	1	mod
2I. Denitration of SR/ICPP UN to UO_3	0.24	23.8	85	27.8	3	1	2	mod
2J. Maintenance on denitrators or fluid beds	0.24	23.8	85	27.8	3	3	1	mod
2K. Conversion of material to UF_4	0.24	23.8	85	27.8	3	3	1	mod
2L. Removal of dry UF_4	0.24	23.8	85	27.8	3	2	1	mod
2M. Bomb reduction to metal	0.24	23.7	85	27.8	3	3	1	mod
Other Activities								
3A. Closure of S-3 Ponds	1.4	65.9	200	3.0	3	2	1	mod
3B. Treatment of nitrate waste	1.4	65.9	200	3.0	3	1	2	mod
3C. RU material stored	0.24	23.7	85	27.8	3	0	1	no sig



Processing of Recycled HEU in the Y-12 Complex



Processing of Recycled DU in the Y-12 Plant

Processing of Recycled HEU
SRS RHEU Material Flow through Y-12
Steady State Flow Model (manual calc procedure to converge on recycle streams)

Feed Stream Definition, mass flows						**Feed Stream Definition, concentration**				
	MTU	Pu, gms	Np, gms	Tc, gms	Th, gms	Pu, ppb	Np, ppb	Tc, ppb	Th, ppb	**Data Source**
UNH	125.2	0.0455	3600	10260		0.363	28754	81949	0	Y-12 & SRS Analysis
UO3	0.00	0.0000	0.00	0.00		0.00	0.00	0.00	0	
U metal						0	0	0		
U-Al						0	0	0		
UF4						0	0	0		
Residues						0	0	0		
Other	0	0	0	0		0	0	0	0	
Totals	125.2	0.0455	3600	10260		0.363	28754	81949		

Feed Stream Concentrations												
	Pu, ppb/U	Np, ppb/U	Tc, ppb/U	U-234 %	U-235 %	U-236 %	U-238 %	Pu-238 %	Pu-239 %	Pu-240 %	Pu-241 %	Pu-242 %
UNH	0.363	28754	81949	1.39	62.6	27.8	8.21	84	14	2	0	0
UO3	0.000	0	0	1.39	62.6	27.8	8.21	84	14	2	0	0
U metal	0	0	0				100					
U-Al	0	0	0				100					
UF4	0	0	0				100					
Residues	0	0	0				100					
Other	0	0	0				100					
Average	0.363	28754	81949	1.39	62.6	27.8	8.21	84	14	2	0	0

U Mix Specific Activity	
dpm/g U	2.35E+08
μCi/g U	1.06E+02

Pu Mix Specific Activity	
dpm/g Pu	3.27E+13
μCi/g Pu	1.47E+07

Other Specific Activity					
	Np-237	Tc-99	Dep U	Nat U	93% U
dpm/g	1.56E+09	3.76E+10	9.00E+05	1.50E+06	1.40E+08
μCi/g	7.04E+02	1.69E+04	4.05E-01	6.76E-01	6.31E+01
Ci/g	7.04E-04	1.69E-02	4.05E-07	6.76E-07	6.31E-05

β Activity of non-RU	
	dpm/μgU
Th-234	0.0670
Pa-234	0.0670
Th-231	4.3197
Total	4.454

Feed Stream Activity										RU Comparison to WU		
	U, ci	Pu, ci	dpm/μgU	Np, ci	dpm/μgU	Tc, ci	dpm/μgU	Th, ci	dpm/μgU	α Ratio	β Ratio	γ Ratio
UNH	1.33E+04	6.69E-01	1.19E-02	2.53E+00	4.49E-02	1.73E+02	3.07E+00			0.2840	0.6903	
UO3	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			0.0000	0.0000	
U metal	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			0	0	
U-Al	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			0	0	
UF4	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			0	0	
Residues	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			0	0	
Other	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00			0.0000	0.00000	
Totals	1.33E+04	6.69E-01	1.19E-02	2.53E+00	4.49E-02	1.73E+02	3.07E+00			0.2840	0.6903	

Notes:
α Ratio = (activity of Pu + Np per gram U)/nominal specific activity of EU*700
β Ratio = beta activity of sample per gram U/nominal specific beta activity of unirradiated EU
γ Ratio = μgram Ra-226 equivalent/gram U

Chemical Process Assumptions										
	Distribution of U		Distribution of Pu		Distribution of Np		Distribution of Tc		Distribution of Th	
Process Step	Product	Raffinate	Product	Raffinate	Product	Raffinate	Product	Raffinate	Product	Raffinate
HNO3 Dissolver	1	0	1	0	1	0	1	0	1	0
Liquid/Solids Filter	0.98	0.02	0.9	0.1	0.9	0.1	0.9	0.1	0.9	0.1
Primary Evaporator	0.999	0.001	0.99	0.01	0.99	0.01	0.99	0.01	0.99	0.01
Primary Extraction	0.99999	0.00001	0.7	0.3	0.8	0.2	0.98	0.02	0.99	0.01
Second Evaporator	0.999	0.001	0.99	0.01	0.99	0.01	0.99	0.01	0.99	0.01
Second Extraction	0.99	0.01	0.4	0.6	0.5	0.5	0.95	0.05	0.9	0.1
Denitration	0.999	0.001	0.999	0.001	0.995	0.005	0.999	0.001	0.999	0.001
H2/HF Fluid Beds	1	0	1	0	1	0	1	0	1	0
Ca Reduction	0.95	0.05	0.9	0.1	0.9	0.1	0.9	0.1	0.95	0.05
HNO3 Still to Recycle	0.001	0.999	0.001	0.999	0.001	0.999	0.001	0.999	0.001	0.999
Fraction UO3 Product	0	1	0	1	0	1	0	1	0	1
Fraction UF4 Product	0	1	0	1	0	1	0	1	0	1
Fraction to WETF	0	1	0	1	0	1	0	1	0	1

Process Stream Flows											
	Stream Number										
Stream Component	1	2	3	4	5	6	7	9	10	11 est	11*
U, kgs	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.25E+05	0.00E+00	0.00E+00	0.00E+00	1.25E+05	1.31E+03	1329.707
Pu, gms	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.55E-02	0.00E+00	0.00E+00	0.00E+00	4.55E-02	2.81E-02	0.048205
Np, gms	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.60E+03	0.00E+00	0.00E+00	0.00E+00	3.60E+03	1.87E+03	3134.245
Tc, gms	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.03E+04	0.00E+00	0.00E+00	0.00E+00	1.03E+04	5.56E+02	590.61637
Th, gms	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.0000
						0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
						0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	

*Loop 1, manually enter "11 Est." values, then use "11 Calc" values n times for convergence of stream "11" with "11 Calc". Go to Loop 2.

Process Stream Flows

Stream Component	Stream Number										
	12	13 est	13**	14	15	16	11 calc*	17	18	19	20
U, kgs	1328.38	6250.634	6575.4656	7.90E+03	1.25E+05	1.33E+05	1329.7066	1.32E+05	0.00E+00	1.32E+05	0.00E+00
Pu, gms	0.05	0.0031216	0.0032105	3.57E-02	4.55E-02	8.03E-02	0.0482053	3.21E-02	0.00E+00	3.21E-02	0.00E+00
Np, gms	3102.90	299.56957	311.857400	2.73E+03	3.60E+03	6.27E+03	3134.2449	3.13E+03	0.00E+00	3.12E+03	0.00E+00
Tc, gms	584.71	1017.8263	1121.0489	1.67E+03	1.03E+04	1.18E+04	590.61637	1.12E+04	0.00E+00	1.12E+04	0.00E+00
Th, gms	0.00	0	0	0.00E+00	0.00E+00	0.00E+00	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00	0	0	0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00	0	0	0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00

**Loop 2 (after convergence of Loop 1), manually enter "13 Est." values, then use "23" values m times for convergence of "13" with "23".
Go back to Loop 1 as required for overall convergence.

Process Stream Flows

Stream Component	Stream Number										
	21	22	23**	25	26	27	28	29	30	31	32
U, kgs	1.32E+05	1.25E+05	6575.4656	1.33E+00	7.90E-02	1.33E+02	1.32E+02	2.66E-01	2.66E+02	1.20E+04	1.00E+02
Pu, gms	3.21E-02	2.89E-02	0.0032105	4.82E-04	1.53E-02	8.12E-04	3.21E-05	1.66E-05	1.66E-02	7.88E-05	0.00E+00
Np, gms	3.12E+03	2.81E+03	311.857372	3.13E+01	6.83E+02	6.33E+01	1.57E+01	7.93E-01	7.92E+02	3.10E-02	2.30E+01
Tc, gms	1.12E+04	1.01E+04	1121.0489	5.91E+00	3.41E+01	1.19E+02	1.12E+01	1.71E-01	1.70E+02	1.09E-01	2.30E+03
Th, gms	0.00E+00	0.00E+00	0	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Process Stream Flows

Stream Component	Stream Number										
	33	34	35				40	41	42	43	44
U, kgs	1.24E+04	0.00E+00	0.00E+00				1.00E+06	1.00E+03	2.00E+05	7.00E+05	2.80E+05
Pu, gms	1.67E-02	0.00E+00	0.00E+00				6.57E-03	6.57E-06	1.31E-03	4.60E-03	1.84E-03
Np, gms	8.16E+02	0.00E+00	0.00E+00				2.58E+00	2.58E-03	5.16E-01	1.81E+00	7.22E-01
Tc, gms	2.47E+03	0.00E+00	0.00E+00				9.10E+00	9.10E-03	1.82E+00	6.37E+00	2.55E+00
Th, gms	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
	0.00E+00	0.00E+00	0.00E+00								
	0.00E+00	0.00E+00	0.00E+00								

Process Stream Flows

	Stream Number										
Stream Component	45	46	47	48	49	50	51	52	53	54	55
U, kgs	2.80E+05	8.40E+04	1.40E+05	1.40E+05	5.65E+05	1.00E+05	1.40E+05	5.60E+04	2.96E+05	2.96E+05	
Pu, gms	1.84E-03	5.52E-04	9.20E-04	9.20E-04	3.71E-03	6.57E-04	9.20E-04	3.68E-04	1.94E-03	1.94E-03	
Np, gms	7.22E-01	2.17E-01	3.61E-01	3.61E-01	1.46E+00	2.58E-01	3.61E-01	1.44E-01	7.64E-01	7.64E-01	
Tc, gms	2.55E+00	7.64E-01	1.27E+00	1.27E+00	5.14E+00	9.10E-01	1.27E+00	5.10E-01	2.69E+00	2.69E+00	
Th, gms	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	

Mass Balance Checks

	Stream Comparison					
Stream Component	Out-In	% Input	Str 11a-11	% Str 11	Str23-13	% Str 13
U, kgs	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pu, gms	0.0000	0.0002	0.0000	-0.0001	0.0000	-0.0009
Np, gms	0.0001	0.0000	-0.0001	0.0000	0.0000	0.0000
Tc, gms	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Th, gms	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Component Distribution			
Fract Res	Fract Sdg	Fract Pro	Totals
0.0000	0.0901	0.9099	1.0000
0.0000	0.3657	0.6339	0.9996
0.0000	0.2251	0.7747	0.9998
0.0000	0.1967	0.8033	1.0000
0.0000	0.0000	0.0000	0.0000

Process Stream Concentrations on U Basis

	Stream Number										
Stream Component	1	2	3	4	5	6	7	9	10	11 est	11
U, kgs	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.25E+05	0.00E+00	0.00E+00	0.00E+00	1.25E+05	1.31E+03	1.33E+03
Pu, ppb/U	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.63E-01	0.00E+00	0.00E+00	0.00E+00	3.63E-01	2.14E+01	3.63E+01
Np, ppb/U	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.88E+04	0.00E+00	0.00E+00	0.00E+00	2.88E+04	1.42E+06	2.36E+06
Tc, ppb/U	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.19E+04	0.00E+00	0.00E+00	0.00E+00	8.19E+04	4.23E+05	4.44E+05
Th, ppb/U	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Process Stream Concentrations on U Basis

	Stream Number										
Stream Component	12	13 est	13	14	15	16	11 cal	17	18	19	20
U, kgs	1.33E+03	6.25E+03	6.58E+03	7.90E+03	1.25E+05	1.33E+05	1.33E+03	1.32E+05	0.00E+00	1.32E+05	0.00E+00
Pu, ppb/U	3.59E+01	4.99E-01	4.88E-01	4.51E+00	3.63E-01	6.04E-01	3.63E+01	2.44E-01	0.00E+00	2.44E-01	0.00E+00
Np, ppb/U	2.34E+06	4.79E+04	4.74E+04	3.46E+05	2.88E+04	4.71E+04	2.36E+06	2.38E+04	0.00E+00	2.37E+04	0.00E+00
Tc, ppb/U	4.40E+05	1.63E+05	1.70E+05	2.11E+05	8.19E+04	8.88E+04	4.44E+05	8.52E+04	0.00E+00	8.52E+04	0.00E+00
Th, ppb/U	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Process Stream Concentrations on U Basis

	Stream Number										
Stream Component	21	22	23	25	26	27	28	29	30	31	32
U, kgs	1.32E+05	1.25E+05	6.58E+03	1.33E+00	7.90E-02	1.33E+02	1.32E+02	2.66E-01	2.66E+02	1.20E+04	1.00E+02
Pu, ppb/U	2.44E-01	2.31E-01	4.88E-01	3.63E+02	1.93E+05	6.10E+00	2.44E-01	6.24E+01	6.24E+01	6.57E-03	0.00E+00
Np, ppb/U	2.37E+04	2.25E+04	4.74E+04	2.36E+07	8.64E+09	4.76E+05	1.19E+05	2.98E+06	2.98E+06	2.58E+00	2.30E+05
Tc, ppb/U	8.52E+04	8.08E+04	1.70E+05	4.44E+06	4.32E+08	8.96E+05	8.52E+04	6.41E+05	6.41E+05	9.08E+00	2.30E+07
Th, ppb/U	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Process Stream Flows

	Stream Number										
Stream Component	33	34	35				40	41	42	43	44
U, kgs	1.24E+04	0.00E+00	0.00E+00				1.00E+06	1.00E+03	2.00E+05	7.00E+05	2.80E+05
Pu, ppb U	1.35E+00	0.00E+00	0.00E+00				6.57E-03	6.57E-03	6.57E-03	6.57E-03	6.57E-03
Np, ppb U	6.59E+04	0.00E+00	0.00E+00				2.58E+00	2.58E+00	2.58E+00	2.58E+00	2.58E+00
Tc, ppb U	2.00E+05	0.00E+00	0.00E+00				9.10E+00	9.10E+00	9.10E+00	9.10E+00	9.10E+00
Th, ppb U	0.00E+00	0.00E+00	0.00E+00				0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Rad Component	Stream Number										
	1	2	3	4	5	6	7	9	10	11 est	11
α Ratio	0.000	0.000	0.0000	0.000	0.284	0.000	0.000	0.000	0.284	14.61	24.31
β Ratio	0.000	0.000	0.0000	0.000	0.692	0.000	0.000	0.000	0.692	3.57	3.75
γ Ratio											

Rad Component	Stream Number										
	12	13 est	13	14	15	16	11 cal	17	18	19	20
α Ratio	24.09	0.455	0.450	3.433	0.284	0.466	24.31	0.226	0.000	0.225	0.000
β Ratio	3.72	1.375	1.439	1.786	0.692	0.750	3.75	0.720	0.000	0.720	0.000
γ Ratio											

Rad Component	Stream Number										
	21	22	23	25	26	27	28	29	30	31	31
α Ratio	0.225	0.213	0.450	243.06	98958.4	4.706	0.968	33.433	33.438	0.001	1.79
β Ratio	0.720	0.682	1.439	37.50	3643.5	7.568	0.720	5.410	5.410	0.000	194
γ Ratio											

Rad Component	Stream Number										
	33	34	35				40	41	42	43	44
α Ratio	0.735	0.000	0.000				0.0011	0.0011	0.0011	0.0011	0.0011
β Ratio	1.687	0.000	0.000				7.68E-05	7.68E-05	7.68E-05	7.68E-05	7.68E-05
γ Ratio											

Notes:

1. Y-12 analysis of incoming SRS UNH in the 1982-1984 timeframe assumed for UNH and U metal feed streams for the duration of campaign
2. SRS data shows significantly less Np than Y-12
3. INEEL analysis of Fernald DU metal assumed for composition of Y-12 stream 31 to S-3 Ponds
4. Sufficient DU added to stream 33 by way of stream 31 to yield observed U-235 content of S-3 sludge (i.e., 0.34% U-235)
5. Tc added to stream 33 by way of stream 32 to yield observed Tc sludge concentration in SE pond of 12,000 pCi/g wet wt
6. Th-228 not included in the calculation of α ratio
7. Assumed nominal specific activity of weapon grade HEU used in calculation of α ratio is 140 dpm/μg
8. Assumed nominal specific activity of uranium sample enriched in U-235 with no TRU for β ratio is based on Th-234, Pa-234, and Th-231

Chemical Forms of Uranium

Form	**Code**	**Form**	**Code**	**Form**	**Code**
U (metal)	1	UO3	0.83	UF6	0.68
UO2	0.88	UF4	0.76	UO2F2	0.77
U3O8	0.85	UCl4	0.63	UO2(NO3)2	0.6

	% U-235	U SpecAct uCi/g U	Ratio
U Enrichment (% U-235) =	62.6	3.75E+01	
	Code	DAC Value	Act to DAC
Chemical Form of U code =	0.6	6E-10	6.25E+10

SUM Constituent Act to DAC= 4.19E+10 | **Fraction Dose from Constituents = 0.6696**

Constituent Data Units	uCi/g sample	uCi/g U	DAC Value	Act to DAC
Pu-238		0.00E+00	3.00E-12	0.00E+00
Pu-239		0.00E+00	2.00E-12	0.00E+00
Pu-240		0.00E+00	2.00E-12	0.00E+00
Np-237		0.00E+00	2.00E-12	0.00E+00
Am-241		0.00E+00	2.00E-12	0.00E+00
U-236		0.00E+00	6.00E-10	0.00E+00
Tc-99		0.00E+00	3.00E-07	0.00E+00

	uCi/g U	DAC Value	Act to DAC
Pu-238	5.17E-03	3.00E-12	1.72E+09
Pu-239	3.12E-06	2.00E-12	1.56E+06
Pu-240	1.63E-06	2.00E-12	8.17E+05
Np-237	2.03E-02	2.00E-12	1.02E+10
Am-241	0.00E+00	2.00E-12	0.00E+00
U-236	1.80E+01	6.00E-10	3.00E+10
Tc-99	1.39E+00	3.00E-07	4.65E+06

9212 HEU Process Stream 5 (Y-12 & SRS Data)

Assume

Pu ppb	0.36
Np ppb	28,800
Tc ppm	82
U-236 ppm	278,000

Assume U @ 62.5% U-235

Assume Weapons Pu Dist

Pu-238	84
Pu-239	14
Pu-240	2
Pu-241	0
Pu-242	0

Chemical Forms of Uranium					
Form	Code	Form	Code	Form	Code
U (metal)	1	UO3	0.83	UF6	0.68
UO2	0.88	UF4	0.76	UO2F2	0.77
U3O8	0.85	UCl4	0.63	UO2(NO3)2	0.6

	% U-235	U SpecAct uCi/g U		
U Enrichment (% U-235) =	62.6	3.75E+01	Ratio	
	Code	DAC Value	Act to DAC	
Chemical Form of U code =	0.6	6E-10	6.25E+10	
SUM Constituent Act to DAC=	1.04E+12	**Fraction Dose from Constituents =**		**16.5699**

Constituent Data Units	uCi/g sample	uCi/g U	DAC Value	Act to DAC
Pu-238		0.00E+00	3.00E-12	0.00E+00
Pu-239		0.00E+00	2.00E-12	0.00E+00
Pu-240		0.00E+00	2.00E-12	0.00E+00
Np-237		0.00E+00	2.00E-12	0.00E+00
Am-241		0.00E+00	2.00E-12	0.00E+00
U-236		0.00E+00	6.00E-10	0.00E+00
Tc-99		0.00E+00	3.00E-07	0.00E+00

	uCi/g U	DAC Value	Act to DAC
Pu-238	5.21E-01	3.00E-12	1.74E+11
Pu-239	3.15E-04	2.00E-12	1.58E+08
Pu-240	1.65E-04	2.00E-12	8.24E+07
Np-237	1.66E+00	2.00E-12	8.32E+11
Am-241	0.00E+00	2.00E-12	0.00E+00
U-236	1.80E+01	6.00E-10	3.00E+10
Tc-99	7.55E+00	3.00E-07	2.52E+07

9212 HEU Process Stream 11 (Y-12 & SRS Data)

Assume

Pu ppb	36.3
Np ppb	2,360,000
Tc ppm	444
U-236 ppm	278,000

Assume U @ 62.5% U-235

Assume Weapons Pu Dist

Pu-238	84
Pu-239	14
Pu-240	2
Pu-241	0
Pu-242	0

Chemical Forms of Uranium

Form	Code	Form	Code	Form	Code
U (metal)	1	UO3	0.83	UF6	0.68
UO2	0.88	UF4	0.76	UO2F2	0.77
U3O8	0.85	UCl4	0.63	UO2(NO3)2	0.6

	% U-235	U SpecAct uCi/g U	
U Enrichment (% U-235) =	62.6	3.75E+01	Ratio
	Code	DAC Value	Act to DAC
Chemical Form of U code =	0.6	6E-10	6.25E+10

SUM Constituent Act to DAC= 1.74E+11 | **Fraction Dose from Constituents = 2.7756**

Constituent Data Units	uCi/g sample	uCi/g U	DAC Value	Act to DAC
Pu-238		0.00E+00	3.00E-12	0.00E+00
Pu-239		0.00E+00	2.00E-12	0.00E+00
Pu-240		0.00E+00	2.00E-12	0.00E+00
Np-237		0.00E+00	2.00E-12	0.00E+00
Am-241		0.00E+00	2.00E-12	0.00E+00
U-236		0.00E+00	6.00E-10	0.00E+00
Tc-99		0.00E+00	3.00E-07	0.00E+00

	uCi/g U	DAC Value	Act to DAC
Pu-238	6.46E-02	3.00E-12	2.15E+10
Pu-239	3.91E-05	2.00E-12	1.95E+07
Pu-240	2.04E-05	2.00E-12	1.02E+07
Np-237	2.44E-01	2.00E-12	1.22E+11
Am-241	0.00E+00	2.00E-12	0.00E+00
U-236	1.80E+01	6.00E-10	3.00E+10
Tc-99	3.59E+00	3.00E-07	1.20E+07

9212 HEU Process Stream 14 (Y-12 & SRS Data)

Assume

Pu ppb	4.5
Np ppb	346,000
Tc ppm	211
U-236 ppm	278,000

Assume U @ 62.5% U-235

Assume Weapons Pu Dist

Pu-238	84
Pu-239	14
Pu-240	2
Pu-241	0
Pu-242	0

Chemical Forms of Uranium					
Form	**Code**	**Form**	**Code**	**Form**	**Code**
U (metal)	1	UO3	0.83	UF6	0.68
UO2	0.88	UF4	0.76	UO2F2	0.77
U3O8	0.85	UCl4	0.63	UO2(NO3)2	0.6

	% U-235	U SpecAct uCi/g U	
U Enrichment (% U-235) =	62.6	3.75E+01	Ratio
	Code	DAC Value	Act to DAC
Chemical Form of U code =	0.83	3E-10	1.25E+11

SUM Constituent Act to DAC= 6.95E+10 | **Fraction Dose from Constituents = 0.5558**

Constituent Data Units	uCi/g sample	uCi/g U	DAC Value	Act to DAC
Pu-238		0.00E+00	3.00E-12	0.00E+00
Pu-239		0.00E+00	2.00E-12	0.00E+00
Pu-240		0.00E+00	2.00E-12	0.00E+00
Np-237		0.00E+00	2.00E-12	0.00E+00
Am-241		0.00E+00	2.00E-12	0.00E+00
U-236		0.00E+00	3.00E-10	0.00E+00
Tc-99		0.00E+00	3.00E-07	0.00E+00

	uCi/g U	DAC Value	Act to DAC
Pu-238	3.45E-03	3.00E-12	1.15E+09
Pu-239	2.08E-06	2.00E-12	1.04E+06
Pu-240	1.09E-06	2.00E-12	5.45E+05
Np-237	1.68E-02	2.00E-12	8.39E+09
Am-241	0.00E+00	2.00E-12	0.00E+00
U-236	1.80E+01	3.00E-10	6.00E+10
Tc-99	1.45E+00	3.00E-07	4.82E+06

9212 HEU Process Stream 19 (Y-12 & SRS Data)

Assume

Pu ppb	0.24
Np ppb	23,800
Tc ppm	85
U-236 ppm	278,000

Assume U @ 62.5% U-235

Assume Weapons Pu Dist

Pu-238	84
Pu-239	14
Pu-240	2
Pu-241	0
Pu-242	0

Chemical Forms of Uranium

Form	Code	Form	Code	Form	Code
U (metal)	1	UO3	0.83	UF6	0.68
UO2	0.88	UF4	0.76	UO2F2	0.77
U3O8	0.85	UCl4	0.63	UO2(NO3)2	0.6

	% U-235	U SpecAct uCi/g U	Ratio
U Enrichment (% U-235) =	62.6	3.75E+01	
	Code	DAC Value	Act to DAC
Chemical Form of U code =	1	3E-10	1.25E+11

SUM Constituent Act to DAC= 6.95E+10

Fraction Dose from Constituents = 0.5555

Constituent Data Units	uCi/g sample	uCi/g U	DAC Value	Act to DAC
Pu-238		0.00E+00	3.00E-12	0.00E+00
Pu-239		0.00E+00	2.00E-12	0.00E+00
Pu-240		0.00E+00	2.00E-12	0.00E+00
Np-237		0.00E+00	2.00E-12	0.00E+00
Am-241		0.00E+00	2.00E-12	0.00E+00
U-236		0.00E+00	3.00E-10	0.00E+00
Tc-99		0.00E+00	3.00E-07	0.00E+00

	uCi/g U	DAC Value	Act to DAC
Pu-238	3.45E-03	3.00E-12	1.15E+09
Pu-239	2.08E-06	2.00E-12	1.04E+06
Pu-240	1.09E-06	2.00E-12	5.45E+05
Np-237	1.67E-02	2.00E-12	8.35E+09
Am-241	0.00E+00	2.00E-12	0.00E+00
U-236	1.80E+01	3.00E-10	6.00E+10
Tc-99	1.45E+00	3.00E-07	4.82E+06

9212 HEU Process Stream 22 (Y-12 & SRS Data)

Assume

Pu ppb	0.24
Np ppb	23,700
Tc ppm	85
U-236 ppm	278,000

Assume U @ 62.5% U-235

Assume Weapons Pu Dist

Pu-238	84
Pu-239	14
Pu-240	2
Pu-241	0
Pu-242	0

Chemical Forms of Uranium

Form	Code	Form	Code	Form	Code
U (metal)	1	UO3	0.83	UF6	0.68
UO2	0.88	UF4	0.76	UO2F2	0.77
U3O8	0.85	UCl4	0.63	UO2(NO3)2	0.6

	% U-235	U SpecAct uCi/g U	Ratio
U Enrichment (% U-235) =	62.6	3.75E+01	
	Code	DAC Value	Act to DAC
Chemical Form of U code =	0.88	3E-10	1.25E+11

SUM Constituent Act to DAC= 7.90E+10

Fraction Dose from Constituents = 0.6319

Constituent Data Units	uCi/g sample	uCi/g U	DAC Value	Act to DAC
Pu-238		0.00E+00	3.00E-12	0.00E+00
Pu-239		0.00E+00	2.00E-12	0.00E+00
Pu-240		0.00E+00	2.00E-12	0.00E+00
Np-237		0.00E+00	2.00E-12	0.00E+00
Am-241		0.00E+00	2.00E-12	0.00E+00
U-236		0.00E+00	3.00E-10	0.00E+00
Tc-99		0.00E+00	3.00E-07	0.00E+00

	uCi/g U	DAC Value	Act to DAC
Pu-238	7.01E-03	3.00E-12	2.34E+09
Pu-239	4.24E-06	2.00E-12	2.12E+06
Pu-240	2.22E-06	2.00E-12	1.11E+06
Np-237	3.34E-02	2.00E-12	1.67E+10
Am-241	0.00E+00	2.00E-12	0.00E+00
U-236	1.80E+01	3.00E-10	6.00E+10
Tc-99	2.89E+00	3.00E-07	9.63E+06

9212 HEU Process Stream 23 (Y-12 & SRS Data)

Assume

Pu ppb	0.488
Np ppb	47,400
Tc ppm	170
U-236 ppm	278,000

Assume U @ 62.5% U-235

Assume Weapons Pu Dist

Pu-238	84
Pu-239	14
Pu-240	2
Pu-241	0
Pu-242	0

Chemical Forms of Uranium					
Form	Code	Form	Code	Form	Code
U (metal)	1	UO3	0.83	UF6	0.68
UO2	0.88	UF4	0.76	UO2F2	0.77
U3O8	0.85	UCl4	0.63	UO2(NO3)2	0.6

	% U-235	U SpecAct uCi/g U	
U Enrichment (% U-235) =	62.6	3.75E+01	Ratio
	Code	DAC Value	Act to DAC
Chemical Form of U code =	0.6	6E-10	6.25E+10
SUM Constituent Act to DAC=	1.01E+13	**Fraction Dose from Constituents =**	**161.3840**

Constituent Data Units	uCi/g sample	uCi/g U	DAC Value	Act to DAC
Pu-238		0.00E+00	3.00E-12	0.00E+00
Pu-239		0.00E+00	2.00E-12	0.00E+00
Pu-240		0.00E+00	2.00E-12	0.00E+00
Np-237		0.00E+00	2.00E-12	0.00E+00
Am-241		0.00E+00	2.00E-12	0.00E+00
U-236		0.00E+00	6.00E-10	0.00E+00
Tc-99		0.00E+00	3.00E-07	0.00E+00

	uCi/g U	DAC Value	Act to DAC
Pu-238	5.21E+00	3.00E-12	1.74E+12
Pu-239	3.15E-03	2.00E-12	1.58E+09
Pu-240	1.65E-03	2.00E-12	8.24E+08
Np-237	1.66E+01	2.00E-12	8.32E+12
Am-241	0.00E+00	2.00E-12	0.00E+00
U-236	1.80E+01	6.00E-10	3.00E+10
Tc-99	7.55E+01	3.00E-07	2.52E+08

9212 HEU Process Stream 25 (Y-12 & SRS Data)

Assume

Pu ppb	363
Np ppb	23,600,000
Tc ppm	4,440
U-236 ppm	278,000

Assume U @ 62.5% U-235

Assume Weapons Pu Dist

Pu-238	84
Pu-239	14
Pu-240	2
Pu-241	0
Pu-242	0

Chemical Forms of Uranium

Form	Code	Form	Code	Form	Code
U (metal)	1	UO3	0.83	UF6	0.68
UO2	0.88	UF4	0.76	UO2F2	0.77
U3O8	0.85	UCl4	0.63	UO2(NO3)2	0.6

	% U-235	U SpecAct uCi/g U	Ratio
U Enrichment (% U-235) =	62.6	3.75E+01	
	Code	DAC Value	Act to DAC
Chemical Form of U code =	0.6	6E-10	6.25E+10

SUM Constituent Act to DAC= 3.97E+15

Fraction Dose from Constituents = 63516.2677

Constituent Data Units	uCi/g sample	uCi/g U	DAC Value	Act to DAC
Pu-238		0.00E+00	3.00E-12	0.00E+00
Pu-239		0.00E+00	2.00E-12	0.00E+00
Pu-240		0.00E+00	2.00E-12	0.00E+00
Np-237		0.00E+00	2.00E-12	0.00E+00
Am-241		0.00E+00	2.00E-12	0.00E+00
U-236		0.00E+00	6.00E-10	0.00E+00
Tc-99		0.00E+00	3.00E-07	0.00E+00

	uCi/g U	DAC Value	Act to DAC
Pu-238	2.77E+03	3.00E-12	9.24E+14
Pu-239	1.68E+00	2.00E-12	8.38E+11
Pu-240	8.76E-01	2.00E-12	4.38E+11
Np-237	6.09E+03	2.00E-12	3.05E+15
Am-241	0.00E+00	2.00E-12	0.00E+00
U-236	1.80E+01	6.00E-10	3.00E+10
Tc-99	7.34E+03	3.00E-07	2.45E+10

9212 HEU Process Stream 26 (Y-12 & SRS Data)

Assume

Pu ppb	193,000
Np ppb	8,640,000,000
Tc ppm	432,000
U-236 ppm	278,000

Assume U @ 62.5% U-235

Assume Weapons Pu Dist

Pu-238	84
Pu-239	14
Pu-240	2
Pu-241	0
Pu-242	0

Chemical Forms of Uranium

Form	Code	Form	Code	Form	Code
U (metal)	1	UO3	0.83	UF6	0.68
UO2	0.88	UF4	0.76	UO2F2	0.77
U3O8	0.85	UCl4	0.63	UO2(NO3)2	0.6

	% U-235	U SpecAct uCi/g U	Ratio
U Enrichment (% U-235) =	62.6	3.75E+01	
	Code	DAC Value	Act to DAC
Chemical Form of U code =	0.6	6E-10	6.25E+10

SUM Constituent Act to DAC= 2.27E+11

Fraction Dose from Constituents = 3.6319

Constituent Data Units	uCi/g sample	uCi/g U	DAC Value	Act to DAC
Pu-238		0.00E+00	3.00E-12	0.00E+00
Pu-239		0.00E+00	2.00E-12	0.00E+00
Pu-240		0.00E+00	2.00E-12	0.00E+00
Np-237		0.00E+00	2.00E-12	0.00E+00
Am-241		0.00E+00	2.00E-12	0.00E+00
U-236		0.00E+00	6.00E-10	0.00E+00
Tc-99		0.00E+00	3.00E-07	0.00E+00

	uCi/g U	DAC Value	Act to DAC
Pu-238	8.76E-02	3.00E-12	2.92E+10
Pu-239	5.29E-05	2.00E-12	2.65E+07
Pu-240	2.77E-05	2.00E-12	1.38E+07
Np-237	3.36E-01	2.00E-12	1.68E+11
Am-241	0.00E+00	2.00E-12	0.00E+00
U-236	1.80E+01	6.00E-10	3.00E+10
Tc-99	1.52E+01	3.00E-07	5.08E+07

9212 HEU Process Stream 27 (Y-12 & SRS Data)

Assume

Pu ppb	6.1
Np ppb	476,000
Tc ppm	896
U-236 ppm	278,000

Assume U @ 62.5% U-235

Assume Weapons Pu Dist

Pu-238	84
Pu-239	14
Pu-240	2
Pu-241	0
Pu-242	0

Chemical Forms of Uranium

Form	Code	Form	Code	Form	Code
U (metal)	1	UO3	0.83	UF6	0.68
UO2	0.88	UF4	0.76	UO2F2	0.77
U3O8	0.85	UCl4	0.63	UO2(NO3)2	0.6

	% U-235	U SpecAct uCi/g U	
U Enrichment (% U-235) =	62.6	3.75E+01	Ratio
	Code	DAC Value	Act to DAC
Chemical Form of U code =	0.6	6E-10	6.25E+10

SUM Constituent Act to DAC= 1.38E+12

Fraction Dose from Constituents = 22.0674

Constituent Data Units	uCi/g sample	uCi/g U	DAC Value	Act to DAC
Pu-238		0.00E+00	3.00E-12	0.00E+00
Pu-239		0.00E+00	2.00E-12	0.00E+00
Pu-240		0.00E+00	2.00E-12	0.00E+00
Np-237		0.00E+00	2.00E-12	0.00E+00
Am-241		0.00E+00	2.00E-12	0.00E+00
U-236		0.00E+00	6.00E-10	0.00E+00
Tc-99		0.00E+00	3.00E-07	0.00E+00

	uCi/g U	DAC Value	Act to DAC
Pu-238	8.96E-01	3.00E-12	2.99E+11
Pu-239	5.42E-04	2.00E-12	2.71E+08
Pu-240	2.83E-04	2.00E-12	1.42E+08
Np-237	2.10E+00	2.00E-12	1.05E+12
Am-241	0.00E+00	2.00E-12	0.00E+00
U-236	1.80E+01	6.00E-10	3.00E+10
Tc-99	1.09E+01	3.00E-07	3.63E+07

9212 HEU Process Stream 30 (Y-12 & SRS Data)

Assume

Pu ppb	62.4
Np ppb	2,980,000
Tc ppm	641
U-236 ppm	278,000

Assume U @ 62.5% U-235

Assume Weapons Pu Dist

Pu-238	84
Pu-239	14
Pu-240	2
Pu-241	0
Pu-242	0

Chemical Forms of Uranium					
Form	Code	Form	Code	Form	Code
U (metal)	1	UO3	0.83	UF6	0.68
UO2	0.88	UF4	0.76	UO2F2	0.77
U3O8	0.85	UCl4	0.63	UO2(NO3)2	0.6

	% U-235	U SpecAct uCi/g U	
U Enrichment (% U-235) =	62.6	3.75E+01	Ratio
	Code	DAC Value	Act to DAC
Chemical Form of U code =	0.6	6E-10	6.25E+10

SUM Constituent Act to DAC= 3.29E+10 | **Fraction Dose from Constituents = 0.5270**

Constituent Data Units	uCi/g sample	uCi/g U	DAC Value	Act to DAC
Pu-238		0.00E+00	3.00E-12	0.00E+00
Pu-239		0.00E+00	2.00E-12	0.00E+00
Pu-240		0.00E+00	2.00E-12	0.00E+00
Np-237		0.00E+00	2.00E-12	0.00E+00
Am-241		0.00E+00	2.00E-12	0.00E+00
U-236		0.00E+00	6.00E-10	0.00E+00
Tc-99		0.00E+00	3.00E-07	0.00E+00

	uCi/g U	DAC Value	Act to DAC
Pu-238	1.94E-02	3.00E-12	6.46E+09
Pu-239	1.17E-05	2.00E-12	5.86E+06
Pu-240	6.13E-06	2.00E-12	3.06E+06
Np-237	4.65E-02	2.00E-12	2.32E+10
Am-241	0.00E+00	2.00E-12	0.00E+00
U-236	1.94E+00	6.00E-10	3.24E+09
Tc-99	3.40E+00	3.00E-07	1.13E+07

9212 HEU Process Stream 33 (Y-12 & SRS Data)

Assume

Pu ppb	1.35
Np ppb	65,900
Tc ppm	200
U-236 ppm	30,000

Assume U @ 62.5% U-235

Assume Weapons Pu Dist

Pu-238	84
Pu-239	14
Pu-240	2
Pu-241	0
Pu-242	0

Chemical Forms of Uranium					
Form	Code	Form	Code	Form	Code
U (metal)	1	UO3	0.83	UF6	0.68
UO2	0.88	UF4	0.76	UO2F2	0.77
U3O8	0.85	UCl4	0.63	UO2(NO3)2	0.6

	% U-235	U SpecAct uCi/g U	
U Enrichment (% U-235) =	78.2	5.09E+01	Ratio
	Code	DAC Value	Act to DAC
Chemical Form of U code =	0.83	3E-10	1.70E+11

SUM Constituent Act to DAC= 2.32E+10 | **Fraction Dose from Constituents = 0.1369**

Constituent Data Units	uCi/g sample	uCi/g U	DAC Value	Act to DAC
Pu-238		0.00E+00	3.00E-12	0.00E+00
Pu-239		0.00E+00	2.00E-12	0.00E+00
Pu-240		0.00E+00	2.00E-12	0.00E+00
Np-237		0.00E+00	2.00E-12	0.00E+00
Am-241		0.00E+00	2.00E-12	0.00E+00
U-236		0.00E+00	3.00E-10	0.00E+00
Tc-99		0.00E+00	3.00E-07	0.00E+00

	uCi/g U	DAC Value	Act to DAC
Pu-238	1.88E-06	3.00E-12	6.27E+05
Pu-239	5.87E-06	2.00E-12	2.94E+06
Pu-240	3.00E-06	2.00E-12	1.50E+06
Np-237	3.31E-03	2.00E-12	1.66E+09
Am-241	0.00E+00	2.00E-12	0.00E+00
U-236	6.47E+00	3.00E-10	2.16E+10
Tc-99	2.21E-03	3.00E-07	7.37E+03

9212 HEU Process Stream 4 (ICPP + Data)

Assume

Pu ppb	0.11
Np ppb	4,700
Tc ppm	0.13
U-236 ppm	100,000

Assume U @ 62.5% U-235

Assume Weapons Pu Dist

Pu-238	0.1
Pu-239	86.1
Pu-240	12
Pu-241	1.6
Pu-242	0.2

Chemical Forms of Uranium

Form	Code	Form	Code	Form	Code
U (metal)	1	UO3	0.83	UF6	0.68
UO2	0.88	UF4	0.76	UO2F2	0.77
U3O8	0.85	UCl4	0.63	UO2(NO3)2	0.6

	% U-235	U SpecAct uCi/g U	
U Enrichment (% U-235) =	78.2	5.09E+01	Ratio
	Code	DAC Value	Act to DAC
Chemical Form of U code =	0.6	6E-10	8.48E+10

SUM Constituent Act to DAC= 1.24E+10

Fraction Dose from Constituents = 0.1467

Constituent Data Units	uCi/g sample	uCi/g U	DAC Value	Act to DAC
Pu-238		0.00E+00	3.00E-12	0.00E+00
Pu-239		0.00E+00	2.00E-12	0.00E+00
Pu-240		0.00E+00	2.00E-12	0.00E+00
Np-237		0.00E+00	2.00E-12	0.00E+00
Am-241		0.00E+00	2.00E-12	0.00E+00
U-236		0.00E+00	6.00E-10	0.00E+00
Tc-99		0.00E+00	3.00E-07	0.00E+00

	uCi/g U	DAC Value	Act to DAC
Pu-238	1.88E-06	3.00E-12	6.27E+05
Pu-239	5.87E-06	2.00E-12	2.94E+06
Pu-240	3.00E-06	2.00E-12	1.50E+06
Np-237	3.31E-03	2.00E-12	1.66E+09
Am-241	0.00E+00	2.00E-12	0.00E+00
U-236	6.47E+00	6.00E-10	1.08E+10
Tc-99	2.21E-03	3.00E-07	7.37E+03

9212 HEU Process Stream 5 (ICPP + Data)

Assume

Pu ppb	0.11
Np ppb	4,700
Tc ppm	0.13
U-236 ppm	100,000

Assume U @ 62.5% U-235

Assume Weapons Pu Dist

Pu-238	0.1
Pu-239	86.1
Pu-240	12
Pu-241	1.6
Pu-242	0.2