**Development Of Derived Investigation Levels For Use In
Internal Dosimetry
At The
West Valley Demonstration Project**

by
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Submitted to
The Faculty of the Graduate School of Public Health
in partial fulfillment of the requirements for
the degree of Master of Science in Hygiene

University of Pittsburgh
1991

MASTER

Abstract

The objective of this project is to determine if the routine internal dosimetry program at the West Valley Demonstration Project is capable of meeting the performance objective of 1 mSv annual effective dose equivalent due to internal contamination.

A review of the contaminated areas that most likely represent sources of potential internal contamination is performed to determine which radionuclides are of concern. It was determined that most of the radionuclides have long half lives and emit alpha particles.

With the use of the computer code REMedy the annual effective dose equivalent is calculated. Some of the radionuclides of concern result in an annual effective dose equivalent that exceeds the performance objective. Although the results exceed the performance objective, in all but two cases they do not exceed the U.S. DOE regulatory limits. In these instances the Th-232 and Am-241 were determined to exceed the committed dose equivalent limit to their limiting tissue. In order to document the potential missed dose for regulatory compliance, Sr-90 is used as an indicator for Th-232. For Am-241 an investigation as to whether or not the minimum detectable amount can be lowered is performed. The derived investigation levels as a result of this project are $4.9\text{E}3$ Bq/lung count for Co-60, $2.2\text{E}4$ Bq/lung count for Cs-137, 1.9 Bq/l for Sr-90 and for radionuclides other than Sr-90 any value greater than or equal to three standard deviations above their net count is considered to require further investigation.

Keywords: REMedy; ICRP; Radionuclide; Internal Dosimetry; Half-life; U.S. DOE; Derived Investigation Level; Annual Effective Dose Equivalent

Acknowledgments

The author wishes to first thank Oak Ridge Associated Universities for awarding him the Operational Health Physics Fellowship. Thanks duly go out to Paul Szalinski and James Griffin for allowing him to perform this project and for the timely review of his essay drafts. Thanks also goes out to the friendly and helpful staff of the Radiation and Safety department at the West Valley Demonstration Project.

Thanks to Daniel J. Strom for his encouragement and technical support in review of this essay as well as Jerry C. Rosen and H. Gregg Claycamp for their participation on his Master's research committee.

Most of all thanks goes out to his wife Tammy for her unending support.

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1. Introduction

The West Valley Demonstration Project (WVDP) was the site of the only operating commercial nuclear fuel reprocessing plant in the United States. Nuclear Fuel Services, Inc. operated the facility from 1966 to 1972, processing 640 metric tons of commercial and defense fuels. Approximately 2.1 million liters of fuel reprocessing waste resulted from these operations. Approximately 98% by volume of these wastes is stored in an underground storage tank, designated 8D-2. The remaining 2 percent of the waste is stored in the tank designated 8D-4. Tank 8D-4 is the result of a special reprocessing campaign involving a mixed uranium-thorium fuel (Rykken 1986). Waste reprocessing was terminated in 1972, so the waste remaining is at least 19 years old. Assuming the waste is 19 years old, radionuclides with relatively short half lives (e.g. ^{131}I 8 day half life) have decayed to levels of little concern.

The West Valley Demonstration Act of October 1, 1980 Public Law 96-368 (U.S. Congress 1980) directs the Department of Energy (DOE) to carry out a high-level radioactive waste (HLRW) management demonstration project. Under the Act, the DOE is responsible for removing the liquid HLRW from the underground storage tanks and solidifying it into a form suitable for final disposal at a federal repository.

In order to maintain compliance with DOE Order 5480.11 (U.S. DOE 1988) "Radiation Protection for Occupational Workers," an established and functional internal dosimetry program is required by DOE contractor facilities where workers are likely to receive, from all occupational intakes of radionuclides, regardless of the date of intake, an annual effective dose equivalent (AEDE) of 1 mSv or more (U.S. DOE 1989a) AEDE is defined in equation 1.

The current contractor responsible for the internal dosimetry program at the WVDP is the West Valley Nuclear Services (WVNS), a subsidiary of Westinghouse Electric Corporation.

2. Background

The main objective of this study is to determine if the internal dosimetry program at the WVDP is capable of meeting the performance objective of 1 mSv AEDE due to internal radionuclide contamination.

$$AEDE = \sum w_T H_{T,a} \quad (\text{eq. 1})$$

AEDE = annual effective dose equivalent (mSv)
 w_T = weighting factor ICRP-26 (ICRP 1977)
 $H_{T,a}$ = annual dose equivalent (mSv) to tissue (T)

General design considerations for internal dosimetry programs include: (U.S. DOE 1989b)

1. radionuclide properties, including
 - a. range of activities
 - b. mixture of radionuclides
 - c. decay products
2. chemical and physical properties, including
 - a. chemical forms of each radionuclide
 - b. expected biokinetics
 - c. physical forms of each radionuclide
 - d. particle size distributions
3. intake characteristics, including
 - a. possible routes of intake
 - b. activity dispersal mechanisms
 - c. intake rate (acute or chronic)

Internal exposure monitoring programs should also include prospective and retrospective monitoring and dose assessment. The aim of the prospective monitoring program is to verify the integrity of radioactive materials containment and to detect inadvertent releases of those materials in the workplace. The objectives of the retrospective monitoring program are to measure radioactive material in the body and in the excreta collected from workers with known or expected intakes so that dose assessment may be performed. Retrospective monitoring is also used to demonstrate compliance with the radiation protection standards for radiation workers exposed to airborne or surface contamination where the worker could receive 1 mSv AEDE from all intakes, of all radionuclides from occupational sources, or if any organ or tissue dose equivalent could exceed 50 mSv annual dose equivalent (U.S. DOE 1989b).

In the design and evaluation of the monitoring required to meet DOE Order 5480.11, the specific characteristics of the contaminants potentially involved should be taken into account, including radionuclide composition, particle size distribution, potential modes of intake, transportability from the lung to other organs, and absorption into the systemic circulation.

If such information is not available, assumptions based on conservative evaluation of facility operations, and the scientific recommendations of advisory groups such as the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP) should be applied (NCRP 1987).

The performance capabilities for retrospective monitoring and dose assessment are specified in terms of the internal component of the AEDE. The minimum detection capability does not include contributions from external dose. As a minimum, the measurements used to assess and document internal dose should be capable of confirming and assessing 1) exposures that could result in an AEDE in excess of 1 mSv from all intakes of radionuclides occurring during the calendar year, and 2) the presence of radionuclides in the body from all previous intakes, irrespective of the year of intake, that would result in an AEDE in excess of 5 mSv (U.S. DOE 1989b).

If the retrospective performance objectives cannot be achieved, the organization responsible for radiation protection should take administrative action to:

- 1) ensure that additional control measures are applied to prevent intakes of radioactive material;
- 2) document these additional control measures for auditing purposes; and
- 3) ensure that state-of-the-art technology is available for internal dose assessments.

The routine internal dosimetry monitoring frequency should be based on two criteria: 1) the nature of the exposure (acute or chronic) and 2) the potential annual "missed dose". Where appropriate, in vivo measurements shall be preferred over in vitro measurements (U.S. DOE 1989a).

The choice of monitoring frequency should depend on the following:

- 1) purpose of the measurement, i.e., to detect acute intakes undetected by workplace monitoring, or chronic intakes.
- 2) the need to meet regulatory requirements (e.g., 50 mSv AEDE for stochastic effects).
- 3) minimum detectable amount (MDA) for the bioassay measurement and radionuclide of interest.
- 4) chemical and physical properties of the radioactive material.
- 5) likelihood and ratios of combinations of radionuclides associated with an intake at a particular facility.

(U.S. DOE 1989a)

The design of a routine internal dosimetry program should be based on the "missed dose" concept. Missed dose refers to the AEDE that would be "missed" at a given measurement interval. The pattern of retention of activity in the body, the minimum detectable amount for bioassay measurement methods, and the frequency with which those methods are applied define a quantity of intake that could go undetected by the given internal dosimetry program. Estimates of missed AEDE should be calculated and documented for each measurement frequency and minimum detectable amount per sample.

The capability of the internal dosimetry program should meet minimum detectable amount (MDA) requirements as stated in Draft ANSI Standard N13.30 "Performance Criteria for Bioassay".

$$MDA = 4.65S_b/KT + 3/KT \quad (\text{eq.2})$$

S_b = standard deviation of the appropriate blank counts
 K = conversion factor (counts per sec. per Bq)
 T = counting time (seconds)

(ANSI 1989)

The value of the MDA indicates the ability of the bioassay laboratory to distinguish between the count rate from the radionuclide under analysis and the count rate from the appropriate blank, as illustrated in (Fig.1). For in vivo measurements, the matrix (i.e., the person) of the radionuclide is a variable; therefore, for the purpose of the ANSI standard, the MDA calculated for a given matrix represented by a person or phantom is used to characterize the detection capability of the bioassay program.

Detection Limit

Figure 1 The MDA is placed far enough above zero so that there is a 5% chance that a MDA quantity will give a signal less than the decision level (DL), Type II Error. The DL is chosen so that there will be a 5% chance that a sample with zero activity will be recorded as containing activity Type I Error (Brodsky 1986).

In order to comply with DOE Order 5480.11 the limiting value for stochastic effects, 50 mSv AEDE shall not be exceeded. Stochastic effects are those which result in malignant and hereditary diseases for which the probability of an effect occurring, rather than its severity is regarded as a function of dose without a threshold.

As a performance objective the WVNS has set a detection limit of 1 mSv AEDE. The internal dosimetry program at the WVDP includes in vitro and in vivo measurements. The program involves regular (routine) measurements on individual workers. The currently used monitoring frequency is one year. The routine in vitro measurement involves the worker providing a urine sample collected over a twenty four hour period. The urine sample is then sent to a contract laboratory for analysis. The in vivo measurements are performed on site using a NaI(Tl) detector in a standard lung geometry.

The following assumptions are used at the WVDP for use in routine internal dose calculations unless data to the contrary is available:

- 1) all intakes of radionuclides are acute.
- 2) intakes occur at the midpoint of the monitoring interval (ICRP 1983).
- 3) Reference Man (ICRP 1975) represents the occupational worker.
- 4) particle size of 1 micrometer activity median aerodynamic diameter (AMAD).
- 5) route of intake is due to inhalation.

3. Materials and Methods

3.1 Determination of the most likely sources of internal contamination

In order to determine which radionuclides are of concern for routine internal dosimetry a review of previous surveys supporting decontamination work is performed (Meigs 1987, Tundo et al. 1988, and Vance 1986).

Decontamination of the main plant was undertaken to maximize re-use of the existing facilities in support of the HLRW solidification project. As of 1988, 30 percent of the main plant remains contaminated (Tundo et al. 1988). It was determined that the areas listed in Table 1 are still contaminated and represent possible sources of internal contamination.

Location

Chemical Process Cell (CPC)
Process Mechanical Cell (PMC)
General Purpose Cell (GPC)
Extraction Cell One (XC-1)
Extraction Cell Two (XC-2)
Hot Acid Cell (HAC)
Plutonium Product Handling (PPH)
Solvent Storage Terrace (SST)

Table 1 Location of potential sources of internal contamination in main operating plant.

3.1.1 Review of radioanalytical reports from contaminated areas

In order to determine the specific radionuclides present in the previously determined locations, radioanalytical reports were requested from the radiochemistry department. A review of the radionuclides and concentrations present is performed for comparison with the main HLRW storage tanks 8D-2 and 8D-4.

3.1.2 Review of radioanalytical data from waste tank farm

As mentioned in the introduction, the bulk of the radioactive waste is located in the waste tank 8D-2. A review of the radioanalyses of this tank and the thorium waste tank 8D-4 is performed. This information is used in determining the radionuclides of concern in the internal dosimetry program.

3.2 Calculation of the missed dose for the American National Standards Institute (ANSI N13.30) MDAs

In order to determine the potential missed dose for the currently used monitoring frequency and at the MDAs specified in ANSI N13.30 Table 2, the computer code REMedy (SAIC 1988) was utilized. REMedy is a series of microcomputer software programs used as a tool for evaluating radionuclide intake and dose on the basis of bioassay results (excreta or in vivo counting). These programs allow the user to input data describing the conditions surrounding a radionuclide exposure or intake event, and process that data according to the calculational methodology recommended by the ICRP to estimate the initial intake and subsequent dose.

3.3 Calculation of the missed dose for the WVDP contracted MDAs

With the use of REMedy, the potential missed dose for the contracted MDAs is determined. WVNS does not have the capability to perform in vitro radioanalyses. Therefore an off site laboratory is contracted to perform the urinalyses. The contracted MDAs are the values in which the outside laboratory has agreed to meet for the WVNS. The contracted values represent the WVNS minimum detectable amount capabilities. A comparison of these results and those using the ANSI N13.30 MDAs is performed to determine which values are more appropriate for use in documenting the missed dose.

3.4 Evaluating missed doses exceeding the performance objective

For any of the radionuclides exceeding the 1 mSv AEDE performance objective various analyses are performed in an attempt to meet this criterion. The following procedures are performed for attempting to meet the performance objective:

- 1) Compute sampling interval required to meet the performance objective
- 2) Determine detection limits (MDAs) necessary to detect 1 mSv AEDE
- 3) Use of activity ratios for linking radionuclides unable to meet the performance objective

3.5 Development of computer algorithm for determining activity levels above the derived investigation level (DIL)

The DILs are the activities or amounts of a radionuclide present in a bioassay compartment at a particular time that may warrant further investigation. After determination of the appropriate DILs a computer algorithm is developed to indicate values exceeding the radionuclide specific DIL. To determine if the algorithm performs properly, values exceeding the appropriate DIL are input for verification.

4. Results

4.1 Selection of specific radionuclides for use in internal dosimetry at the WVDP

After review of the radioanalytical data from contaminated areas in the main plant it was decided that the radionuclides in Table 2 are representative of those that a worker may be exposed to at the WVDP. The chemical form of these radionuclides was determined previously for use in characterizing the high-level waste for future vitrification (Rykken 1986).

<u>Radionuclide</u>	<u>Chemical Form</u>	<u>Inhalation Class</u>
Am-241	All Forms	W
Co-60	Co(NO ₃) ₂	Y
Cs-137	All Forms	D
Pu-238	PuO ₂	Y
Pu-239/240	PuO ₂	Y
Sr-90	SrSO ₄	D
Th-228	Th(NO ₃) ₄	W
Th-232	Th(NO ₃) ₄	W
U-234	UO ₂ (OH) ₂	Y
U-235	UO ₂ (OH) ₂	Y
U-238	UO ₂ (OH) ₂	Y

Table 2. Radionuclides of concern at the WVDP, with the associated chemical form and ICRP lung retention half-times. Inhalation classes are D= days, less than 10 days; W= weeks, between 10 and 100 days; Y= years, greater than 100 days.

4.2 Calculation of AEDE for the ANSI N13.30 MDAs

The values listed in Table 3 are the MDAs for the radionuclides of concern at the WVDP and the associated AEDE. Results were calculated with the use of REMedy.

4.3 Calculation of the AEDE for the contracted MDAs

Table 3 shows the radionuclides of concern and their associated AEDE. The AEDE values were calculated using the contracted MDAs and the computer code REMedy.

<u>Radionuclide</u>	<u>ANSI</u>	<u>Contract</u>	<u>ANSI</u>	<u>Contract</u>
	<u>(MDA mBq/l)</u>		<u>(AEDE mSv)</u>	
Am-241 **	2.2	1.1	2.75 *	1.36 *
Pu-238	2.2	0.33	24.50 *	3.64 *
Pu-239/240	2.2	0.33	22.90 *	3.40 *
Sr-90	700	560	0.12	0.10
Th-228	3.7	1.9	4.97 *	2.55 *
Th-232 **	3.7	1.9	0.66	0.34
U-234	3.7	1.9	2.08 *	1.07 *
U-235	3.7	1.9	1.92 *	0.99
U-238	3.7	1.9	1.85 *	0.95

* Values exceeding the 1 mSv performance objective

** Exceed committed dose equivalent to organ or tissue for contracted MDAs

Table 3 Radionuclides and MDAs with the associated AEDE, results calculated assuming analysis of a 24 hour urine sample at 180 days after acute inhalation intake.

4.4 Determination of appropriate MDAs for use in documenting the missed dose

The contracted laboratories' MDAs are lower than the ANSI values for each radionuclide. As a result of using the ANSI N13.30 MDAs it was determined that the AEDE exceeded 1 mSv for eight of the radionuclides in Table 3. When calculated using the contracted MDA values, the AEDE exceeded the 1 mSv performance objective for six of the radionuclides. MDAs for two of the eight radionuclides (U-235 and U-238) that exceed the performance objective for the ANSI N13.30 MDAs meet it for the contracted MDAs.

Both the ANSI and the contracted MDAs for the six remaining radionuclides Am-241, Pu-238, Pu-239, Pu-240, U-234 and Th-228, result in AEDE values above the performance objective. Because of uncertainties in the metabolic models and the fact that the U-234 potential missed dose is 1.07 mSv, the MDA for U-234 is considered to meet the performance objective.

It was also determined by using REMedy that the radioisotopes Pu-239 and Pu-240 result in the same AEDE; therefore the Pu-239 is used to determine the DIL for both radionuclides. Due to the fact that the contracted MDAs are lower and represent increased sensitivity (i.e., can detect smaller intakes), it was decided that the contracted MDAs are more appropriate for use in documenting the missed dose.

4.5 Determination of the AEDE at various times after intake

The values given in Table 4 are the result of calculating the AEDE at various times after acute inhalation intake for the radionuclides in Table 3 resulting in an AEDE of greater than 1 mSv.

Radionuclide	Time After Intake(Days)					
	(180)	(90)	(60)	(30)	(5)	(2)
Am-241	1.36	0.63	-	-	-	-
Pu-238	3.64	3.80	3.86	3.94	3.98	0.30
Pu-239/240	3.40	3.56	3.62	3.69	3.73	0.28
Th-228	2.55	1.72	1.47	1.23	0.81	-

* Values in mSv (AEDE)

Table 4 Radionuclides of concern and their associated AEDE, calculated assuming a 24 hour urinalyses at the contracted MDA and acute inhalation.

4.6 Calculation of detection levels (MDAs) required to detect 1 mSv AEDE

The hypothetical values listed in Table 5 are the MDA values required by an analytical laboratory in order to determine a 1 mSv AEDE at 180 days after inhalation intake using a 24 hour urinalysis.

Radionuclide	Contracted MDA (Bq/l)	Hypothetical MDA (Bq/l)
Am-241	1.1E-3	8.3E-4
Pu-238	3.3E-4	9.0E-5
Pu-239/240	3.3E-4	1.0E-4
Th-228	1.9E-3	7.5E-4

Table 5 Radionuclides with the contracted MDAs and MDAs required to detect a 1 mSv AEDE, calculated for a 24 hour urinalysis at 180 days after an acute inhalation intake.

4.7 Determination of activity ratios for use in tracing radionuclides with an AEDE exceeding 1 mSv

In an effort to achieve the performance objective of 1 mSv, AEDE activity ratios for the nuclides Pu-239, Am-241, and Th-228 (radionuclides exceeding the performance objective) were used. These radionuclides activities were correlated with Sr-90 activities. The reason for using Sr-90 is that it is easily detectable and is below the 1 mSv AEDE performance objective. The assumption was made that where Sr-90 is found the other radionuclides will be present in amounts represented by the given ratio.

Tables 6 and 7 show the ratios of Pu-239/Sr-90 and Am-241/Sr-90 as determined from the various radioanalyses.

<u>Analysis</u>	<u>1000[Pu-239]/[Sr-90]</u>
1. (McVay 1986) 8D-2 Supernatant	9.5
2. (Safety Analysis Report,(SAR) 1987)	
SAR 8D-2 Total	0.27
SAR Chemical Process Cell (CPC)	14
SAR Process Mechanical Cell (PMC)	15
SAR General Purpose Cell (GPC)	15
SAR Extraction Cell One (XC-1)	14
SAR Extraction Cell Two (XC-2)	14
3. (CPC Smears, 1984)	
CPC84-116-1	14
CPC84-116-3	22 *
4. (CPC Transfer Car Basket, 1987)	
CPC87-0406 Slag	19
CPC87-0406 Filings	14
5. (CPC Crud, 1987)	
CPC87-0756	15
6. (GPC Sponge Sample, 1986)	
GPC86-1523	0.98

* Maximum activity concentration ratio

Table 6 Various analyses and their corresponding Pu-239/Sr-90 activity ratios.

<u>Analysis</u>	<u>1000[Am-241]/[Sr-90]</u>
1. (McVay 1986) 8D-2 Supernatant	0.0
2. (SAR 1987) SAR 8D-2 Total	11
SAR CPC	42
SAR PMC	43 *
SAR GPC	43 *
SAR XC-1	42
SAR XC-2	43 *
3. (CPC Smears, 1984) CPC84-116-1	14
CPC84-116-3	36
4. (CPC Transfer Car Basket, 1987) CPC87-0406 Slag	3.9
CPC87-0406 Filings	24
5. (CPC Crud, 1987) CPC87-0756	18
6. (GPC Sponge Sample, 1986) GPC86-1523	2.3

* Maximum activity concentration ratio

Table 7 Various analyses and their corresponding Am-241/Sr-90 activity ratios.

For analysis three for both the Pu-239/Sr-90 and Am-241/Sr-90, one smear sample (CPC84-116-2) was not used because it was determined to be greater than three standard deviations from the mean value.

For tracing the Th-228, one analysis was used for determining the activity ratio. The reason for using only one value is that none of the other analyses have any indication of thorium contamination. Therefore the main source of thorium activity was determined to be in the waste tank 8D-4. Thorium does not represent a widespread source of potential contamination. From the results of Rykken 1986, it was determined that the ratio of Th-228 to Sr-90 is 5.5E-6, decay corrected to 1991 using the computer code Raddecay (Negin 1987).

4.7.1 Calculations for estimating the intake of radionuclides that result in AEDEs exceeding 1 mSv

The maximum activity ratios for Pu-239/Sr-90, Am-241/Sr-90 and Th-228/Sr-90 are determined to be 2.2E-2, 4.3E-2, and 5.5E-6 respectively. The following calculations are performed in an attempt to identify the radionuclides that exceeded the performance objective.

- 1) For estimating Pu-239 intake from Sr-90 in urine, the following calculation is performed:

$$EA = [I \times R \times RF(t)] / 1.4 \text{ l} \quad (\text{eq. 3})$$

EA = estimated activity concentration (Bq/l)
I = Intake of Sr-90 (1.03E4 Bq)
R = ratio of Pu-239/Sr-90 (2.2E-2)
RF = retention fraction for Pu-239 at time (t)
1.4 l = amount of urine excretion per day (l)

From the above equation it is determined that when a urine sample contains the minimum detectable amount of Sr-90 there will be 1.8E-4 Bq/l of Pu-239 present assuming that where there is Sr-90, there is Pu-239.

- 2) For Am-241/Sr-90 and using the Sr-90 intake that corresponds to the MDA and the ratio 4.3E-2, (1.9E-3 Bq/l of Am-241) is obtained.
- 3) The Th-228/Sr-90 ratio results in 1.2E-6 Bq/l of Th-228 using a ratio of 5.6E-6.

4.7.2 Calculation of the AEDE using the estimated activities computed in section 4.7.1

The following table is the result of calculating the AEDE for the values obtained in section (4.7.1).

<u>Radionuclide</u>	<u>Calculated Activity(Bq/l)</u>	<u>AEDE(mSv)</u>
Am-241	1.9E-3	2.36
Pu-239/240	1.8E-4	1.86
Th-228	1.2E-6 *	0.0000016

* Below contracted MDA

Table 8 Radionuclides of concern and calculated activities as a result of tracing with the MDA of Sr-90 and the associated AEDE 180 days after an acute inhalation intake.

To better understand the biokinetics of Am-241 as compared to Sr-90, the AEDE and activity ratios of Am-241/Sr-90 at various times after acute inhalation were calculated. Assuming the Am-241 is in the constant ratio of $4.3E-2$ Am-241/Sr-90 at the time of intake the ratio of AEDE for Am-241/Sr-90 at various times between acute inhalation intake and bioassay for Sr-90 is 24.4. Figure 2 shows the activity concentration ratios of Am-241/Sr-90 in urine at various times after acute inhalation intake assuming the constant ratio $4.3E-2$ Am-241/Sr-90 at the time of intake.

Figure 2 Activity concentration ratios in urine sample of Am-241/Sr-90 at various times after acute inhalation intake assuming the constant ratio of $4.3E-2$ Am-241/Sr-90 at the time of intake.

4.8 Calculation of dose equivalent at 5% of the limiting ALI

Table 9 shows the results of calculating the dose due to an acute inhalation of 5 percent of the ALI (ICRP 1968).

Radionuclide	Limiting ALI	Routine Urinalysis (Bq/l)		Committed Dose (mSv)
		DIL	Contract(MDA)	
Am-241	Non-Stochastic	4.3E-5	< 1.1E-3	25.0
Pu-238	Stochastic	2.3E-5	< 3.3E-4	2.5
Pu-239/240	Non-Stochastic	2.1E-5	< 3.3E-4	25.0
Sr-90	Non-Stochastic	1.9E0 *	> 5.6E-1	25.0
Th-228	Non-Stochastic	3.7E-4	< 1.9E-3	25.0
Th-232	Non-Stochastic	5.5E-5	< 1.9E-3	25.0
U-234	Stochastic	9.0E-4	< 1.9E-3	2.5
U-235	Stochastic	9.8E-4	< 1.9E-3	2.5
U-238	Stochastic	1.0E-3	< 1.9E-3	2.5

In-vivo Lung Count (Bq) MDA

Co-60	Stochastic	4.9E3 *,**	> 5.5E1 **	2.5
Cs-137	Stochastic	5.3E4 *,**	> 1.9E2 **	2.5

* Values exceed MDA

** Units in (Bq/lung count)

Table 9 Radionuclides of concern and the DIL that results from an intake of 5% of the ALI (2.5 mSv stochastic and 25 mSv for non-stochastic effects) assuming a 24 hour urinalysis and 180 days after an acute inhalation intake.

The only radionuclide for routine in vitro urinalyses that results in a DIL above the contracted MDA is Sr-90, for in vivo monitoring Co-60 and Cs-137 result in a DIL above the WVNS MDAs. The DIL for Co-60 Table 9 is used for determining if further investigation is appropriate. The DIL for Cs-137 results in an AEDE (2.4 mSv) exceeding the performance objective. Therefore the in vivo bioassay that results in an AEDE of 1 mSv is calculated. The resulting DIL for Cs-137 is 2.2E4 Bq.

4.9 Statistically significant results (DILs)

An alternative to the DIL shown above is needed for the radionuclides shown in Table 9 for which the contracted MDA results in an AEDE greater than 1 mSv. I suggest a "three sigma" DIL as defined below.

The activity concentration in a sample (Bq/L) is given by

$$C = R_n / Y \cdot V \quad (\text{eq. 4})$$

where R_n = the net count rate (s^{-1})
 Y = the counting yield (counts per second per Bq)
 V = the volume of the sample analyzed (L)

The net count rate is

$$R_n = R_g - R_b \quad (\text{eq. 5})$$

where

R_g = the gross count rate (s^{-1})
 R_b = the background count rate (s^{-1})

The [sample] standard deviation of the net count rate (s^{-1}) is

$$s_n = (n_g^2/t_g + n_b^2/t_b)^{1/2} \quad (\text{eq. 6})$$

where n_g = gross counts
 t_g = gross counting time (s)
 n_b = background counts
 t_b = background counting time (s)

Substituting 3 s_n into the concentration equation, the "3 sigma" DIL is calculated as

$$DIL_{3\sigma} = 3 s_n / Y \cdot V \quad (\text{eq. 7})$$

where all terms are as defined above.

4.9.1 Computer Algorithm

The radionuclides in Table 9 that have DILs below the current technical capabilities of detection, result in the inability to meet the ICRP-10 (ICRP 1968) recommendation. Therefore the statistically significant result approach is used for determining the DIL. The following algorithm is developed for determining bioassay results that warrant further investigation.

Algorithm:

5. Discussion

5.1 Documenting the missed dose

In order to determine the potential missed dose for the radionuclides of concern (Table 2) the ANSI N13.30 MDAs were used. The monitoring interval of one year was used as a starting point to determine if the 1 mSv AEDE performance objective could be met. The values listed in Table 3 are the ANSI N13.30 MDAs and the resulting potential missed dose. These values were relatively high compared to the performance objective except for Sr-90 and Th-232. Due to the high values it was decided that a comparison with the contracted values was appropriate.

A comparison of the ANSI and contract MDAs showed that, for each of the radionuclides, the contract values were smaller. Therefore, the potential missed dose is smaller than those calculated for the ANSI MDAs. For U-235 and U-238 the potential missed dose meets the performance objective for the contracted MDAs. Because of uncertainties in the metabolic modeling, the U-234 value of 1.07 mSv is considered to meet the performance objective.

Because the one-year monitoring interval resulted in values exceeding the performance objective, monitoring intervals that would result in an AEDE meeting the performance objective were calculated.

Although it can be seen from Table 4 that the performance objective could be met for all of the radionuclides, it is not a practical method for routine internal dosimetry. Only one radionuclide met the performance objective at a monitoring interval of 6 months (Am-241), at a 10 day monitoring interval (Th-228), and at a 4 day interval Pu-238, Pu-239, and Pu-240 meet the criterion.

From a practical (economic) standpoint, a change in the monitoring frequency is not justified.

Example:

Assume: \$375/urinalysis
 250 Workers

1. One year monitoring frequency

$$\begin{aligned}\text{Cost} &= \$375/\text{urin.} \times 250 \text{ workers} \times 1 \text{ urin./yr-worker} \\ &= \$94,000/\text{yr}\end{aligned}$$

2. Four day monitoring frequency

$$\begin{aligned}\text{Cost} &= \$375/\text{urin.} \times 250 \text{ workers} \times 90 \text{ urin./yr-worker} \\ &= \$8,400,000/\text{yr}\end{aligned}$$

Not only is changing the monitoring frequency not economically practical, but the increased work load would be quite taxing on the staff, not to mention the inconvenience to the worker (urine sample every 4 days).

Since it has been shown that a change in the monitoring frequency is not practical the MDAs required to meet the performance objective were determined. The values in Table 5 are the result of the execution of REMedy. Compared to the contracted MDAs, the hypothetical values are 25% less for Am-241, 73% less for Pu-238, 97% less for Pu-239/240, and 61% less for Th-228. Because the MDA is a result of various factors e.g., counting time, sample volume, and efficiency the hypothetical values may be obtainable for some of the radionuclides. Therefore an investigation of the contract laboratories' capabilities is recommended.

In cases where there is an inability to meet the performance objective, an attempt at linking the radionuclides of concern to more easily detectable isotopes is performed. After review of various radioanalyses it was decided that activity ratios greater than three standard deviations would be considered outliers. To be conservative, that is, to err on the side of safety, the resulting maximum ratio is used for linking the radionuclides of concern.

As a result of linking Am-241 and Pu-239/240 to Sr-90, it was determined that the resulting AEDE would exceed the performance objective. Because the isotopes of thorium are a result of one source term and do not represent a likely source of internal contamination, the method used for linking these radionuclides is used for documenting the potential missed dose.

In calculating the AEDE, it was determined that two of the radionuclides of concern exceed the 50 year committed dose equivalent (500 mSv) limit to their limiting tissue (bone surface). The values for the radionuclides that exceed the regulatory limits are (640 mSv for Am-241 and 870 mSv for Th-232).

In order to document the potential tissue dose equivalent, the Th-232 is linked with Sr-90. Using equation 3 and the ratio $3.87\text{E-}6$ Th-232/Sr-90 (Rykken 1986) results in a sample activity of $1.7\text{E-}6$ Bq/l of Th-232. This activity results in a dose equivalent to the bone of .8 mSv and an AEDE of $3\text{E-}7$ mSv. Because the hypothetical value for Am-241 is only 25% less than the current MDA, and results in a committed dose equivalent to the bone surface of 482 mSv an investigation of the contract laboratories' MDA capabilities is recommended.

5.2 REMedy vs. ICRP-30

Following the recommendations of ICRP-10 (ICRP 1968), the DILs that would correspond to a 5 % intake of the limiting ALI were determined. Table 9 shows the DIL and the resulting committed dose for the radionuclides of concern. The calculated values (DILs) as a result of executing REMedy are slightly smaller than those that would result from the ICRP-30 (ICRP 1979) models. The intake that results in a dose of:

- 25 mSv 50 year Committed Dose to an organ or tissue and
- 2.5 mSv 50 year Committed Effective Dose

is 5 % of the ALI. It was determined that the REMedy values are within 10 % for most radionuclides for calculating the tissue or organ dose equivalent. The effective dose equivalent is higher because the REMedy program does not drop doses that are considered to be insignificant.

The "10% rule" ICRP-30 (ICRP 1979) states "A tissue is deemed to be irradiated to a significant extent if for that tissue the weighted value of the 50 year committed dose equivalent ($H_{50,T}$) per unit intake is greater than 10 percent of the maximum weighted value of $H_{50,T}$ per unit intake in any tissue.

$$\text{i.e., } w_T H_{50,T} \text{ per unit intake} \geq .1 (w_T H_{50,T} \text{ per unit intake})_{\max}$$

REMedy is therefore more conservative in that more tissues are used for calculating the committed effective dose. The DILs that result from the ICRP-10 recommendations are lower than the contracted MDAs except for Sr-90. The DIL for Sr-90 is determined to be 1.9 Bq/l using the 5 % criterion.

As a result of the technological inability to meet the ICRP-10 recommendation for most of the radionuclides, the alternative approach developed in section 4.9 is used for determining the DILs for the radionuclides of concern. By investigating any bioassay result exceeding the 3 standard deviation level, the WVDP will result in regulatory compliance.

Due to time limitations, the program for the computer algorithm was not written. This program is used as backup to health physics review and it was determined that an off site contractor will be able to write the program.

6. Conclusions

It has been determined that current technology is not capable of achieving the performance objective of 1 mSv AEDE for the one year monitoring interval and contracted MDAs for Am-241, Pu-238, Pu-239/240, and Th-228. It has been shown that a change in the monitoring interval is not practical for attempting to meet the performance objective.

When documenting the missed dose for an internal dosimetry program, it is important that the appropriate regulatory limits are met. The recommendations from groups such as the American National Standards Institute are used to attempt to meet the regulatory requirements. The recommendations by these groups do not always represent the lowest possible minimum detectable amount capabilities. Therefore it is important for a given facility to investigate their site-specific capabilities when determining regulatory compliance. In regards to the current WVNS minimum detectable amount capabilities it is recommended that the lowest attainable MDA capabilities of various bioassay laboratories be investigated. If the MDA capabilities result in an AEDE meeting the performance objective, a cost analysis should be performed to determine if it is economically feasible to achieve lower MDAs.

Although the performance objective cannot be achieved for some of the radionuclides, the DOE regulatory limit (50 mSv AEDE) is not exceeded for any of them. Historically the WVDP does not have a problem with internal contamination but continual evaluation of the work environment and MDA capabilities is performed for continued worker safety and regulatory compliance.

References

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TABLE 2-6: SUPERNATANT RADIOCHEMICAL COMPOSITION (as of 07/01/86)

ISOTOPE	T 1/2 (HALF LIFE)	CL	METHOD OF DECAY CORRECTION
H-3	12.3 yr	103	$\propto e^{-\lambda T}$
C-14	5,730 yr	137	$\propto e^{-\lambda T}$
Ni-63	100 yr	686	$\propto e^{-\lambda T}$
Se-76	6.5×10^4 yr	37	$\propto e^{-\lambda T}$
Sr-90	29 yr	2,968	$\propto e^{-\lambda T}$
Y-90	64 hr	2,968	Same as Sr-90 (short-lived daughter)
Zr-93	1.53×10^6 yr	0.23	$\propto e^{-\lambda T}$
Nb-93m	13.6 yr	0.14	From Decay chain Zr-93 → Nb-92m → Nb-93
Te-99	2.13×10^5 yr	1,888	$\propto e^{-\lambda T}$
Ru-106	369d	2.8	$\propto e^{-\lambda T}$
Rh-106	30s	2.8	Same as Ru-106 (short-lived daughter)
Pd-107	6.5×10^6 yr	1.2×10^{-2}	$\propto e^{-\lambda T}$
Cd-113m	14.6 yr	21	$\propto e^{-\lambda T}$
Sn-121m	50.0 yr	$1.5E-3$	$\propto e^{-\lambda T}$
Sb-125	2.73 yr	72	$\propto e^{-\lambda T}$
Te-126m	58d	16.6	23% of Sb-125 (short-lived daughter, 23% of Sb-125 → Te-126m)
Sn-126	1.06×10^5	0.40	$\propto e^{-\lambda T}$
Sb-126m	19m	0.40	Same as Sn-126 (short-lived daughter)
Sb-126	12.5d	0.08	14% of Sb-126m based on 14% of Sb-126m → Sb-126
I-129	1.56×10^7 yr	0.21	$\propto e^{-\lambda T}$
Cs-134	2.08 yr	1.84×10^4	$\propto e^{-\lambda T}$
Cs-136	2.3×10^6 yr	198	$\propto e^{-\lambda T}$
Cs-137	30.0 yr	7.43×10^8	$\propto e^{-\lambda T}$
Ba-137m	2.5m	7.03×10^8	94.6% of Cs-137 (short-lived daughter, 94.6% of Cs-137 → Ba-137m)
Ce-144	284d	7.23×10^{-5}	$\propto e^{-\lambda T}$
Pr-144	17m	7.23×10^{-5}	Same as Ce-144 (short-lived daughter)
Pm-147	2.62 yr	217	$\propto e^{-\lambda T}$
Sm-151	93 yr	1.11	$\propto e^{-\lambda T}$
Eu-152	13.4 yr	4.47×10^{-2}	$\propto e^{-\lambda T}$
Eu-154	6.2 yr	14.8	$\propto e^{-\lambda T}$
Eu-156	4.78 yr	2.73	$\propto e^{-\lambda T}$
U-233	1.59×10^5 yr	0.5	$\propto e^{-\lambda T}$
U-234	2.44×10^5 yr	0.3	$\propto e^{-\lambda T}$
U-236	7.04×10^8 yr	6.5×10^{-3}	$\propto e^{-\lambda T}$
U-238	2.34×10^7 yr	2.0×10^{-2}	$\propto e^{-\lambda T}$
U-236	4.47×10^8 yr	5.8×10^{-2}	$\propto e^{-\lambda T}$
Pu-238	87.7 yr	130	$\propto e^{-\lambda T}$
Pu-239	2.4×10^4 yr	26	$\propto e^{-\lambda T}$
Pu-240	6,537 yr	18	$\propto e^{-\lambda T}$
Pu-241	14.4 yr	1.58×10^3	$\propto e^{-\lambda T}$
Pu-242	3.8×10^5 yr	2.50×10^{-2}	$\propto e^{-\lambda T}$

$$\lambda = \ln 2 / T_{1/2}$$

T = Time from reference (may be negative)

T 1/2, t in same units

TABLE 12: REFERENCE 1987 RADIONUCLIDE CONTENT (CURIES) OF THOREX WASTE

<u>Radionuclide</u>	<u>Total Curies</u>	<u>Radionuclide</u>	<u>Total Curies</u>
3-H	<1.74E+00	216-Po	9.76E+00
14-C	1.30E-01	217-At	2.07E-01
55-Fe	5.63E+02	219-Rn	7.52E+00
60-Co	1.14E+03	220-Rn	9.76E+00
59-Ni	2.03E+01	221-Fr	2.07E-01
63-Ni	2.51E+03	223-Fr	1.04E-01
79-Se	3.35E+00	223-Ra	7.52E+00
90-Sr	4.54E+05	224-Ra	9.76E+00
90-Y	4.54E+05	225-Ra	2.07E-01
93-Zr	1.62E+01	228-Ra	1.48E+00
93m-Nb	1.02E+01	225-Ac	2.07E-01
99-Tc	1.04E+02	227-Ac	7.52E+00
106-Ru	6.24E-01	228-Ac	1.48E+00
106-Rh	6.24E-01	227-Th	7.42E+00
107-Pd	1.14E-01	228-Th	9.76E+00
113m-Cd	3.75E+01	229-Th	2.07E-01
121m-Sn	5.99E-01	230-Th	4.38E-02
126-Sn	3.11E+00	231-Th	5.17E-03
125-Sb	2.89E+02	232-Th	1.64E+00
126-Sb	4.35E-01	234-Th	7.11E-05
126m-Sb	3.11E+00	231-Pa	1.52E-01
125m-Te	7.08E+01	233-Pa	3.02E-01
129-I	<1.80E-01	234m-Pa	7.11E-05
134-Cs	3.10E+02	232-U	2.74E+00
135-Cs	5.47E+00	233-U	2.09E+00
137-Cs	4.75E+05	234-U	2.17E-01
137m-Ba	4.49E+05	235-U	5.17E-03
144-Ce	1.39E-01	236-U	9.80E-03
144-Pr	1.39E-01	238-U	7.11E-05
146-Pm	5.07E-01	236-Np	1.23E-01
147-Pm	9.11E+03	237-Np	3.02E-01
151-Sm	4.78E+03	239-Np	4.49E+00
152-Eu	4.82E+01	236-Pu	1.09E-02
154-Eu	2.53E+03	238-Pu	4.80E+02
155-Eu	8.44E+02	239-Pu	1.54E+01
207-Tl	7.50E+00	240-Pu	8.09E+00
208-Tl	3.51E+00	241-Pu	8.50E+02
209-Pb	2.07E-01	242-Pu	1.19E-02
211-Pb	7.52E+00	241-Am	2.41E+02
212-Pb	9.76E+00	242-Am	6.76E+00
211-Bi	7.52E+00	242m-Am	6.79E+00
212-Bi	9.76E+00	243-Am	7.83E+00
213-Bi	2.07E-01	242-Cm	5.59E+00
212-Po	6.25E+00	243-Cm	2.34E-01
213-Po	2.03E-01	244-Cm	1.37E-01
215-Po	7.52E+00	245-Cm	2.00E-02
		246-Cm	2.29E-03

Analysis Summary:

Sample Name CPC Smears Log Number 84-116
 Sample Form Smears Chain Number 4142122
 Surface Date Rate Surface R/TG Rep.
 Request for Dick Smearmaker Phone Number 310
 Submitted by Don Sawyer Date 5-24-83 Time
 Location Sampled CPC Base Chain Number 4142122

32 - Below Detectable limits "All were below detectable limits"

Recd. by: RF Date: 6 Time: —

2.14.12. 505.93:03

[illegible]

Date Recorder M. P. L. H. on Date 6/27/84
Results Approved [Signature] Date 7-12-84

(MRC-1226)

SECRET

29

ANALYTICAL REQUEST

(MRC-1206)

SAMPLE NAME 400 (1000) CHARGE NO 100212 LOG NO 87-0756
 RESULTS REPORT TO 2100005/10000 / 10.10.10 PHONE 427/4809
 SAMPLE BY D. HARRIS DATE 9/20 TIME 1200 LOCATION 200

EITHER A OR B AND C MUST BE INITIALED OR THE SAMPLE WILL NOT BE ACCE
 A THE SAMPLE DOES NOT CONTAIN RADIOACTIVE MATERIAL OR
 THIS IS A ROUTINE SAMPLE WITH GROSS ACTIVITY (SEE-3) OCC/ME
 B GROSS RATE AT 1 INCHES 2 INCHES 1 INCHES 1 INCHES 1 INCHES
 C IS THIS SAMPLE SUSPECTED OF CONTAINING U OR PU? YES N

TO BE FILLED IN WHEN SAMPLE DELIVERED TO LABORATORY OR CABINET
 RECEIVED DATE TIME 2030 DATE 9/20/87 TIME 1315 DATE 9/21/87

COMMENTS DRY Sample

ANALYSIS REQUESTED	ANALYSIS RESULT	UNIT	ANALYSIS RESULT	UNIT	ANALYSIS RESULT	UNIT
TOTAL Pu	(1.96 ± 0.30) E-2	μCi/g				
TOTAL U	1.025 E-04	μCi/g				
GROSS α	5.98 E-02	μCi/g				
GROSS β	4.32 E+00	μCi/g				
gross gamma	(2.34 ± 0.20) E-2	μCi/g				
Cs-137	(1.72 ± 0.02) E-0	μCi/g				
Sr-90	(1.36 ± 0.06) E-00	μCi/g				
Co-60	3.86 ± 0.12 E-2	μCi/g				

DATA APPROVED MTC DATE 5-12-87 TIME 1100

WV 1112

ANALYTICAL REQUEST

MRC-1206

SAMPLE NAME GPC Sponge Sample CHARGE NO 4412041206 NO 86-1543
 RESULTS REPORTED TO R Vance - Russell J Thorne PHONE 404 444 4442
 SAMPLED BY Jim Burrell DATE 6-27-86 TIME 8:01 LOCATION GAC

EITHER A OR B AND C MUST BE INITIALED OR THE SAMPLE WILL NOT BE ACCE
 A THE SAMPLE DOES NOT CONTAIN RADIOACTIVE MATERIAL OR
 THIS IS A ROUTINE SAMPLE WITH GROSS ACTIVITY (SE-1) UCI/ML
 B DOSE RATE AT 2 INCHES 1/4 MR/HR R/NE REP # DATE
 C IS THIS SAMPLE SUSPECTED OF CONTAINING Y OR PO OR N GC

TO BE FILLED IN WHEN SAMPLE DELIVERED TO LABORATORY PERSONNEL
 DELIVERED JA TIME 11:30 DATE 6-27-86 RECEIVED TIME 11:30 DATE 6-27-86

COMMENTS # No Survey on Initial Sample taken since sample was transferred to
SEC directly from RMC

ANALYSIS REQUESTED	SAMPLE IDENTIFICATION			
	Liquid from			
	Sponge			
Sr-90	✓ (7.63±0.1) E-1			
	Units <u>uCi/ml</u>			
T-Pu	✓ (6.39±0.66) E-04			
	Units <u>uCi/ml</u>			
Gamma Scan	✓ <1.5 E-03			
(Ampl) Units	<u>uCi/ml</u>			
Gamma Scan	✓ (3.86±0.00) E-00			
(Cs137) Units	<u>uCi/ml</u>			
Gamma Scan	✓ (7.44±2.0) E-03			
(Cs134) Units	<u>uCi/ml</u>			
Gamma Scan	✓ (4.10±0.09) E-03			
(Co60) Units	<u>uCi/ml</u>			
Gross α	✓ BDL			
Units	<u>uCi/ml</u>			
Gross β	✓ 4.77 E 00			
Units	<u>uCi/ml</u>			
Total Uranium	✓ 1.9 E-03			
Units	<u>g/g</u>			

DATA APPROVED Alfred C. Fung DATE 9-3-86 TIME 16:35

HV 1112

TABLE C.2. Selection of "Acceptable MRLs" for Urinalysis

Radionuclide	Selected from Published Literature	Based on Applied Health Physics Data & Considerations	Units of pCi/l (except where noted)			Accepted for Inclusion in MSL MRL, pp
			Results of Pilot Study Calculated MRL			
			1-σ	Median	95%	
Americium-241	0.05	0.05	0.1	0.5	0.8	0.05
Carbon-14	1×10^3	1×10^3				1×10^4
Cesium-137	6×10^3	60	1.0	10	1000	60
Cobalt-60	5×10^2	50	1.1	10	200	50
Curium-242/244	0.02	0.05				0.05
Deuterium-2	1×10^3	1×10^3				1×10^3
Deuterium-3	1×10^2	1×10^2				1×10^2
Lead-210	5	5				5
Hydrogen-3	0.05	0.05				0.05
Phosphorus-32	40	20				20
Plutonium-238/239/240	0.05	0.05	0.05	---	0.3	0.05
Plutonium-241	10	5				5
Polonium-210	0.1	0.1				0.1
Protactinium-231	3	10				10
Radium-226	0.1	0.1				0.1
Radium-228	5	5				5
Strontium-89/90 or Strontium-90	10	20	2.5	12	40	20
Sulfur-35	1×10^2	1×10^2				1×10^2
Thorium-230/232/232	0.05	0.1				0.1
Tritium	1×10^3	1×10^3	0.2×10^3	3.0×10^3	7.2×10^3	1×10^3
Uranium-234/235/238	0.1	0.1				0.1
Uranium (total)	5 pp/l	5 pp/l	0.7 pp/l	2.7 pp/l	20 pp/l	

ANSI N3.30 DRAFT 49 0724180 0004724 8

(Attachment 2)

Table 2. Analytical and Reporting Requirements for Priority 2 Processing of Samples

<u>Analyte</u>	<u>Radionuclides</u>	<u>Contractual Detection Level (a)</u>			<u>Reporting Time</u>	
		<u>Urine</u>	<u>Fecal</u>	<u>TAT(b)</u>	<u>Oral</u>	<u>Written</u>
Pb Isotopic	Pb-210/210/210	1E-6	1E-5	0	0	13
Am-241	Am-241	1E-6	1E-5	0	0	13
Ce Isotopic	Ce-243/244/245	1E-6	1E-5	0	0	13
Th Isotopic	Th-228/230/232	1E-6	1E-6	0	0	13
H-3	H-3	4.1E-3 uCi/ml	-----	0	0	13
Sr-90	Sr-90	1.1E-5	1E-2	0	0	13
Sa-151	Sa-151	1E-5	1E-1	0	0	13
Eu Isotopic	Eu-154/155	1E-6	1E-2	0	0	13
Trans Uranium	Elemental U	1.0 ug/sample	240 ug/sample	0	0	13
U Isotopic	U-233/234/235/238	1E-6	1E-5	0	0	13

- (a) Note - Results shall be reported in units of uCi/sample with the exceptions of H-3 which shall be reported as uCi/ml and Uranium Base which shall be reported as ug/sample.
 (b) Turn Around Time (TAT) represents working days following sample receipt.
 (c) Oral report required at TAT if analyte is greater than Contractual Detection Level.
 (d) Written report required for all results within five working days of required TAT.

Printed on 04/29/91 at 08:42:04 This report resides in file 1.131.
Generated on 04/29/91 at 08:42:05 Generated from REMedy File 1 Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****

CASE : Acute INHALATION of AM-241w on 30 JUN 1990
BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 2.22E-03 Bq : 10W AMDAs

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure : 180.0

Lung Model : ICRP30 Lung Model ID : LungDet110
ALI Bq : 2.00E-02 Screening Level Bq : 1.1E-01
ALI uCi : 5.41E-03 Screening Level uCi : 2.75E-04

TC Half-Time Days : 2.50E-01 Fu : 5.40E-01
f1 : 1.00E-03 f2 : 4.50E-01

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 6.09E-06
Intake (Bq) : 5.10E-02 % ALI : 254.97
Intake (uCi) : 1.38E-02 % Screening Level : 5099.40

ORGAN	50-year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	1.66E+00	1.66E-02	3.03E-02	3.03E-04
BREAST	1.11E-04	1.11E-06	5.25E-05	5.25E-07
R.MARROW	1.04E-01	1.04E-01	2.20E-01	2.20E-01
LUNGS	9.38E-01	9.38E-03	9.23E-01	9.23E-03
THYROID	3.82E-05	3.82E-07	4.96E-05	4.96E-07
ENDOSTEAL	1.29E+02	1.29E+00	2.75E+00	2.75E-02
REMAINDER	5.56E+00	5.56E-02	1.99E-01	1.99E-03
EFFECTIVE	7.29E+00	7.29E-02	2.75E-01	2.75E-03

*** WARNING *** Intake Requires Investigation
*** WARNING *** Calculated Intake Exceeds ALI

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	3.25E-05
BREAST	2.18E-09
R.MARROW	2.03E-04
LUNGS	1.84E-05
THYROID	7.50E-10
ENDOSTEAL	2.93E-03
REMAINDER	1.09E-04
EFFECTIVE	1.43E-04

COMMENTS:

SIGNATURE:

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Printed on 04/29/91 at 10:59:19 This report resides in File : 1st1
 Generated on 04/29/91 at 10:59:19 Generated from REMedy File : Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****
 *
 * CASE : Acute INHALATION of PU-238Y on 30 JUN 1990
 * BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 2.22E-03 Bq/l ID# AMDAs
 *

***** INPUT DATA *****

Subject Name : ID#
 Analyst : Paul ID#

 AMAD (um) : 1.00
 Days Post Exposure: 180.0

 Lung Model : ICRP30 Lung Model ID : LungDat.lib

 ALI (Bq) : 7.00E+02 Screening Level(Bq) : 3.50E-01
 ALI (uCi) : 1.89E-02 Screening Level(uCi) : 9.46E-04

 TC Half-Time(Days): 2.50E-01 Fd : 5.40E-01
 FI : 1.00E-05 Ff : 4.60E-01

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 1.10E-06
 Intake (Bq) : 2.84E+03 % ALI : 405.10
 Intake (uCi) : 7.66E-02 % Screening Level : 8102.01

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	2.95E+00	2.95E-02	1.15E-02	1.15E-04
BREAST	1.71E-05	1.71E-07	2.60E-05	2.60E-07
R.MARROW	1.89E+01	1.89E-01	8.42E-02	8.42E-04
LUNGS	9.07E+01	9.07E-01	1.99E+01	1.99E-01
THYROID	5.64E-07	5.64E-09	2.30E-05	2.30E-07
ENDOSTEAL	2.36E+02	2.36E+00	9.95E-01	9.95E-03
REMAINDER	1.04E+01	1.04E-01	8.62E-02	8.62E-04
EFFECTIVE	2.41E+01	2.41E-01	2.45E+00	2.45E-02

*** WARNING *** Intake Requires investigation
 *** WARNING *** Calculated Intake Exceeds ALI

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	1.04E-05
BREAST	6.04E-11
R.MARROW	6.65E-05
LUNGS	3.20E-04
THYROID	1.99E-12
ENDOSTEAL	8.31E-04
REMAINDER	3.68E-05
EFFECTIVE	8.50E-05

COMMENTS:

SIGNATURE:

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Generated on 04/29/91 at 11:01:31 Generated from REMedy File : Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****

*
* CASE : Acute INHALATION of PU-239Y on 30 JUN 1990
* BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 2.22E-03 Bq/l ID# AMDAs
*

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.lib

ALI (Bq) : 6.00E+02 Screening Level(Bq) : 3.00E+01
ALI (uCi) : 1.62E-02 Screening Level(uCi) : 8.11E-04

TC Half-Time(Days): 2.50E-01 Fu : 5.40E-01
F1 : 1.00E-05 Ff : 4.60E-01

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 1.10E-06
Intake (Bq) : 2.83E+03 % ALI : 471.00
Intake (uCi) : 7.64E-02 % Screening Level : 9419.96

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	3.39E+00	3.39E-02	1.07E-02	1.07E-04
BREAST	7.88E-06	7.88E-08	2.59E-05	2.59E-07
R.MARROW	2.15E+01	2.15E-01	7.63E-02	7.63E-04
LUNGS	9.13E+01	9.13E-01	1.91E+01	1.91E-01
THYROID	6.61E-07	6.61E-09	2.21E-05	2.21E-07
ENDOSTEAL	2.68E+02	2.68E+00	9.92E-01	9.92E-03
REMAINDER	1.18E+01	1.18E-01	1.53E+00	1.53E-02
EFFECTIVE	2.60E+01	2.60E-01	2.29E+00	2.29E-02

*** WARNING *** Intake Requires investigation
*** WARNING *** Calculated Intake Exceeds ALI

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	1.20E-05
BREAST	2.79E-11
R.MARROW	7.60E-05
LUNGS	3.23E-04
THYROID	2.34E-12
ENDOSTEAL	9.50E-04
REMAINDER	4.16E-05
EFFECTIVE	9.19E-05

COMMENTS: _____

SIGNATURE: _____

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Printed on 04/29/91 at 11:03:28 This report resides in File T:\p1
Generated on 04/29/91 at 11:03:28 Generated from REMedy File : Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****
*
* CASE : Acute INHALATION of SR-90 D on 30 JUN 1990
* BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 7.00E-01 Bq/l ID# AMDAs
*

***** INPUT DATA *****
Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.lib

ALI (Bq) : 7.00E+05 Screening Level(Bq) : 3.50E+04
ALI (uCi) : 1.89E+01 Screening Level(uCi) : 9.46E-01

IC Half-Time(Days): 2.50E-01 Fu : 8.00E-01
F1 : 3.00E-01 Ff : 2.00E-01

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****
Retention Fraction at Time Post-Exposure : 7.59E-05
Intake (Bq) : 1.29E+04 % ALI : 1.84
Intake (uCi) : 3.49E-01 % Screening Level : 36.89

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	3.41E-03	3.41E-05	1.99E-03	1.99E-05
BREAST	3.41E-03	3.41E-05	1.99E-03	1.99E-05
R.MARROW	4.34E-01	4.34E-03	5.93E-02	5.93E-04
LUNGS	4.82E-03	4.82E-05	3.42E-03	3.42E-05
THYROID	3.41E-03	3.41E-05	1.99E-03	1.99E-05
ENDOSTEAL	9.39E-01	9.39E-03	9.06E-02	9.06E-04
REMAINDER	4.34E-03	4.34E-05	8.52E-03	8.52E-05
EFFECTIVE	8.35E-02	8.35E-04	1.22E-02	1.22E-04

***** DOSE FACTORS USED IN CALCULATIONS *****
Organ Dose Factor [Sv/Bq]

GONADS 2.64E-09
BREAST 2.64E-09
R.MARROW 3.36E-07
LUNGS 3.73E-09
THYROID 2.64E-09
ENDOSTEAL 7.27E-07
REMAINDER 3.36E-09
EFFECTIVE 6.47E-08

COMMENTS: _____

SIGNATURE: _____

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Printed on 04/29/91 at 11:04:52 This report resides in File : 1011
Generated on 04/29/91 at 11:04:52 Generated from REMedy File : Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****

CASE : Acute INHALATION of TH-228W on 30 JUN 1990
BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 3.70E-03 Bq/l ID# AMDAs

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.lib

ALI (Bq) : 4.00E+02 Screening Level (Bq) : 2.00E+01
ALI (uCi) : 1.08E-02 Screening Level (uCi) : 5.41E-04

TC Half-Time(Days): 5.00E-01 Fd : 9.90E-01
F1 : 2.00E-04 Ff : 1.00E-02

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 2.82E-05
Intake (Bq) : 1.84E+02 % ALI : 45.98
Intake (uCi) : 4.97E-03 % Screening Level : 919.61

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	2.48E-02	2.48E-04	1.14E-02	1.14E-04
BREAST	2.48E-02	2.48E-04	1.14E-02	1.14E-04
R.MARROW	2.06E+00	2.06E-02	5.96E-01	5.96E-03
LUNGS	1.74E+00	1.74E-02	1.74E+00	1.74E-02
THYROID	2.46E-02	2.46E-04	1.14E-02	1.14E-04
ENDOSTEAL	2.52E+01	2.52E-01	7.45E+00	7.45E-02
REMAINDER	6.33E-02	6.33E-04	0.00E+00	0.00E+00
EFFECTIVE	1.24E+00	1.24E-02	4.97E-01	4.97E-03

*** WARNING *** Intake Requires Investigation

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	1.35E-06
BREAST	1.35E-06
R.MARROW	1.12E-04
LUNGS	9.48E-05
THYROID	1.34E-06
ENDOSTEAL	1.37E-03
REMAINDER	3.44E-06
EFFECTIVE	6.75E-05

COMMENTS: _____

SIGNATURE: _____

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Printed on 04/29/91 at 11:05:35
Generated on 04/29/91 at 11:05:35

This report resides in File: 1101.
Generated from REMedy File: Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****
*
* CASE : Acute INHALATION of TH-232W on 30 JUN 1990
* BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 3.70E-03 Bq/l ID# AMDAs
*

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.11b

ALI (Bq) : 4.00E+01 Screening Level (Bq) : 2.00E+00
ALI (uCi) : 1.08E-03 Screening Level (uCi) : 5.41E-05

TC Half-Time (Days): 5.00E-01 Fu : 1.00E+00
F1 : 2.00E-04 Ff : 0.00E+00

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 3.40E-05
Intake (Bq) : 1.32E+02 % ALI : 380.70
Intake (uCi) : 4.12E-03 % Screening Level : 7613.94

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	1.16E-02	1.16E-04	1.48E-03	1.48E-05
BREAST	1.18E-02	1.18E-04	1.48E-03	1.48E-05
R.MARROW	1.36E+01	1.36E-01	7.81E-02	7.81E-04
LUNGS	2.19E-01	2.19E-03	2.06E-01	2.06E-03
THYROID	1.13E-02	1.13E-04	1.48E-03	1.48E-05
ENDOSTEAL	1.65E+02	1.69E+00	9.87E-01	9.87E-03
REMAINDER	2.85E-02	2.85E-04	4.42E-02	4.42E-04
EFFECTIVE	6.75E+00	6.75E-02	6.58E-02	6.58E-04

*** WARNING *** Intake Requires investigation
*** WARNING *** Calculated Intake Exceeds ALI

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	7.62E-07
BREAST	7.72E-07
R.MARROW	8.93E-04
LUNGS	1.44E-05
THYROID	7.44E-07
ENDOSTEAL	1.11E-02
REMAINDER	1.87E-06
EFFECTIVE	4.43E-04

COMMENTS: _____

SIGNATURE: _____

Authorized Licensee : CP2325 ***** WEST VALLEY NUCLEAR SERVICES *****

Printed on 04/29/91 at 11:06:35 This report resides in File : 1351
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***** SAIC REMedy Intake/Dose Evaluation Report *****

CASE : Acute INHALATION of U-234 Y on 30 JUN 1990
BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 3.70E-03 Bq/l ID# AMDAs

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.lib

ALI Bq : 1.00E-03 Screening Level(Bq) : 5.00E+01
ALI uCi : 2.70E-02 Screening Level(uCi) : 1.35E+00

TC Half-Time(Days): 2.50E-01 Fu : 1.00E+00
F1 : 2.00E-03 Ff : 0.00E+00

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 1.82E-05
Intake (Bq) : 2.85E+02 % ALI : 28.50
Intake (uCi) : 7.70E-03 % Screening Level : 570.01

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	7.55E-05	7.55E-07	1.00E-05	1.00E-07
BREAST	7.64E-05	7.64E-07	1.00E-05	1.00E-07
R.MARROW	2.06E-03	2.06E-05	4.16E-05	4.16E-07
LUNGS	8.49E+00	8.49E-02	1.77E+00	1.77E-02
THYROID	7.55E-05	7.55E-07	1.00E-05	1.00E-07
ENDOSTEAL	3.22E-02	3.22E-04	5.24E-04	5.24E-06
REMAINDER	3.02E-03	3.02E-05	0.00E+00	0.00E+00
EFFECTIVE	1.02E+00	1.02E-02	2.08E-01	2.08E-03

*** WARNING *** Intake Requires investigation

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	2.65E-09
BREAST	2.68E-09
R.MARROW	7.22E-08
LUNGS	2.98E-04
THYROID	2.65E-09
ENDOSTEAL	1.13E-06
REMAINDER	1.06E-07
EFFECTIVE	3.58E-05

COMMENTS: _____

SIGNATURE: _____

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Printed on 04/29/91 at 11:07:10 This report resides in File: 1btl
Generated on 04/29/91 at 11:07:10 Generated from REMedy File: Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****

* CASE : Acute INHALATION of U-235 Y on 30 JUN 1990
* BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 3.70E-03 Bq/l ID# AMDAs
*

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.lib

ALI (Bq) : 2.00E+03 Screening Level(Bq) : 1.00E+02
ALI (uCi) : 5.41E-02 Screening Level(uCi) : 2.70E-03

TC Half-Time(Days): 2.50E-01 Fu : 1.00E+00
F1 : 2.00E-03 Ff : 0.00E+00

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 1.82E-05
Intake (Bq) : 2.85E+02 % ALI : 14.25
Intake (uCi) : 7.70E-03 % Screening Level : 285.00

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	8.09E-05	8.09E-07	1.00E-05	1.00E-07
BREAST	1.53E-04	1.53E-06	2.62E-05	2.62E-07
R.MARROW	2.04E-03	2.04E-05	6.07E-05	6.07E-07
LUNGS	7.87E+00	7.87E-02	1.62E+00	1.62E-02
THYROID	1.17E-04	1.17E-06	1.85E-05	1.85E-07
ENDOSTEAL	2.99E-02	2.99E-04	5.24E-04	5.24E-06
REMAINDER	2.91E-03	2.91E-05	1.28E-01	1.28E-03
EFFECTIVE	9.46E-01	9.46E-03	1.92E-01	1.92E-03

*** WARNING *** Intake Requires Investigation

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	2.84E-09
BREAST	5.37E-09
R.MARROW	7.15E-08
LUNGS	2.76E-04
THYROID	4.11E-09
ENDOSTEAL	1.05E-06
REMAINDER	1.02E-07
EFFECTIVE	3.32E-05

COMMENTS:

SIGNATURE:

Authorized Licensee : CP2325 ***** WEST VALLEY NUCLEAR SERVICES *****

Printed on 04/29/91 at 11:07:47 This report resides in File 1101
Generated on 04/29/91 at 11:07:47 Generated from REMedy File 1 Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****
CASE : Acute INHALATION of U-238 Y on 30 JUN 1990
BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 3.70E-03 Bq/l ID# AMDA

***** INPUT DATA *****
Subject Name : ID#
Analyst : Paul ID#
AMAD (um) : 1.00
Days Post Exposure: 180.0
Lung Model : ICRP30 Lung Model ID : LungDat.lib
ALI Bq : 2.00E+03 Screening Level Bq : 1.00E+03
ALI uCi : 5.41E-02 Screening Level uCi : 2.77E-02
T1/2 Half-Time Days : 2.50E-01 FU : 1.00E+00
FI : 2.00E-03 FF : 0.00E+00

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****
Retention Fraction at Time Post-Exposure : 1.82E-05
Intake (Bq) : 2.89E+02 % ALI : 14.25
Intake (uCi) : 7.70E-03 % Screening Level : 285.00

ORGAN	50-Year Committed Dose		First-year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	6.90E-05	6.90E-07	8.46E-06	8.46E-08
BREAST	8.29E-05	8.29E-07	1.15E-05	1.15E-07
R. MARROW	1.96E-03	1.96E-05	4.16E-05	4.16E-07
LUNGS	7.58E+00	7.58E-02	1.54E+00	1.54E-02
THYROID	7.78E-05	7.78E-07	1.08E-05	1.08E-07
ENDOSTEAL	2.88E-02	2.88E-04	4.70E-04	4.70E-06
REMAINDER	2.74E-03	2.74E-05	1.23E-01	1.23E-03
EFFECTIVE	9.12E-01	9.12E-03	1.85E-01	1.85E-03

*** WARNING *** Intake Requires investigation

***** DOSE FACTORS USED IN CALCULATIONS *****
Organ Dose Factor [Sv/Bq]
GONADS 2.42E-09
BREAST 2.91E-09
R. MARROW 6.88E-08
LUNGS 2.66E-04
THYROID 2.73E-09
ENDOSTEAL 1.01E-06
REMAINDER 9.61E-08
EFFECTIVE 3.20E-05

COMMENTS: _____

SIGNATURE: _____
Authorized Licensee : CP2325 ***** WEST VALLEY NUCLEAR SERVICES *****

Printed on 04 29 91 at 11:08:57
Generated on 04 29 91 at 11:08:57

This report resides in File 1 Totl
Generated from REMed File 1 Current.dat

***** SAIC REMed Intake/Dose Evaluation Report *****

CASE : Acute INHALATION of AM-241w on 30 JUN 1990
BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 1.10E-03 Bq/l ID# 17 MDA

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.11a

ALI Bq : 2.00E+02 Screening Level Bq : 1.00E+01
ALI uCi : 5.41E-03 Screening Level uCi : 2.70E-04

T_{1/2} Half-Time(Days): 2.50E-01 F_u : 5.40E-01
F₁ : 1.00E-03 F₁ : 4.60E-01

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 6.09E-06
Intake (Bq) : 2.53E+02 % ALI : 126.34
Intake (uCi) : 6.83E-03 % Screening Level : 2526.73

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	8.21E-01	8.21E-03	1.50E-02	1.50E-04
BREAST	5.51E-05	5.51E-07	2.60E-05	2.60E-07
R.MARROW	5.13E+00	5.13E-02	1.09E-01	1.09E-03
LUNGS	4.65E-01	4.65E-03	4.57E-01	4.57E-03
THYROID	1.90E-05	1.90E-07	2.46E-05	2.46E-07
ENDOSTEAL	6.39E+01	6.39E-01	1.36E+00	1.36E-02
REMAINDER	2.75E+00	2.75E-02	9.85E-02	9.85E-04
EFFECTIVE	3.61E+00	3.61E-02	1.36E-01	1.36E-03

*** WARNING *** Intake Requires investigation
*** WARNING *** Calculated Intake Exceeds ALI

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	3.25E-05
BREAST	2.18E-09
R.MARROW	2.03E-04
LUNGS	1.84E-05
THYROID	7.50E-10
ENDOSTEAL	2.93E-03
REMAINDER	1.09E-04
EFFECTIVE	1.43E-04

COMMENTS: _____

SIGNATURE: _____
Authorized Licensee : CP2325 ***** WEST VALLEY NUCLEAR SERVICES *****

Printed on 14 29 91 at 11109147 This report resides in File 1:1st.
 Generated on 14 29 91 at 11109147 Generated from REMedy File 1:Current.dat

***** SAID REMedy Intake/Dose Evaluation Report *****
 :
 : CASE 1 Acute INHALATION of PU-238Y on 30 JUN 1990
 : BIOASSAY 1 24hr Urine Analysis on 27 DEC 1990 - 3.30E-04 Bq/l IDW IT MDA
 :
 :*****

***** INPUT DATA *****
 :
 : Subject Name : IDW
 : Analyst : Paul IDW
 :
 : AMAD (um) : 1.00
 : Days Post Exposure : 180.0
 :
 : Lung Model : ICRP30 Lung Model ID : LungDat.lib
 :
 : ALI Bq : 7.00E+02 Screening Level (Bq) : 3.30E+01
 : ALI uCi : 1.89E-02 Screening Level (uCi) : 9.46E-04
 :
 : TC Half-Time (Days) : 2.50E+01 Pu : 5.40E+01
 : FI : 1.00E+05 Ff : 4.60E+01

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****
 : Retention Fraction at Time Post-Exposure : 1.10E-06
 : Intake (Bq) : 4.22E+02 % ALI : 60.22
 : Intake (uCi) : 1.14E-02 % Screening Level : 1204.39

ORGAN	50-Year Committed Dose		First-Year Dose	
	(Rem)	(Sv)	(Rem)	(Sv)
GONADS	4.38E-01	4.38E-03	1.71E-03	1.71E-05
BREAST	2.55E-06	2.55E-08	3.87E-06	3.87E-08
R.MARROW	2.80E+00	2.80E-02	1.25E-02	1.25E-04
LUNGS	1.35E+01	1.35E-01	2.96E+00	2.96E-02
THYROID	8.39E-08	8.39E-10	3.41E-06	3.41E-08
ENDOSTEAL	3.50E+01	3.50E-01	1.48E-01	1.48E-03
REMAINDER	1.55E+00	1.55E-02	1.28E-02	1.28E-04
EFFECTIVE	3.58E+00	3.58E-02	3.64E-01	3.64E-03

*** WARNING *** Intake Requires Investigation

***** DOSE FACTORS USED IN CALCULATIONS *****
 :
 : Organ Dose Factor (Sv/Bq)
 :
 : GONADS 1.04E-05
 : BREAST 6.04E-11
 : R.MARROW 6.65E-05
 : LUNGS 3.20E-04
 : THYROID 1.99E-12
 : ENDOSTEAL 8.31E-04
 : REMAINDER 3.68E-05
 : EFFECTIVE 8.50E-05

COMMENTS: _____
 :
 : SIGNATURE: _____
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Printed on 04 29 91 at 11:10:19 This report resides in file: 1.txt
Generated on 04 29 91 at 11:10:19 Generated from REMed File: 1 Current.dat

***** SAIC REMed Intake/Dose Evaluation Report *****

CASE : Acute INHALATION of PU-239Y on 30 JUN 1990
BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 3.30E-04 Bq/l ID# 17 MDA

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.lib

ALI Bq : 5.00E-02 Screening Level Bq : 3.00E-01
ALI UCI : 1.62E-02 Screening Level UCI : 9.11E-04

T1/2 Half-Time(Days): 2.50E-01 F1 : 5.40E-01
F1 : 1.00E-05 F1 : 4.60E-01

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 1.10E-06
Intake (Bq) : 4.20E-02 % ALI : 70.1
Intake (UCI) : 1.14E-02 % Screening Level : 1400.26

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	5.04E-01	5.04E-03	1.59E-03	1.59E-05
BREAST	1.17E-06	1.17E-08	3.86E-06	3.86E-08
R.MARROW	3.19E-00	3.19E-02	1.13E-02	1.13E-04
LUNGS	1.36E-01	1.36E-01	2.84E-00	2.84E-02
THYROID	9.83E-08	9.83E-10	3.29E-06	3.29E-08
ENDOSTEAL	3.99E-01	3.99E-01	1.47E-01	1.47E-03
REMAINDER	1.75E-00	1.75E-02	2.27E-01	2.27E-03
EFFECTIVE	3.86E-00	3.86E-02	3.40E-01	3.40E-03

*** WARNING *** Intake Requires investigation

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	1.20E-05
BREAST	2.79E-11
R.MARROW	7.60E-05
LUNGS	3.23E-04
THYROID	2.34E-12
ENDOSTEAL	9.50E-04
REMAINDER	4.16E-05
EFFECTIVE	9.19E-05

COMMENTS:

SIGNATURE:

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Printed on 04 29 91 at 11:11:17 This report resides in file 1121
 Generated on 04 29 91 at 11:11:17 Generated from REMedy file 1 Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****
 CASE : Acute INHALATION of SR-90 D on 30 JUN 1990
 BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 5.60E-01 Bq/l ID# IT MDA

***** INPUT DATA *****

Subject Name : ID#
 Analyst : Paul ID#
 AMAD (um) : 1.00
 Days Post Exposure : 180.0
 Lung Model : ICRP30 Lung Model ID : LungDat.11b
 ALI Bq : 7.00E+05 Screening Level Bq : 2.50E+04
 ALI uCi : 1.99E+01 Screening Level uCi : 9.46E-01
 TC Half-Time (Days) : 2.50E-01 Fu : 8.00E-01
 F1 : 3.00E-01 F2 : 2.00E-01

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 7.59E-05
 Intake (Bq) : 1.03E+04 % ALI : 1.48
 Intake (uCi) : 2.79E-01 % Screening Level : 29.91

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	2.73E-03	2.73E-05	1.59E-03	1.59E-05
BREAST	2.73E-03	2.73E-05	1.59E-03	1.59E-05
R.MARROW	3.47E-01	3.47E-03	4.74E-02	4.74E-04
LUNGS	3.85E-03	3.85E-05	2.74E-03	2.74E-05
THYROID	2.73E-03	2.73E-05	1.59E-03	1.59E-05
ENDOSTEAL	7.91E-01	7.91E-03	7.25E-02	7.25E-04
REMAINDER	3.47E-03	3.47E-05	6.82E-03	6.82E-05
EFFECTIVE	6.68E-02	6.68E-04	9.76E-03	9.76E-05

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	2.64E-09
BREAST	2.64E-09
R.MARROW	3.36E-07
LUNGS	3.73E-09
THYROID	2.64E-09
ENDOSTEAL	7.27E-07
REMAINDER	3.36E-09
EFFECTIVE	6.47E-08

COMMENTS: _____

SIGNATURE: _____

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Generated on 04/29/91 at 11:12:06 Generated from REMed File: Current.dat

***** SAIC REMed Intake/Dose Evaluation Report *****

CASE: Acute INHALATION of TH-232W on 30 JUN 1990
BIOASSAY: 24hr Urine Analysis on 27 DEC 1990 - 1.90E-03 Bq/L ID# 17 MDA

***** INPUT DATA *****

Subject Name: ID#
Analyst: Paul ID#
AMAD (um): 1.00
Days Post Exposure: 180.0
Lung Model: ICRP30 Lung Model ID: LungDat.lib
ALI (Bq): 4.00E+02 Screening Level (Bq): 2.00E+01
ALI (uCi): 1.08E-02 Screening Level (uCi): 5.41E-04
TC Half-Time (Days): 5.00E-01 F1: 9.90E-01
F1: 2.00E-04 F1: 1.00E-02

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure: 2.82E-05
Intake (Bq): 9.44E+01 % ALI: 23.61
Intake (uCi): 2.55E-03 % Screening Level: 472.23

ORGAN	30-year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	1.28E-02	1.28E-04	5.87E-03	5.87E-05
BREAST	1.28E-02	1.28E-04	5.87E-03	5.87E-05
R.MARROW	1.06E+00	1.06E-02	3.06E-01	3.06E-03
LUNGS	8.95E-01	8.95E-03	8.93E-01	8.93E-03
THYROID	1.27E-02	1.27E-04	5.87E-03	5.87E-05
ENDOSTEAL	1.29E+01	1.29E-01	3.83E+00	3.83E-02
REMAINDER	3.25E-02	3.25E-04	0.00E+00	0.00E+00
EFFECTIVE	6.38E-01	6.38E-03	2.55E-01	2.55E-03

*** WARNING *** Intake Requires Investigation

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	1.35E-06
BREAST	1.35E-06
R.MARROW	1.12E-04
LUNGS	9.48E-05
THYROID	1.34E-06
ENDOSTEAL	1.37E-03
REMAINDER	3.44E-06
EFFECTIVE	6.75E-05

COMMENTS:

SIGNATURE:

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Printed on 04/29/91 at 11:12:49
Generated on 04/29/91 at 11:12:49

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***** SAIC REMedy Intake/Dose Evaluation Report *****
: CASE 1 Acute INHALATION of TH-232W on 30 JUN 1990
: BIOASSAY 1 24hr Urine Analysis on 27 DEC 1990 - 1.90E-03 Bq/l ID# 17 MDA
: *****

***** INPUT DATA *****
Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.lib

ALI (Bq) : 4.00E-01 Screening Level(Bq) : 2.00E-00
ALI (uCi) : 1.08E-03 Screening Level(uCi) : 5.41E-15

TC Half-Time(Days): 5.00E-01 Fu : 1.00E+00
F1 : 2.00E-04 Ff : 0.00E+00

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****
Retention Fraction at Time Post-Exposure : 3.40E-03
Intake (Bq) : 7.82E+01 % ALI : 195.49
Intake (uCi) : 2.11E-03 % Screening Level : 3909.86

ORGAN	50-year Committed Dose		First-year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	5.96E-03	5.96E-05	7.60E-04	7.60E-06
BREAST	6.04E-03	6.04E-05	7.60E-04	7.60E-06
R.MARROW	6.98E+00	6.98E-02	4.01E-02	4.01E-04
LUNGS	1.13E-01	1.13E-03	1.06E-01	1.06E-03
THYROID	5.82E-03	5.82E-05	7.60E-04	7.60E-06
ENDOSTEAL	8.68E+01	8.68E-01	5.07E-01	5.07E-03
REMAINDER	1.46E-02	1.46E-04	2.27E-02	2.27E-04
EFFECTIVE	3.46E+00	3.46E-02	3.38E-02	3.38E-04

*** WARNING *** Intake Requires Investigation
*** WARNING *** Calculated Intake Exceeds ALI

***** DOSE FACTORS USED IN CALCULATIONS *****
Organ Dose Factor [Sv/Bq]

GONADS 7.62E-07
BREAST 7.72E-07
R.MARROW 8.93E-04
LUNGS 1.44E-05
THYROID 7.44E-07
ENDOSTEAL 1.11E-02
REMAINDER 1.87E-06
EFFECTIVE 4.43E-04

COMMENTS: _____
SIGNATURE: _____
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Printed on 04/29/91 at 11:13:54 Generated from REMedy File : Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****
*
* CASE : Acute INHALATION of U-234 Y on 30 JUN 1990
* BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 1.90E-03 Bq/l ID# IT MDA
*

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.lib

ALI (Bq) : 1.00E+03 Screening Level(Bq) : 5.00E+01
ALI (uCi) : 2.70E-02 Screening Level(uCi) : 1.35E-03

TC Half-Time(Days): 2.50E-01 Fu : 1.00E+00
F1 : 2.00E-03 Ff : 0.00E+00

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 1.82E-05
Intake (Bq) : 1.46E+02 % ALI : 14.64
Intake (uCi) : 3.96E-03 % Screening Level : 292.71

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	3.88E-05	3.88E-07	5.14E-06	5.14E-08
BREAST	3.92E-05	3.92E-07	5.14E-06	5.14E-08
R.MARROW	1.06E-03	1.06E-05	2.14E-05	2.14E-07
LUNGS	4.36E+00	4.36E-02	9.09E-01	9.09E-03
THYROID	3.88E-05	3.88E-07	5.14E-06	5.14E-08
ENDOSTEAL	1.65E-02	1.65E-04	2.69E-04	2.69E-06
REMAINDER	1.55E-03	1.55E-05	0.00E+00	0.00E+00
EFFECTIVE	5.24E-01	5.24E-03	1.07E-01	1.07E-03

*** WARNING *** Intake Requires investigation

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	2.65E-09
BREAST	2.68E-09
R.MARROW	7.22E-08
LUNGS	2.98E-04
THYROID	2.65E-09
ENDOSTEAL	1.13E-06
REMAINDER	1.06E-07
EFFECTIVE	3.58E-05

COMMENTS: _____

SIGNATURE: _____

Authorized Licensee : CP2325 ***** WEST VALLEY NUCLEAR SERVICES *****

Printed on 04/29/91 at 11:14:33 This report resides in file : lot1
Generated on 04/29/91 at 11:14:33 Generated from REMedy File : Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****
*
* CASE : Acute INHALATION of U-235 Y on 30 JUN 1990
* BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 1.90E-03 Bq/l ID# IT MDA
*

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.lib

ALI (Bq) : 2.00E+03 Screening Level(Bq) : 1.00E+02
ALI (uCi) : 5.41E-02 Screening Level(uCi) : 2.70E-03

TC Half-Time(Days): 2.50E-01 Fu : 1.00E+00
F1 : 2.00E-03 Ff : 0.00E+00

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 1.82E-05
Intake (Bq) : 1.46E+02 % ALI : 7.32
Intake (uCi) : 3.96E-03 % Screening Level : 146.35

ORGAN	30-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	4.16E-05	4.16E-07	5.14E-06	5.14E-08
BREAST	7.86E-05	7.86E-07	1.34E-05	1.34E-07
R.MARROW	1.05E-03	1.05E-05	3.12E-05	3.12E-07
LUNGS	4.04E+00	4.04E-02	8.30E-01	8.30E-03
THYROID	6.02E-05	6.02E-07	9.48E-06	9.48E-08
ENDOSTEAL	1.54E-02	1.54E-04	2.69E-04	2.69E-06
REMAINDER	1.49E-03	1.49E-05	6.59E-02	6.59E-04
EFFECTIVE	4.86E-01	4.86E-03	9.88E-02	9.88E-04

*** WARNING *** Intake Requires investigation

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	2.84E-09
BREAST	5.37E-09
R.MARROW	7.15E-08
LUNGS	2.76E-04
THYROID	4.11E-09
ENDOSTEAL	1.05E-06
REMAINDER	1.02E-07
EFFECTIVE	3.32E-05

COMMENTS: _____

SIGNATURE: _____

Authorized Licensee : CP2325 ***** WEST VALLEY NUCLEAR SERVICES *****

Generated on 04/29/91 at 11:15:48 Generated from REMedy File : Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****

* CASE : Acute INHALATION of U-238 Y on 30 JUN 1990
* BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 1.90E-03 Bq/l ID# IT MDA
*

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.lib
ALI (Bq) : 2.00E+03 Screening Level (Bq) : 1.00E+02
ALI (uCi) : 5.41E-02 Screening Level (uCi) : 2.70E-03

TC Half-Time (Days) : 2.50E-01 Fu : 1.00E+00
F1 : 2.00E-03 Ff : 0.00E+00

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 1.82E-05
Intake (Bq) : 1.46E+02 % ALI : 7.32
Intake (uCi) : 3.96E-03 % Screening Level : 146.35

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	3.54E-05	3.54E-07	4.35E-06	4.35E-08
BREAST	4.26E-05	4.26E-07	5.93E-06	5.93E-08
R.MARROW	1.01E-03	1.01E-05	2.14E-05	2.14E-07
LUNGS	3.89E+00	3.89E-02	7.90E-01	7.90E-03
THYROID	4.00E-05	4.00E-07	5.53E-06	5.53E-08
ENDOSTEAL	1.48E-02	1.48E-04	2.41E-04	2.41E-06
REMAINDER	1.41E-03	1.41E-05	6.29E-02	6.29E-04
EFFECTIVE	4.68E-01	4.68E-03	9.48E-02	9.48E-04

*** WARNING *** Intake Requires investigation

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	2.42E-09
BREAST	2.91E-09
R.MARROW	6.88E-08
LUNGS	2.66E-04
THYROID	2.73E-09
ENDOSTEAL	1.01E-06
REMAINDER	9.61E-08
EFFECTIVE	3.20E-05

COMMENTS: _____

SIGNATURE: _____

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Printed on 04/29/91 at 11:16:55 Generated from REMedy File : Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****

CASE : Acute INHALATION of AM-241W on 30 JUN 1990
BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 4.30E-05 Bq/l ID# D1L

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#
AMAD (um) : 1.00
Days Post Exposure: 180.0
Lung Model : ICRP30 Lung Model ID : LungDat.110
ALI (Bq) : 2.00E+02 Screening Level(Bq) : 1.00E+01
ALI (uCi) : 5.41E-03 Screening Level(uCi) : 2.70E-04
IC Half-Time(Days): 2.50E-01 Fu : 5.40E-01
F1 : 1.00E-03 Ff : 4.60E-01

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 6.09E-06
Intake (Bq) : 9.88E+00 % ALI : 4.94
Intake (uCi) : 2.67E-04 % Screening Level : 98.77

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	3.21E-02	3.21E-04	5.87E-04	5.87E-06
BREAST	2.15E-06	2.15E-08	1.02E-06	1.02E-08
R.MARROW	2.01E-01	2.01E-03	4.27E-03	4.27E-05
LUNGS	1.82E-02	1.82E-04	1.79E-02	1.79E-04
THYROID	7.41E-07	7.41E-09	9.60E-07	9.60E-09
ENDOSTEAL	2.50E+00	2.50E-02	5.33E-02	5.33E-04
REMAINDER	1.08E-01	1.08E-03	3.85E-03	3.85E-05
EFFECTIVE	1.41E-01	1.41E-03	5.33E-03	5.33E-05

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	3.25E-05
BREAST	2.18E-09
R.MARROW	2.03E-04
LUNGS	1.84E-05
THYROID	7.50E-10
ENDOSTEAL	2.53E-03
REMAINDER	1.09E-04
EFFECTIVE	1.43E-04

COMMENTS:

SIGNATURE:

Authorized Licensee : CP2325 ***** WEST VALLEY NUCLEAR SERVICES *****

Printed on 04/29/91 at 11:17:46 This report resides in File : job
Generated on 04/29/91 at 11:17:46 Generated from REMedy File : Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****
*
* CASE : Acute INHALATION of PU-238Y on 30 JUN 1990
* BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 2.30E-05 Bq/l ID# DIL
*

***** INPUT DATA *****
Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.lib

ALI (Bq) : 7.00E-02 Screening Level Bq : 3.50E-01
ALI (uCi) : 1.89E-02 Screening Level uCi : 9.46E-04

TC Half-Time(Days): 2.50E-01 Fu : 5.40E-01
F1 : 1.00E-05 Ff : 4.60E-01

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****
Retention Fraction at Time Post-Exposure : 1.10E-06
Intake (Bq) : 2.94E+01 % ALI : 4.20
Intake (uCi) : 7.94E-04 % Screening Level : 83.94

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	3.06E-02	3.06E-04	1.19E-04	1.19E-06
BREAST	1.77E-07	1.77E-09	2.70E-07	2.70E-09
R.MARROW	1.95E-01	1.95E-03	8.73E-04	8.73E-06
LUNGS	9.40E-01	9.40E-03	2.06E-01	2.06E-03
THYROID	5.85E-09	5.85E-11	2.38E-07	2.38E-09
ENDOSTEAL	2.44E+00	2.44E-02	1.03E-02	1.03E-04
REMAINDER	1.08E-01	1.08E-03	8.93E-04	8.93E-06
EFFECTIVE	2.50E-01	2.50E-03	2.54E-02	2.54E-04

***** DOSE FACTORS USED IN CALCULATIONS *****
Organ Dose Factor [Sv/Bq]

GONADS	1.04E-05
BREAST	6.04E-11
R.MARROW	6.65E-05
LUNGS	3.20E-04
THYROID	1.99E-12
ENDOSTEAL	8.31E-04
REMAINDER	3.68E-05
EFFECTIVE	8.50E-05

COMMENTS: _____

SIGNATURE: _____
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Printed on 04/29/91 at 11:18:46
Generated on 04/29/91 at 11:18:46

This report resides in file: 1001
Generated from REMedy File: Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****

CASE : Acute INHALATION of PU-239Y on 30 JUN 1990
BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 2.10E-05 Bq/l ID# DIL

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.115

ALI (Bq) : 6.00E+02 Screening Level(Bq) : 3.00E-01
ALI (uCi) : 1.62E-02 Screening Level(uCi) : 8.11E-04

TC Half-Time(Days): 2.50E-01 Fu : 5.40E-01
F1 : 1.00E-05 Ff : 4.60E-01

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 1.10E-06
Intake (Bq) : 2.67E+01 % ALI : 4.46
Intake (uCi) : 7.22E-04 % Screening Level : 89.11

ORGAN	30-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	3.21E-02	3.21E-04	1.01E-04	1.01E-06
BREAST	7.46E-08	7.46E-10	2.45E-07	2.45E-09
R.MARROW	2.03E-01	2.03E-03	7.22E-04	7.22E-06
LUNGS	8.63E-01	8.63E-03	1.80E-01	1.80E-03
THYROID	6.26E-09	6.26E-11	2.09E-07	2.09E-09
ENDOSTEAL	2.54E+00	2.54E-02	9.38E-03	9.38E-05
REMAINDER	1.11E-01	1.11E-03	1.44E-02	1.44E-04
EFFECTIVE	2.46E-01	2.46E-03	2.17E-02	2.17E-04

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	1.20E-05
BREAST	2.79E-11
R.MARROW	7.60E-05
LUNGS	3.23E-04
THYROID	2.34E-12
ENDOSTEAL	9.50E-04
REMAINDER	4.16E-05
EFFECTIVE	9.19E-05

COMMENTS:

SIGNATURE:

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Printed on 04/29/91 at 11:19:48
Generated on 04/29/91 at 11:19:48

This report resides in file: 1051
Generated from REMedy File: Current.dat

***** SAIC REMedy Intake Dose Evaluation Report *****

CASE : Acute INHALATION of SR-90 D on 30 JUN 1990
BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 1.90E+00 Bq/l ID# DIL

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.lib

ALI (Bq) : 7.00E+05 Screening Level (Bq) : 3.50E-04
ALI (uCi) : 1.89E+01 Screening Level (uCi) : 9.46E-01

TC Half-Time (Days): 2.50E-01 Fu : 8.00E-01
F1 : 3.00E-01 Ff : 2.00E-01

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 7.59E-05
Intake (Bq) : 3.50E+04 % ALI : 5.01
Intake (uCi) : 9.47E-01 % Screening Level : 100.12

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	9.25E-03	9.25E-05	5.40E-03	5.40E-05
BREAST	9.25E-03	9.25E-05	5.40E-03	5.40E-05
R.MARROW	1.18E+00	1.18E-02	1.61E-01	1.61E-03
LUNGS	1.31E-02	1.31E-04	9.29E-03	9.29E-05
THYROID	9.25E-03	9.25E-05	5.40E-03	5.40E-05
ENDOSTEAL	2.55E+00	2.55E-02	2.46E-01	2.46E-03
REMAINDER	1.18E-02	1.18E-04	2.31E-02	2.31E-04
EFFECTIVE	2.27E-01	2.27E-03	3.31E-02	3.31E-04

*** WARNING *** Intake Requires Investigation

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	2.64E-09
BREAST	2.64E-09
R.MARROW	3.36E-07
LUNGS	3.73E-09
THYROID	2.64E-09
ENDOSTEAL	7.27E-07
REMAINDER	3.36E-09
EFFECTIVE	6.47E-08

COMMENTS: _____

SIGNATURE: _____

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Printed on 04/29/91 at 08:25:21 This report resides in File: 1061
Generated on 04/29/91 at 08:25:21 Generated from REMedv File: Current.dat

***** SAIC REMedv Intake/Dose Evaluation Report *****

CASE: Acute INHALATION of TH-228W on 30 JUN 1990
BIOASSAY: 24hr Urine Analysis on 27 DEC 1990 - 3.70E-04 Bq/l ID# DIL

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.110

AI: Bq : 4.00E+02 Screening Level(Bq) : 3.00E+01
AI: uCi : 1.08E-02 Screening Level(uCi) : 5.31E-04

T_{1/2} Half-Time(Days): 5.00E-01 F_u : 9.90E-01
F_i : 2.00E-04 F_f : 1.00E-02

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 2.82E-05
Intake (Bq) : 1.84E+01 % ALI : 4.60
Intake (uCi) : 4.97E-04 % Screening Level : 91.96

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	2.48E-03	2.48E-05	1.14E-03	1.14E-05
BREAST	2.48E-03	2.48E-05	1.14E-03	1.14E-05
R.MARROW	2.06E-01	2.06E-03	5.96E-02	5.96E-04
LUNGS	1.74E-01	1.74E-03	1.74E-01	1.74E-03
THYROID	2.46E-03	2.46E-05	1.14E-03	1.14E-05
ENDOSTEAL	2.52E+00	2.52E-02	7.45E-01	7.45E-03
REMAINDER	6.33E-03	6.33E-05	0.00E+00	0.00E+00
EFFECTIVE	1.24E-01	1.24E-03	4.97E-02	4.97E-04

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	1.35E-06
BREAST	1.35E-06
R.MARROW	1.12E-04
LUNGS	9.48E-05
THYROID	1.34E-06
ENDOSTEAL	1.37E-03
REMAINDER	3.44E-06
EFFECTIVE	6.75E-05

COMMENTS: _____

SIGNATURE: _____

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Printed on 04/29/91 at 08:28:44 This report resides in File : 101
 Generated on 04/29/91 at 08:28:44 Generated from REMedy File : Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****
 :
 : CASE : Acute INHALATION of TH-232w on 30 JUN 1990
 : BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 5.47E-05 Bq/l ID# DIL
 :
 : *****

***** INPUT DATA *****
 Subject Name : ID#
 Analyst : Paul ID#

 AMAD (um) : 1.00
 Days Post Exposure : 180.0

 Lung Model : ICRP30 Lung Model ID : LungDat.lib

 ALI (Bq) : 4.00E+01 Screening Level (Bq) : 2.00E+00
 ALI (uCi) : 1.08E-03 Screening Level (uCi) : 5.41E-05

 TC Half-Time (Days) : 5.00E-01 Fu : 1.00E+00
 F1 : 2.00E-04 Ff : 0.00E+00

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****
 Retention Fraction at Time Post-Exposure : 3.40E-05
 Intake (Bq) : 2.25E+00 % ALI : 5.63
 Intake (uCi) : 6.08E-05 % Screening Level : 112.56

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	1.72E-04	1.72E-06	2.19E-05	2.19E-07
BREAST	1.74E-04	1.74E-06	2.19E-05	2.19E-07
R.MARROW	2.01E-01	2.01E-03	1.15E-03	1.15E-05
LUNGS	3.24E-03	3.24E-05	3.04E-03	3.04E-05
THYROID	1.67E-04	1.67E-06	2.19E-05	2.19E-07
ENDOSTEAL	2.50E+00	2.50E-02	1.46E-02	1.46E-04
REMAINDER	4.21E-04	4.21E-06	6.53E-04	6.53E-06
EFFECTIVE	9.97E-02	9.97E-04	9.73E-04	9.73E-06

*** WARNING *** Intake Requires investigation

***** DOSE FACTORS USED IN CALCULATIONS *****
 Organ Dose Factor (Sv/Bq)

 GONADS 7.62E-07
 BREAST 7.72E-07
 R.MARROW 8.93E-04
 LUNGS 1.44E-05
 THYROID 7.44E-07
 ENDOSTEAL 1.11E-02
 REMAINDER 1.87E-06
 EFFECTIVE 4.43E-04

COMMENTS: _____

SIGNATURE: _____
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Printed on 04/29/91 at 08:31:20 This report resides in file: 1201
Generated on 04/29/91 at 08:31:20 Generated from REMedy File: 1201rem.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****

CASE : Acute INHALATION of U-234 Y on 30 JUN 1990
BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 9.00E-04 Bq/L ID# 01L

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure: 180.0

Lung Model : ICRP30 Lung Model ID : LungDatLib
ALI (Bq) : 1.00E+03 Screening Level (Bq) : 9.00E-01
ALI (uCi) : 2.70E-02 Screening Level (uCi) : 1.35E-02

TC Half-Time (Days): 2.90E-01 Pu : 1.00E+00
P1 : 2.00E-03 P2 : 0.00E+00

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 1.82E-03
Intake (Bq) : 6.93E+01 %ALI : 6.93
Intake (uCi) : 1.87E-03 % Screening Level : 138.65

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	1.84E-05	1.84E-07	2.43E-06	2.43E-08
BREAST	1.86E-05	1.86E-07	2.43E-06	2.43E-08
R. MARROW	9.01E-04	9.01E-06	1.01E-05	1.01E-07
LUNGS	2.07E+00	2.07E-02	4.31E-01	4.31E-03
THYROID	1.84E-05	1.84E-07	2.43E-06	2.43E-08
ENDOSTEAL	7.83E-03	7.83E-05	1.28E-04	1.28E-06
REMAINDER	7.35E-04	7.35E-06	0.00E+00	0.00E+00
EFFECTIVE	2.48E-01	2.48E-03	9.05E-02	9.05E-04

*** WARNING *** Intake Requires Investigation

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	2.65E-09
BREAST	2.68E-09
R. MARROW	7.22E-08
LUNGS	2.98E-04
THYROID	2.65E-09
ENDOSTEAL	1.13E-06
REMAINDER	1.06E-07
EFFECTIVE	3.98E-05

COMMENTS:

SIGNATURE:

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Printed on 04/29/91 at 08:32:25
Generated on 04/29/91 at 08:32:25

This report resides in File 111111
Generated from REMedy File 11 Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****

CASE : Acute INHALATION of U-235 Y on 30 JUN 1990
BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 9.80E-04 Bq/l ID# 011

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure : 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.115

ALI (Bq) : 2.00E+03 Screening Level (Bq) : 1.00E+03
ALI (uCi) : 5.41E-02 Screening Level (uCi) : 2.70E-02

TC Half-Time (Days) : 2.50E+01 Fd : 1.00E+00
F1 : 2.00E-03 Ff : 0.00E+00

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 1.82E-05
Intake (Bq) : 7.99E+01 % ALI : 3.77
Intake (uCi) : 2.04E-03 % Screening Level : 75.49

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	2.14E-05	2.14E-07	2.69E-06	2.69E-08
BREAST	4.09E-05	4.09E-07	6.93E-06	6.93E-08
R.MARROW	5.40E-04	5.40E-06	1.61E-05	1.61E-07
LUNGS	2.08E+00	2.08E-02	4.28E-01	4.28E-03
THYROID	3.10E-05	3.10E-07	4.89E-06	4.89E-08
ENDOSTEAL	7.93E-03	7.93E-05	1.39E-04	1.39E-06
REMAINDER	7.70E-04	7.70E-06	3.40E-02	3.40E-04
EFFECTIVE	2.51E-01	2.51E-03	5.10E-02	5.10E-04

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	2.84E-09
BREAST	5.37E-09
R.MARROW	7.15E-08
LUNGS	2.76E-04
THYROID	4.11E-09
ENDOSTEAL	1.05E-06
REMAINDER	1.02E-07
EFFECTIVE	3.32E-05

COMMENTS:

SIGNATURE:

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Printed on 04/29/91 at 08:33:44 This report resides in file 11st1
Generated on 04/29/91 at 08:33:44 Generated from REMedy File 1 Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****

CASE 1: Acute INHALATION of U-238 Y on 30 JUN 1990
BIOASSAY 1: 24hr Urine Analysis on 27 DEC 1990 - 1.00E-03 Bq/l ID# DIL

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure : 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.1.b

ALI (Bq) : 3.00E-03 Screening Level (Bq) : 1.00E-02
ALI (uCi) : 9.41E-02 Screening Level (uCi) : 3.70E-03

TC Half-Time (Days) : 2.50E-01 Fu : 1.00E-00
F1 : 2.00E-03 Ff : 0.00E-00

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 1.82E-03
Intake (Bq) : 7.70E-01 % ALI : 3.89
Intake (uCi) : 2.08E-03 % Screening Level : 77.03

ORGAN	30-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	1.86E-05	1.86E-07	2.29E-06	2.29E-08
BREAST	2.24E-05	2.24E-07	3.12E-06	3.12E-08
R. MARROW	9.30E-04	9.30E-06	1.12E-05	1.12E-07
LUNGS	2.09E+00	2.09E-02	4.16E-01	4.16E-03
THYROID	2.10E-05	2.10E-07	2.91E-06	2.91E-08
ENDOSTEAL	7.78E-03	7.78E-05	1.27E-04	1.27E-06
REMAINDER	7.40E-04	7.40E-06	3.31E-02	3.31E-04
EFFECTIVE	2.46E-01	2.46E-03	4.99E-02	4.99E-04

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	2.42E-09
BREAST	2.91E-09
R. MARROW	6.88E-08
LUNGS	2.66E-04
THYROID	2.73E-09
ENDOSTEAL	1.01E-06
REMAINDER	9.61E-08
EFFECTIVE	3.20E-05

COMMENTS:

SIGNATURE:

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Printed on 04/29/91 at 09:16:24
Generated on 04/29/91 at 09:16:24

This report resides in File 111511
Generated from REMedy File 1 Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****

CASE : Acute INHALATION of TH-232W on 30 JUN 1990
BIOASSAY : 24hr Urine Analysis on 27 DEC 1990 - 1.70E-06 Bq/l ID# Link

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure : 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.lib

ALI (Bq) : 4.00E-01 Screening Level (Bq) : 2.00E-00
ALI (uCi) : 1.08E-03 Screening Level (uCi) : 5.41E-05

TC Half-Time (Days) : 5.00E-01 Fu : 1.00E+00
F1 : 2.00E-04 Ff : 0.00E+00

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 3.40E-05
Intake (Bq) : 7.00E-02 % ALI : 0.17
Intake (uCi) : 1.89E-06 % Screening Level : 3.50

ORGAN	50-Year Committed Dose		First-Year Dose	
	(Rem)	(Sv)	(Rem)	(Sv)
GONADS	5.33E-06	5.33E-08	6.80E-07	6.80E-09
BREAST	5.40E-06	5.40E-08	6.80E-07	6.80E-09
R. MARROW	6.25E-03	6.25E-05	3.59E-05	3.59E-07
LUNGS	1.01E-04	1.01E-06	9.45E-05	9.45E-07
THYROID	5.21E-06	5.21E-08	6.80E-07	6.80E-09
ENDOSTEAL	7.77E-02	7.77E-04	4.53E-04	4.53E-06
REMAINDER	1.31E-05	1.31E-07	2.03E-05	2.03E-07
EFFECTIVE	3.10E-03	3.10E-05	3.02E-05	3.02E-07

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ Dose Factor (Sv/Bq)

GONADS	7.62E-07
BREAST	7.72E-07
R. MARROW	8.93E-04
LUNGS	1.44E-05
THYROID	7.44E-07
ENDOSTEAL	1.11E-02
REMAINDER	1.87E-06
EFFECTIVE	4.43E-04

COMMENTS: _____

SIGNATURE: _____

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Printed on 04/29/91 at 09113128 This report resides in File 1: rpt1
Generated on 04/29/91 at 09113128 Generated from REMedy File 1: Current.dat

***** SAIC REMedy Intake/Dose Evaluation Report *****

CASE : Acute INHALATION of CO-60 Y on 30 JUN 1990
BIOASSAY : Lung Count on 27 DEC 1990 - 4.90E+03 Bq ID# WVNS DIL

***** INPUT DATA *****

Subject Name : ID#
Analyst : Paul ID#

AMAD (um) : 1.00
Days Post Exposure : 180.0

Lung Model : ICRP30 Lung Model ID : LungDat.lib

ALI (Bq) : 1.00E+06 Screening Level (Bq) : 5.00E+04
ALI (uCi) : 2.70E+01 Screening Level (uCi) : 1.35E+00

TC Half-Time (Days) : 5.00E-01 F1 : 7.00E-01
F1 : 5.00E-02 Ff : 3.00E-01

***** RESULTS USING ICRP-30 SYSTEMIC MODEL *****

Retention Fraction at Time Post-Exposure : 1.17E-01
Intake (Bq) : 4.19E+04 % ALI : 4.19
Intake (uCi) : 1.13E+00 % Screening Level : 83.85

ORGAN	50-Year Committed Dose		First-Year Dose	
	[Rem]	[Sv]	[Rem]	[Sv]
GONADS	2.00E-02	2.00E-04	9.64E-03	9.64E-05
BREAST	7.71E-02	7.71E-04	2.83E-02	2.83E-04
R. MARROW	7.21E-02	7.21E-04	2.60E-02	2.60E-04
LUNGS	1.45E+00	1.45E-02	5.20E-01	5.20E-03
THYROID	6.79E-02	6.79E-04	2.38E-02	2.38E-04
ENDOSTEAL	5.66E-02	5.66E-04	2.04E-02	2.04E-04
REMAINDER	1.51E-01	1.51E-03	1.36E-02	1.36E-04
EFFECTIVE	2.48E-01	2.48E-03	8.93E-02	8.93E-04

***** DOSE FACTORS USED IN CALCULATIONS *****

Organ	Dose Factor [Sv/Bq]
GONADS	4.76E-09
BREAST	1.84E-08
R. MARROW	1.72E-08
LUNGS	3.45E-07
THYROID	1.62E-08
ENDOSTEAL	1.35E-08
REMAINDER	3.60E-08
EFFECTIVE	5.91E-08

COMMENTS:

SIGNATURE:

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