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PUBLICATION RECORD

EFFECTIVE DATE	REVISION NUMBER	DESCRIPTION
07/23/2013	00	New report to compare organ doses from an intake of fission products determined from urinalysis using the default guidance in Revision 03 of ORAUT-TKBS-0003, *Savannah River Site* (SRS Site Profile, p. 70) versus using an approach based on the method in ORAUT-OTIB-0054, *Fission and Activation Product Assignment for Internal Dose-Related Gross Beta and Gross Gamma Analyses*. This report also compares organ doses from an intake of 4,400 dpm/d of mixed fission products using the radionuclide guidance mixture in Table 4.4.2-7 of the SRS Site Profile (p. 82) with organ doses from an intake of 4,400 dpm/d of fission products apportioned as recommended in OTIB-0054. This addresses an SRS Advisory Board Work Group issue regarding fission products. Incorporates comparisons of organ doses computed using the nine representative reactor cases from OTIB-0054 with five cases selected to represent production reactor operations at the Savannah River Site (SRS). Develops site-specific intake and activity fraction values to be used for evaluating SRS claims and draws comparisons of committed organ doses assigned using these new values with doses assigned using the guidance currently given in the SRS Site Profile. Incorporates formal internal and NIOSH review comments. Training required: As determined by the Objective Manager. Initiated by Robert E. Burns, Jr.

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ACRONYMS AND ABBREVIATIONS

ATR	Advanced Test Reactor
Bq	becquerel
cm	centimeter
cpm	counts per minute
d	day
DCF	dose conversion factors
DOE	U.S. Department of Energy
dpm	disintegrations per minute
F	fast solubility type
FFTF	Fast Flux Test Facility
FP	fission products (method)
Ge(Li)	lithium-drifted germanium
HPGe	hyper-pure germanium
hr	hour
IA	induced activity (method)
IMBA	Integrated Modules for Bioassay Analysis
IRF	intake retention fraction
m	meter
M	moderate solubility type
MDA	minimum detectable activity
MFAP	mixed fission and activation product
mSv	millisievert
MTHM	metric tons of heavy metal
MTU	metric tons of uranium
MW	megawatt
MWd	megawatt-day
nCi	nanocurie
NIF	normalized intake fraction
NIOSH	National Institute for Occupational Safety and Health
ORAU	Oak Ridge Associated Universities Team
pCi	picocurie
S	slow solubility type
SRDB Ref ID	Site Research Database Reference Identification (number)
SRS	Savannah River Site
TRIGA	Training, Research, Isotopes, General Atomics
WBC	whole-body count
µCi	microcurie

1.0 INTRODUCTION

ORAUT-OTIB-0054, *Fission and Activation Product Assignment for Internal Dose-Related Gross Beta and Gross Gamma Analyses* (ORAUT 2013; referred to in this report as OTIB-0054), provides a method for assigning radionuclide intakes from non-radionuclide-specific radioassays associated with mixed fission and activation product (MFAP) source terms from operations involving irradiated nuclear fuels. The purpose of this report is threefold:

1. To determine if differences in reactor parameters can have a significant impact on doses assigned per OTIB-0054,

2. To use the OTIB-0054 method to develop site-specific intake and activity fraction values for assigning MFAP intakes from non-specific (i.e., gross beta and gross gamma) urinalyses performed at Savannah River Site (SRS), and

3. To compare doses computed using the SRS-specific intake and activity fraction values with doses computed using the guidance given in ORAUT-TKBS-0003, *Savannah River Site* (ORAUT 2005), referred to in this report as the SRS Site Profile.

The results of the evaluation performed for item 1 above showed that reactor operating parameters different from those in OTIB-0054 could in some cases result in assigned doses that would exceed those obtained from OTIB-0054. However, no such combination of reactor parameters and assay methods is known to exist at this time. The results in Section 2.0 of this report indicated hypothetical increases approaching 30% for doses assigned based on gross gamma assays of raw urine for the 180-day and 1-year decay times. The results indicated that hypothetical increases in assigned dose based on gross beta assays would be small, showing a maximum of 5.2%. In cases where both were available, gross beta results would generally be favored over gross gamma due to the greater sensitivity. The hypothetical increases in assigned doses determined for different reactor parameters were primarily the result of higher specific power levels. They were not due to differences in neutron spectrum or moderation.

The conclusion from the evaluation for item 3 above, which were based on the results from item 2, is that SRS Site Profile should be revised to incorporate the OTIB-0054 method for assigning fission product intakes for both beta and gamma counting. The OTIB-0054 method was developed after the guidance in the SRS Site Profile and is considered more rigorous.

Section 2.0 of this report documents comparisons between organ doses computed for the nine representative reactor cases considered in OTIB-0054 and doses computed for five cases selected to represent production reactor operations at SRS. The purpose of these comparisons was to evaluate if differences in reactor parameters could affect the results obtained through application of OTIB-0054. The comparisons used intake and activity fraction values derived from fission and activation product inventory data for the five SRS-specific cases using the OTIB-0054 method. These comparisons were intended only to determine the effect of reactor parameters when using the bioassay assumptions from OTIB-0054. They did not include the effects of SRS-specific bioassay methods and thus should not be viewed as an evaluation of differences in assigned dose that would be obtained using the two sets of reactor data. SRS only performed gross beta or gross gamma counting of urinalyses after chemical separation procedures, so the comparisons for other samples (i.e., raw urine) are not representative of actual differences. (SRS did count raw urine samples beginning in the mid-1960s, but those assays were via gamma spectrometry, not gross gamma counting.) Further, differences in radiochemical yields between the separations procedure used at SRS and that assumed in OTIB-0054 are not accounted for. Such differences have a trivial effect on gross beta counting results (for MFAP source terms) but can result in appreciable differences for gross gamma results. However, that must be weighed with the fact gross beta results are the preferred data in

situations when both gross beta and gross gamma assays were performed for a particular type of urinalysis, such as the induced activity procedure used at SRS from late 1956 until mid-1966 or so. In general, differences in chemical separations procedures are not as important as the difference between assays for raw samples versus processed samples (i.e., those subjected to chemical separations). That is particularly true for gross beta assays, where the results are dominated by radiostrontium, with a minor contribution from barium for short-decayed fuels.

Section 3.0 of this report expounds upon the SRS-specific activity and intake fraction data derived in Section 2.0 to derive activity and intake fraction values that reflect both SRS production reactor operations and the specific radiochemistry methods used for gross beta and gross gamma urinalyses (i.e., the "fission product" and "induced activity" assay methods). Urine activity fraction data are provided for three chronic intake periods (90 days, 2 years, and 30 years).

Section 4.0 of this report documents calculations of committed organ doses for assumed values of urinary excretion and intake rate using the SRS-specific intake and activity fraction values derived in Section 3.0. The committed organ doses are then compared with those assigned using the default guidance provided in the SRS Site Profile (ORAUT 2005, p. 70).

Because beta urinalysis counting was much more sensitive than gamma urinalysis counting the need to calculate intake and dose from a gamma urinalysis result is rare. Therefore, this document focuses on beta urinalysis and the default 4,400-dpm/d intake specified in the SRS Site Profile as a means to evaluate urinalysis results reported as less than the minimum detectable activity. However, data are included to allow interpretation of gross gamma analyses if necessary.

2.0 COMPARISON OF ORGAN DOSES COMPUTED USING THE OTIB-0054 REPRESENTATIVE REACTOR CASES WITH THOSE COMPUTED FOR THE SRS PRODUCTION REACTORS

This section documents comparisons between organ doses computed for the nine representative reactor cases considered in OTIB-0054 and doses computed for five cases selected to represent production reactor operations at SRS. The purpose was to evaluate if differences in reactor parameters could affect the results obtained through application of OTIB-0054. These comparisons should not be viewed as an evaluation of differences in assigned dose that would be obtained using the two sets of reactor data. SRS only performed gross beta or gross gamma counting of urinalyses after chemical separation procedures, so the comparisons for other samples are not representative of actual differences. Further, differences in radiochemical yields between the separations procedure used at SRS versus that assumed in OTIB-0054 are not accounted for. Such differences have a trivial effect on gross beta counting results (for MFAP source terms) but can result in appreciable differences for gross gamma results. However, that should be weighed with the fact gross beta results are the preferred data in situations when both gross beta and gross gamma assays were performed for a particular type of urinalysis, such as the induced activity procedure used at SRS from late 1956 until mid-1966 or so. In general, differences in chemical separations procedures are not as important as the difference between assays for raw samples versus processed samples (i.e., those subjected to chemical separations). That is particularly true for gross beta assays, where the results are dominated by radiostrontium, with a minor contribution from barium for short-decayed fuels. The SRS chemical separations procedures for gross beta and gross gamma urinalyses are considered in Section 3.0, which documents the development of SRS-specific activity and intake fraction values for assigning dose for non-radionuclide-specific assays for SRS claims.

2.1 OTIB-0054 METHOD

OTIB-0054 provides a method for deriving intake and activity fraction values for assigning MFAP intakes from gross beta or gross gamma radioassay results. The intake and activity fraction values were derived from fission and activation product inventory calculations performed using the ORIGEN-S code for selected reactors and reactor fuels at predefined decay times (10 days, 40 days, 180 days, and 1 year). Inventory data were determined across a range of reactor parameters (specific power and burnup) for each reactor, as appropriate. Activity fraction values were used to convert gross beta or gross gamma results to activity for a given indicator radionuclide (^{90}Sr for gross beta counts and ^{137}Cs for gross gamma). The indicator nuclide activity values were then used to establish the corresponding intake, which was subsequently used with the intake fraction data to assign the intake for the other radionuclides in the mix.

With respect to urinalysis, the OTIB-0054 method accounts for the following factors:

1. The dosimetrically significant radionuclides in the source term and their intake fractions;

2. The fractions of the significant radionuclides in urine taking into account the body's biokinetic effects on each radionuclide and radioactive decay and progeny ingrowth that occur in a sample in the time between collection and counting;

3. The effect of the radiochemistry procedure on the fractions of the radionuclides actually carried through to the counting planchet; and

4. The beta and gamma emission rates (i.e., intensities) for each radionuclide.

OTIB-0054 also addresses gross beta or gross gamma assays for air or surface activity. The method is the same as that above for urinalysis except the steps accounting for biokinetics and radiochemistry are not needed.

Figure 2-1 is a flowchart that shows the relationship these factors have in going from intake to a count on a urine sample or vice versa. (The figure specifically references beta counts but the process is identical for a gamma count.) The factors are multipliers going from top to bottom or divisors when going from bottom to top. In most cases these factors are not known exactly or vary over time and by laboratory.

2.2 REACTORS CONSIDERED IN OTIB-0054 AND IN THIS REPORT

OTIB-0054 considered four reactors representative of reactor sites across the U.S. Department of Energy (DOE) complex. The four reactors were the Advanced Test Reactor (ATR), the Fast Flux Test Facility (FFTF), the Hanford N Reactor, and a Training, Research, Isotopes, General Atomics (TRIGA) reactor (see OTIB-0054 for details). A total of nine ORIGEN-S cases were run to encompass different operating conditions with respect to fission and activation product inventory for discharged fuel. The nine cases are summarized in Table 2-1. (All tables in this document appear after the References section and before Attachment A.)

To evaluate if differences in the reactor parameters considered in the ORIGEN-S runs for OTIB-0054 could affect assigned doses, three reactor fuels were selected to represent production reactor operations at SRS over time. These were:

- The Mark V-B, representing plutonium production in tubular fuels of natural uranium metal;

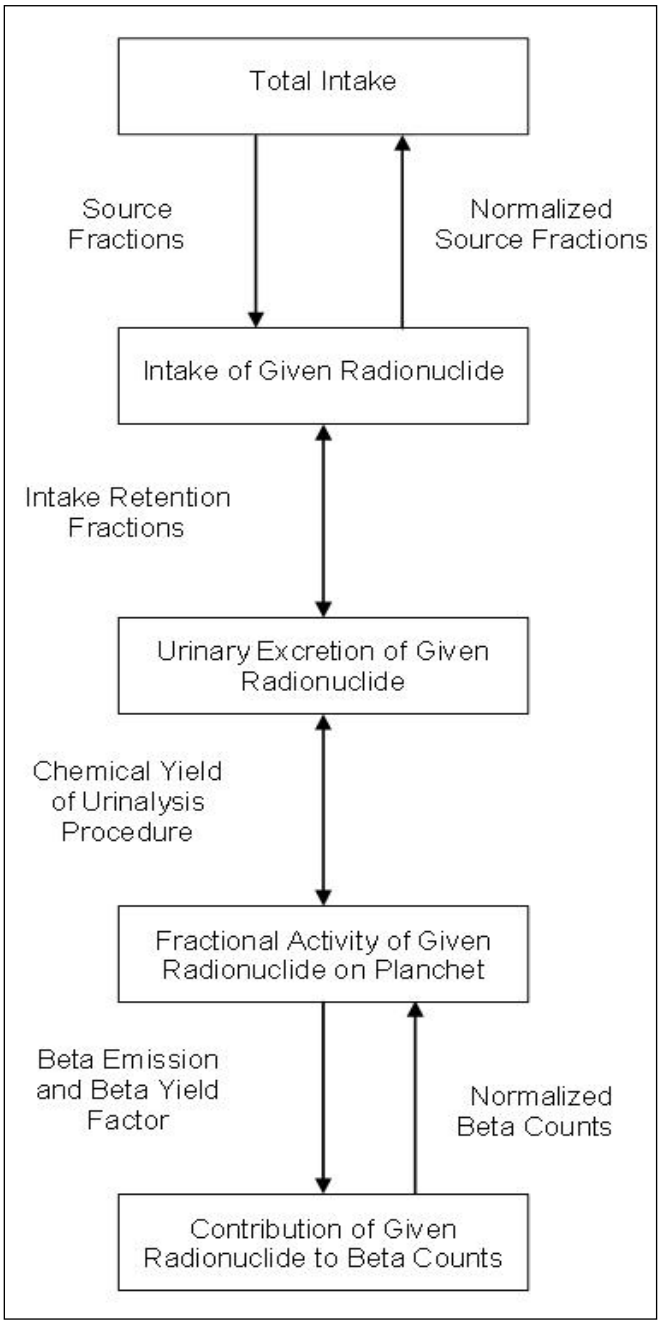

Figure 2-1. Steps and factors in determining beta counts in a urine sample from a given intake or in determining intake from beta counts.

- The Mark 16, representing plutonium production in mixed lattice cores consisting of oralloy-aluminide driver assemblies and depleted uranium targets; and
- The Mark VI-B, representing tritium production in single-assembly driver-target arrangements using oralloy aluminide fuel.

Two sets of irradiation parameters were selected for the Mark 16 and Mark VI-B cases. No appropriate alternate parameters were identified for the Mark V-B case, so it was run using nominal parameters only. The irradiation parameters selected for the five SRS cases are given in Table 2-2.

2.3 INTAKE AND ACTIVITY FRACTION DATA FOR THE FIVE SRS CASES

The OTIB-0054 method was applied to the fission and activation product inventory data for the five SRS cases to establish intake and activity fraction values. These values were determined to facilitate comparisons with the nine representative reactor cases in OTIB-0054 to evaluate if differences in reactor parameters had an effect on assigned intakes. These values do not represent radioassay procedures used at SRS and cannot be used for evaluating SRS claims.

Table 2-3 presents the normalized intake fraction (NIF) values for the dosimetrically significant nuclides that were determined from the five SRS cases on the basis of contributing ≥1% to committed organ dose. The methods for determining the dosimetrically significant radionuclides and associated NIFs for a given set of reactor discharge data are detailed in OTIB-0054. The data specific to the nine representative reactor cases are from OTIB-0054.

Table 2-4 presents the NIF values for the simplified source term for the five SRS cases. The simplified source term reflects the radionuclides in Table 2-3 that contribute ≥1% to effective dose. The NIFs for the simplified source term are the basis for the intake ratio values in Table 2-5. These values are used to assign intakes for the associated radionuclides once the indicator radionuclide (^{90}Sr or ^{137}Cs) intake has been established.

Tables 2-6, 2-7, and 2-8 present the activity fraction values determined for the five SRS cases. The fractions in Table 2-6 are used to convert from gross beta or gross gamma urinalysis results to ^{90}Sr or ^{137}Cs activity, respectively, for samples that have had little or no radiochemical processing before counting. It is reiterated that these data are included to facilitate comparison with the OTIB-0054 representative reactor cases and do not represent routine bioassay procedures at SRS.

The activity fractions in Table 2-7 represent gross beta urinalyses after the radiochemistry procedure documented in Section 7.1 of OTIB-0054. This does not represent the procedure used at SRS.

The activity fractions in Table 2-8 represent gross beta or gross gamma assays for assessments of air concentration or surface contamination.

2.4 ORGAN DOSE CALCULATIONS FOR THE REPRESENTATIVE REACTOR AND SRS CASES

The activity fraction values for the SRS cases (Tables 2-6, 2-7, and 2-8 of this report) and the representative reactor cases (Tables 7-1a, 7-1b, 7-2, and 7-4 of OTIB-0054) were used to calculate intakes corresponding to unit assay results for gross beta and gross gamma urinalyses and air sample counts.

For the urinalyses, a unit result of 1 pCi/d gross beta or gross gamma was assumed for a 24-hour urinalysis after a 1-year chronic intake. For the gross beta analyses, the ^{90}Sr excretion calculated for a given reactor case and decay time was converted to intake based on a chronic intake rate of 4.414 pCi/d of Type F ^{90}Sr, which results in a urinary excretion rate of 1 pCi/d after 1 year. For the gross gamma analyses, excretion was converted to intake based on a chronic intake of 2.877 pCi/d of Type F ^{137}Cs, which corresponds to an excretion rate of 1 pCi/d at 1 year of chronic intake. The intake values for the unit excretion rates were determined using the Integrated Modules for Bioassay Analysis (IMBA).

For air samples, a unit concentration of 1×10^{-10} μCi/cm^3 was used to convert from the indicator radionuclide activity values to concentration. Intake was then determined by assuming a respiration rate of 1.2 m^3/hr for 2,000 hours.

Once the indicator radionuclide intakes were established for each scenario, the corresponding associated radionuclide intakes were computed using the intake ratio values in Table 2-5 of this report (for the five SRS cases) or Table 7-3 of OTIB-0054 (for the nine representative reactor cases). Organ doses were then computed for each scenario and decay interval using dose conversion factors (DCFs) determined from IMBA. The DCFs represented dose (in rem) for each radionuclide in the mix for a 1-year chronic intake. These values were used to establish dose per unit intake of the indicator radionuclide for each reactor case and decay interval for two absorption categories: Most Soluble and Least Soluble. The Most Soluble category represented the most soluble absorption type for each nuclide in the mix. The Least Soluble category likewise represented the least soluble absorption types for each nuclide. Exceptions were that only Type F was used for radiostrontium and only Type V (SR-1) for radioiodines.

Per OTIB-0054, the dose assigned for a given assay result should be the maximum obtained across the applicable reactor cases and decay times. That guidance was applied to the organ doses computed as above for the representative reactor and SRS cases to facilitate comparisons. Tables 2-9 through 2-28 show comparisons of the organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for the following scenarios:

- Gross beta urinalysis for raw urine samples (Tables 2-9 through 2-12),
- Gross beta urinalysis for samples after significant radiochemistry (Tables 2-13 through 2-16),
- Gross gamma urinalysis for raw urine samples (Tables 2-17 through 2-20),
- Gross beta analysis for an air sample (Tables 2-21 through 2-24), and
- Gross gamma analysis for an air sample (Tables 2-25 through 2-28).

In each table, highlights identify instances in which the SRS cases produced a dose that was greater than or equal to that from the OTIB-0054 representative reactors.

Note that the 40-day decay time has been included in these dose comparisons for completeness in evaluating the effect of different reactor parameters on assigned doses. The 40-day decay time is not applicable for assigning doses for SRS claims because separations were not performed on short-decayed fuels.

2.5 DISCUSSION OF ORGAN DOSE COMPARISONS BETWEEN THE REPRESENTATIVE REACTOR AND SRS CASES

The organ dose comparisons for the gross beta urinalyses for the raw urine samples (Tables 2-9 through 2-12) show that in most cases the representative reactors give doses that are larger than those for the SRS cases. Exceptions in which the SRS cases give higher doses are for the thyroid for the 10-and 40-day decay times and for four organs at 1 year of decay. The differences in dose for these exceptions are not significant. The largest difference is for the thyroid, where the doses from the SRS cases exceeded those from the representative reactor cases by 5.2%. Per OTIB-0054, in most cases iodine intakes would only be assigned for early years, before the use of ventilation and collection systems. For later years it is reasonable to assume that there were no significant intakes from iodine at most sites.

The organ dose comparisons for the gross beta urinalyses after significant radiochemistry (Tables 2-13 through 2-16) show that the representative reactors produce significantly larger doses than the SRS cases for all organs and decay times.

For the gross gamma urinalyses (Tables 2-17 through 2-20) the comparisons show numerous instances in which the SRS cases gave higher doses than the representative reactor cases. In particular, the SRS cases gave higher doses for nearly all of the organs for the 180-day and 1-year

decay times. The differences range from a low of 0.34% to a maximum of 29% (for the adrenals at 1 year of decay).

The comparisons for the gross beta and gross gamma air samples (Tables 2-21 through 2-28) show just three instances where the SRS cases gave larger doses than the representative reactor cases, the largest of those being 1.1%.

3.0 DEVELOPMENT OF SRS-SPECIFIC ACTIVITY FRACTION VALUES FOR ASSIGNING MFAP INTAKES FROM GROSS BETA AND GROSS GAMMA URINALYSES

The OTIB-0054 method as described in that document and in Section 2.0 above was used to compute activity fraction values applicable to gross beta and gross gamma urinalyses after the fission product and induced activity procedures described in Section 3.1. Activity fractions were derived for two indicator radionuclides for three chronic intake periods. The selected indicator radionuclides were ^{90}Sr for gross beta analyses and ^{95}Zr for gross gamma. (Cesium-137 could not be used as the indicator radionuclide because the SRS radiochemistry procedure did not capture cesium). The three chronic intake periods considered were 90 days, 2 years, and 30 years.

Accounting for the site-specific radiochemistry does not affect the determination of the dosimetrically significant nuclides or the NIF values from the five SRS cases. Therefore, Tables 2-3, 2-4, and 2-5 of this report are unaffected.

The following subsections focus on urinalyses. For air or other workplace samples at SRS when chemical processing was not performed before counting, the activity fraction data in Table 2-8 should be used in conjunction with the intake ratio values in Table 2-5 to assign intakes using (1) the ^{90}Sr data for gross beta assays and (2) the ^{137}Cs data for gross gamma assays.

3.1 RADIOCHEMISTRY FOR MFAP URINALYSES AT SRS

There were two urinalysis methods at SRS that employed gross beta or gross gamma counting for MFAP in urine samples. The first of these was the “fission products” (FP) procedure that appears to have come into use in December 1954 (DuPont 1955). The second urinalysis method for MFAP was the “induced activity” procedure (IA) that came into use in December 1956 (DuPont 1957, Health Physics section). The IA procedure, detailed by Boni (1959), employed both gross beta and gross gamma counting after an ammoniacal alkaline-earth phosphate precipitation procedure. The specific radiochemical method for the FP procedure is not clear but appears to be either similar or indeed identical to the IA procedure. The FP assays were only counted for gross beta, so the specifics of the radiochemical method are unimportant. Gross beta results for MFAP source terms are dominated by radiostrontium activity with a minor contribution from barium for short-decayed fuels. It was considered unlikely that a separations procedure for fission products would not have captured strontium and barium, even if it did differ from the IA procedure. In a later document, Boni (1963) refers to the “mixed fission product analysis” as an ammoniacal alkaline-earth phosphate precipitation procedure (i.e., the same procedure he described for the IA procedure in 1959). The FP and IA bioassay procedures were differentiated in SRS reports until the combined procedure came into use in April 1966, although the only difference could have been the counting methods (gross beta only for FP versus gross beta and gross gamma for IA). The gross beta count was the more sensitive of the two and would therefore be the primary result for dose assignments.

As of April 1966, a combined fission product and induced activity procedure came into use at SRS that involved gamma spectrometry on what appear to be raw urine samples (due to the presence of both ^{40}K and ^{137}Cs in the results). The urine activity fractions that are derived in this report for the FP and IA analyses are not needed for the combined procedure because it was radionuclide specific.

Some use of the FP and IA methods (FP in particular) are still seen in bioassay data from SRS in periods after the gamma spectrometry procedure came into use.

The chemical separation procedure used at SRS did not significantly capture all of the beta-emitting radionuclides present in the urine. According to Boni (1959), chemical yields for some of the common fission products were measured as follows: ^{60}Co 85%, ^{59}Fe 98%, ^{65}Zn 95%, ^{51}Cr 90%, ^{89}Sr 92%, ^{90}Sr 103%, ^{103}Ru 40% to 50%, ^{144}Ce 101%, and Zr/Nb 95%. This analysis assumed that the SRS procedure also quantitatively captured promethium, europium, praseodymium, and neodymium (the Boni paper states that rare earths are captured) as well as barium, lanthanum, and yttrium (though it does not appear SRS tested for these directly). It was also assumed that cesium, iodine, tellurium, and molybdenum were not captured because of the similarities between the SRS and Hanford procedures. Because chemical yields vary by batch, and consistent with the OTIB-0054 approach, the fractional chemical yields in this report were rounded to 1 or 0. These yields are shown in Table 3-1 for the complete list of dosimetrically significant radionuclides for the five SRS cases (i.e., those in Table 2-3). The yields for ruthenium have been set to zero in Table 3-1 because ruthenium was volatilized in the muffling step of the Boni procedure and was therefore not present when samples were counted [DuPont 1957, p. 228].

3.2 CALCULATION OF THE SRS-SPECIFIC ACTIVITY FRACTIONS FOR GROSS BETA AND GROSS GAMMA URINALYSES

Activity fractions for ^{90}Sr and ^{95}Zr were calculated per Section 7.1 of OTIB-0054 using the chemical yield values in Table 3-1 in conjunction with the appropriate beta and gamma emission yields and the intake retention fraction (IRF) values in Table 3-2. Emission yields and IRFs are only shown for the radionuclides carried through by the SRS radiochemistry procedure. Per the OTIB-0054 method, indicator radionuclide activity fraction values were computed using only the least soluble absorption type for the associated radionuclides in the mix. The SRS-specific ^{90}Sr (gross beta) and ^{95}Zr (gross gamma) activity fraction values are in Tables 3-3 and 3-4, respectively.

The activity fraction values in Tables 3-3 and 3-4 were used to determine the indicator radionuclide activity associated with a given counting result. The indicator radionuclide excretion values were then used to establish the corresponding intake. Next, intake ratio tables were used to compute the intake for the additional associated radionuclides. For ^{90}Sr, the applicable intake ratio values are given in Table 2-5. Intake ratios for ^{95}Zr (to be used for SRS-specific gross gamma urinalyses) are given in Table 3-5.

4.0 COMMITTED ORGAN DOSES COMPUTED USING THE SRS-SPECIFIC ACTIVITY AND INTAKE FRACTION VALUES

In Section 4.1 below the SRS-specific gross beta urine activity fractions developed in Section 3.2 were used in conjunction with the SRS-specific associated radionuclide intake ratios discussed in Section 2.3 to compute committed organ doses for a unit gross beta urinalysis result. Organ doses were computed for both 90-day and 30-year intake periods.

Section 4.2 describes use of the SRS-specific NIF values discussed in Section 2.3 to apportion an intake of 4,400 dpm/d, which is the recommended intake to assign for missed dose calculations per the SRS site profile. The apportioned intake was used to compute committed organ doses for intake periods of 90 days and 30 years.

4.1 COMMITTED ORGAN DOSES FOR A UNIT URINARY EXCRETION RATE OF 1 BECQUEREL PER DAY

The SRS-specific ^{90}Sr activity fractions (Table 3-3) for the 90-day and 30-year intake periods were used to compute the ^{90}Sr activity corresponding to a gross beta assay result of 1 Bq/d for a 24-hour urinalysis for each of the five SRS cases for the 10-day, 180-day, and 1-year decay times. SRS seldom dissolved short-cooled fuel (Kantelo et al. 1993, p. 26). Therefore, these evaluations only considered fuel cooled or decayed 10 days, 180 days, or 1 year, as discussed in OTIB-0054. In general, these categories apply to reactor workers (10-day-decayed fuel mixtures), dissolution facilities (180-day-decayed fuel mixtures) and waste management facilities (1-year-decayed fuel mixtures).

The ^{90}Sr activity (excretion) results were converted to chronic intake rate using factors of 4.691 Bq/d for the 90-day intake period and 4.017 Bq/d for the 30-year period. These are values from IMBA version 4.0.9 for chronic intake of Type F ^{90}Sr for a urinary excretion of 1 Bq/d. The intakes of the associated radionuclides were determined from the ^{90}Sr intakes using the ratios in Table 2-5. Committed organ doses (two sets, one for each intake period) were then computed using DCFs (in mSv/Bq) from RadToolbox Version 2.0.0 for the most soluble and least soluble absorption types.

Tables 4-1 through 4-3 show the computed committed organ doses (in mSv) for each decay time for the two intake periods. Per the OTIB-0054 method, the maximum value determined for a given organ was assigned for each intake period.

4.2 COMMITTED ORGAN DOSES FOR AN INTAKE RATE OF 4,400 DPM PER DAY

The SRS Site Profile recommends assigning an intake of 4,400 dpm/d for missed dose calculations for mixed fission products (ORAUT 2005, p. 82). Tables 4.4.2-6 and 4.4.2-7 of that document provide guidance on how to apportion the 4,400 dpm/d among radionuclides and absorption types. Table 4.4.2-6 can be used for upper bound doses and Table 4.4.2-7 can be used for more realistic assessments. Committed organ doses were compared using the intake radionuclide ratios from OTIB-0054 with doses using the guidance in Table 4.4.2-7.

The SRS-specific NIF values in Table 2-4 were used to apportion an intake of 4,400 dpm (73.3 Bq) to determine the fraction due to ^{90}Sr. However, because the 4,400 dpm/d intake specified by the SRS Site Profile represents particulate activity only, the Table 2-4 values were renormalized with the ^{131}I components removed. These modified (particulate-only) NIF values (Table 4-4) were then used to compute the ^{90}Sr component of the 4,400 dpm/d intake rate for each reactor case for the 10-day, 180-day, and 1-year decay times. The intake rates were then converted to total intake by multiplying by periods of 90 days and 30 years (10,957 days).

The ^{90}Sr intakes that correspond to the 4,400 dpm/d intake rate were used in conjunction with Table 2-5 to determine the associated radionuclide intakes for each reactor and decay time for the 90-day and 30-year periods. Note that these values include the ^{131}I components. The resulting intake values were then used to compute committed organ doses using DCFs from RadToolbox. The organ doses were computed for the most soluble and least soluble absorption types and the maximum for each organ was selected for the two intake periods.

Tables 4-5 through 4-7 show comparisons of the maximum committed doses determined for each organ from the 4,400-dpm/d intake rate for the two intake periods and each of the 10-day, 180-day, and 1-year decay times.

5.0 COMPARISON OF DOSES ASSIGNED USING THE SRS-SPECIFIC INTAKE AND ACTIVITY FRACTION VALUES WITH THOSE ASSIGNED PER THE SRS SITE PROFILE

The SRS Site Profile recommends that fission product urinalysis results be interpreted as follows (ORAUT 2005, p. 70):

1. 100% Type F ^{90}Sr if the disease is related to bone or bone marrow plus an equal intake of ^{137}Cs (Type F) and a 3-fold intake of ^{106}Ru (Type F). This assumption should be used for other disease locations that are not specifically mentioned in the next two bullets.

2. 100% Type M ^{144}Ce if the disease is related to the liver plus an equal intake of ^{106}Ru (Type F) and a 20% intake of ^{137}Cs (Type F)

3. 100% Type M ^{144}Ce if the disease is related to the respiratory tract or digestive tract plus an equal intake of Type S ^{106}Ru and a 20% intake of ^{137}Cs (Type F)

Tables 5-1 through 5-3 show comparisons of committed organ doses computed using the Site Profile assumptions with those determined using the SRS-specific intake and activity fraction values for a 1-Bq/d unit excretion rate. Comparisons are given for the 10-day, 180-day, and 1-year decay times for the 90-day and 30-year intake periods.

Tables 5-4 through 5-6 show comparisons of committed organ doses computed using the Site Profile assumptions with those determined using the SRS-specific intake and activity fraction values for a chronic intake rate of 4,400 dpm/d. Comparisons are given for the 10-day, 180-day, and 1-year decay times for the 90-day and 30-year intake periods.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 COMPARISONS OF THE REPRESENTATIVE REACTOR AND SRS CASES

The comparisons between organ doses computed using the activity and intake fraction values for the nine representative reactor cases considered in OTIB-0054 with those computed using activity and intake fraction values for cases selected to represent production reactor operations at SRS showed that the representative reactor doses exceeded those from the SRS cases in most cases, with the notable exception of the gross gamma results for the 180-day and 1-year decay times. The maximum amount by which dose from the SRS values exceeded that from the representative reactors was 28.9%. This occurred for the adrenals at 1 year of decay for a gross gamma urinalysis. That result represents a gross gamma count on a raw urine sample, a type of analysis not known to have been used at SRS. Therefore, it does not represent a nonfavorable bias between doses assigned via OTIB-0054 and those assigned using the SRS-specific values in this report. However, it does show that differences in reactor parameters from those in OTIB-0054 can, hypothetically, result in higher assigned doses, although in general gross gamma results would only be used if there was no corresponding gross beta result for a given assay.

6.2 COMPARISON BASED ON BETA ACTIVITY IN URINE

For all organs except the thyroid, the SRS Site Profile guidance resulted in overestimated doses in comparison with those from the SRS-specific intake and activity fraction values that were established using the OTIB-0054 method for all absorption types and fuel decay periods and over a very broad range of intake periods. The overestimates ranged from 2 to 5 orders of magnitude for all organs and decay times except for the thyroid at 10 days decay. For the thyroid for reactor workers (10-day-decayed fuel), the SRS Site Profile guidance underestimated the dose by approximately 1 order of

magnitude for the 90-day intake period because ^{131}I represents such a large component of the total activity at short decay times.

6.3 COMPARISON BASED ON INTAKES

For all organs except the thyroid, the SRS Site Profile guidance in Table 4.4.2-7 resulted in overestimated doses in comparison with those from the OTIB-0054 method for all absorption types, fuel decay periods, and a broad range of intake periods. The overestimates ranged from 3% to more than a factor of 20 for all organs and decay times except for the thyroid at 10 days decay. For the thyroid, for 10-day-decayed fuel contamination only, the Table 4.4.2-7 guidance underestimated the dose by more than 3 orders of magnitude because of the large impact of the ^{131}I.

6.4 COMPARISON TO TEST CASE WHOLE BODY COUNTS

The method for calculating the ratios of the fission products in relation to the indicator radionuclides introduces considerable conservatism. To evaluate whether the ratios are reasonable, the body burdens that would be predicted by using these ratios were compared to actual values. Attachment A contains an evaluation of 14 test cases for individuals with positive ^{137}Cs whole-body count (WBC) results. The positive results for these individuals were used to calculate intakes in accordance with normal dose reconstruction methods. Intakes of associated fission products were then calculated, and predicted body burdens of these radionuclides were modeled for ^{106}Ru, ^{95}Zr/Nb, and ^{144}Ce, three radionuclides detectable by WBCs. The predicted body burdens were generally consistent with the WBC results.

7.0 RECOMMENDATION

The SRS Site Profile guidance was developed before OTIB-0054. The latter is considered more accurate, and it is used for other sites. The SRS Site Profile should be revised to incorporate the OTIB-0054 method for assigning MFAP intakes from gross beta and gross gamma counting results (i.e. the fission product and induced activity procedures). This may result in the need for upward revision of assigned thyroid doses in some cases. In cases where both gross beta and gross gamma results are available for a given sample the gross beta results should be used by default since that was the more sensitive of the two methods. Table 3-3 of this report would be used to assign the ^{90}Sr intake associated with a given gross beta urinalysis result. If the gross gamma result was selected then Table 3-4 would be used to assign the ^{95}Zr intake. Intakes for the other radionuclides in the mix would then be assigned using Table 2-5 for the ^{90}Sr indicator (i.e. gross beta) or Table 3-5 for ^{95}Zr (i.e. gross gamma).

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Table 2-1. ORIGEN-S irradiation parameters for the nine representative reactor cases.

Case	Parameters	Basis
ATR 1	Specific power = 2379.1 MW/MTU Irradiation time = 132.27 days Burnup = 314,684 MWd/MTU	Maximum burnup at nominal power.
ATR 2	Specific power = 8651.2 MW/MTU Irradiation time = 36.4 days Burnup =314,904 MWd/MTU	Maximum burnup at maximum assembly power.
ATR 3	Specific power = 2379.1 MW/MTU Irradiation time = 56 days Burnup = 133,230 MWd/MTU	Nominal burnup at nominal power.
FFTF 1	Specific power = 163.8 MW/MTHM Irradiation time = 929.4 days Burnup = 152,230 MWd/MTHM	Maximum burnup at nominal power.
FFTF 2	Specific power = 163.8 MW/MTHM Irradiation time = 488.3 days Burnup = 79,984 MWd/MTHM	Nominal burnup at nominal power.
N Reactor 1	Specific power = 10.4 MW/MTU Irradiation time = 114.2 days Burnup = 1188 MWd/MTU	Production of weapons-grade plutonium (nominal 6% ^{240}Pu content) at nominal power.
N Reactor 2	Specific power = 10.4 MW/MTU Irradiation time = 285.6 days Burnup = 2970 MWd/MTU	Production of fuel-grade plutonium (nominal 12% ^{240}Pu content) at nominal power.
TRIGA 1	Specific power = 15.57 MWd/MTU Irradiation time = 730.1 days Burnup = 11,368 MWd/MTU	Maximum burnup at nominal power.
TRIGA 2	Specific power = 15.57 MW/MTU Irradiation time = 115.2 days Burnup = 1994 MWd/MTU	Nominal burnup at nominal power.

Table 2-2. ORIGEN-S irradiation parameters for the five SRS cases.

Case	Parameters	Basis
Mark V-B	Specific power = 25.5 MW/MTU Irradiation time = 43.14 days Burnup = 1,100 MWd/MTU	Production of weapons-grade plutonium (nominal 6% ^{240}Pu content) at nominal power.
Mark 16 1	Specific power = 896.08 MW/MTU Irradiation time = 240 days Burnup = 215,059 MWd/MTU	Typical Mark 16/31 core irradiated for four sub-cycles of 60 days each, representing the high burnup case.
Mark 16 2	Specific power = 896.08 MW/MTU Irradiation time = 160 days Burnup = 143,373 MWd/MTU	Typical Mark 16/31 core irradiated for four sub-cycles of 40 days each, representing the low burnup case.
Mark VI-B 1	Specific power = 1392.9 MW/MTU Irradiation time = 182 days Burnup = 253,508 MWd/MTU	Maximum assembly power for a typical cycle duration.
Mark VI-B 2	Specific power = 1160.32 MW/MTU Irradiation time = 182 days Burnup = 211,178 MWd/MTU	Nominal assembly power for a typical cycle duration.

Table 2-3. Normalized intake fractions for the dosimetrically important radionuclides.

	Mk V-B 1				Mk 16 1				Mk 16 2			
Radionuclide	**10 d**	**40 d**	**180 d**	**1 y**	**10 d**	**40 d**	**180 d**	**1 y**	**10 d**	**40 d**	**180 d**	**1 y**
Sr-89	1.40E-02	6.79E-02	6.83E-02	1.69E-02	2.95E-02	8.30E-02	4.98E-02	9.71E-03	2.80E-02	8.60E-02	5.73E-02	1.21E-02
Sr-90	1.28E-04	9.35E-04	6.36E-03	1.96E-02	6.94E-04	2.94E-03	1.19E-02	2.90E-02	4.74E-04	2.20E-03	9.88E-03	2.61E-02
Y-90	1.28E-04	9.35E-04	6.36E-03	1.96E-02	6.97E-04	2.94E-03	1.19E-02	2.90E-02	4.76E-04	2.20E-03	9.88E-03	2.61E-02
Y-91	1.62E-02	8.28E-02	1.08E-01	3.77E-02	3.65E-02	1.09E-01	8.48E-02	2.33E-02	3.39E-02	1.10E-01	9.51E-02	2.85E-02
Zr-95	1.77E-02	9.34E-02	1.41E-01	5.92E-02	4.04E-02	1.24E-01	1.12E-01	3.71E-02	3.68E-02	1.24E-01	1.23E-01	4.45E-02
Nb-95	9.03E-03	8.51E-02	2.58E-01	1.26E-01	4.16E-02	1.62E-01	2.17E-01	7.99E-02	3.40E-02	1.52E-01	2.37E-01	9.56E-02
Mo-99	4.19E-03	1.58E-05	4.94E-20	8.20E-40	3.55E-03	7.79E-06	1.45E-20	1.90E-40	3.72E-03	8.90E-06	1.84E-20	2.62E-40
Ru-103	1.42E-02	6.11E-02	3.54E-02	4.21E-03	1.92E-02	4.81E-02	1.66E-02	1.56E-03	1.86E-02	5.07E-02	1.94E-02	1.98E-03
Ru-106	6.28E-04	4.34E-03	2.29E-02	5.07E-02	1.20E-03	4.83E-03	1.52E-02	2.66E-02	8.39E-04	3.68E-03	1.29E-02	2.44E-02
Te-129m	4.99E-04	1.97E-03	7.52E-04	5.16E-05	6.12E-04	1.40E-03	3.19E-04	1.73E-05	6.01E-04	1.50E-03	3.79E-04	2.24E-05
Te-132	4.58E-03	5.65E-05	4.50E-17	1.13E-33	3.73E-03	2.68E-05	1.27E-17	2.52E-34	3.89E-03	3.05E-05	1.61E-17	3.46E-34
I-131	5.55E-01	3.05E-01	1.20E-05	4.44E-12	4.63E-01	1.48E-01	3.48E-06	1.01E-12	4.78E-01	1.67E-01	4.34E-06	1.38E-12
I-132	2.36E-01	2.91E-03	2.32E-15	5.83E-32	1.92E-01	1.38E-03	6.55E-16	1.30E-32	2.00E-01	1.57E-03	8.27E-16	1.78E-32
Cs-134	1.33E-05	9.44E-05	5.70E-04	1.50E-03	6.50E-04	2.69E-03	9.67E-03	2.01E-02	2.68E-04	1.21E-03	4.83E-03	1.09E-02
Cs-137	1.44E-04	1.05E-03	7.16E-03	2.21E-02	7.05E-04	2.99E-03	1.21E-02	2.95E-02	4.81E-04	2.23E-03	1.00E-02	2.65E-02
Ba-140	2.71E-02	3.87E-02	1.32E-04	1.76E-08	2.67E-02	2.22E-02	4.50E-05	4.75E-09	2.76E-02	2.50E-02	5.62E-05	6.45E-09
La-140	3.11E-02	4.46E-02	1.52E-04	2.03E-08	3.07E-02	2.56E-02	5.18E-05	5.47E-09	3.16E-02	2.88E-02	6.48E-05	7.43E-09
Ce-141	2.37E-02	9.12E-02	3.16E-02	1.91E-03	3.49E-02	7.82E-02	1.62E-02	7.70E-04	3.49E-02	8.54E-02	1.96E-02	1.01E-03
Ce-144	4.34E-03	2.94E-02	1.44E-01	2.86E-01	1.78E-02	7.04E-02	2.05E-01	3.22E-01	1.33E-02	5.73E-02	1.85E-01	3.16E-01
Pr-143	2.82E-02	4.46E-02	2.40E-04	5.90E-08	2.80E-02	2.57E-02	8.25E-05	1.60E-08	2.90E-02	2.91E-02	1.04E-04	2.18E-08
Pr-144	4.34E-03	2.94E-02	1.44E-01	2.86E-01	1.78E-02	7.04E-02	2.05E-01	3.22E-01	1.33E-02	5.73E-02	1.85E-01	3.16E-01
Nd-147	9.13E-03	1.00E-02	1.00E-05	2.64E-10	8.39E-03	5.37E-03	3.19E-06	6.65E-11	8.78E-03	6.13E-03	4.03E-06	9.15E-11
Pm-147	4.52E-04	3.88E-03	2.48E-02	6.76E-02	1.95E-03	8.46E-03	3.15E-02	6.79E-02	1.50E-03	7.22E-03	2.99E-02	7.00E-02
Eu-154	7.70E-07	5.59E-06	3.72E-05	1.11E-04	2.05E-05	8.64E-05	3.43E-04	8.11E-04	8.43E-06	3.89E-05	1.71E-04	4.39E-04
Eu-155	4.25E-06	3.07E-05	1.99E-04	5.76E-04	1.15E-05	4.81E-05	1.86E-04	4.25E-04	5.80E-06	2.66E-05	1.14E-04	2.83E-04

Radionuclide	Mk VI-B 1				Mk VI-B 2			
	10 d	40 d	180 d	1 y	10 d	40 d	180 d	1 y
Sr-89	2.87E-02	8.55E-02	5.51E-02	1.14E-02	2.86E-02	8.55E-02	5.51E-02	1.14E-02
Sr-90	5.35E-04	2.40E-03	1.05E-02	2.70E-02	5.34E-04	2.40E-03	1.05E-02	2.70E-02
Y-90	5.37E-04	2.41E-03	1.05E-02	2.70E-02	5.35E-04	2.40E-03	1.05E-02	2.70E-02
Y-91	3.50E-02	1.10E-01	9.22E-02	2.69E-02	3.49E-02	1.10E-01	9.23E-02	2.69E-02
Zr-95	3.82E-02	1.24E-01	1.20E-01	4.22E-02	3.81E-02	1.24E-01	1.20E-01	4.23E-02
Nb-95	3.67E-02	1.56E-01	2.32E-01	9.09E-02	3.66E-02	1.56E-01	2.32E-01	9.09E-02
Mo-99	3.67E-03	8.53E-06	1.70E-20	2.37E-40	3.68E-03	8.56E-06	1.71E-20	2.38E-40
Ru-103	1.87E-02	4.96E-02	1.84E-02	1.83E-03	1.86E-02	4.95E-02	1.84E-02	1.83E-03
Ru-106	9.13E-04	3.89E-03	1.31E-02	2.43E-02	9.02E-04	3.85E-03	1.30E-02	2.41E-02
Te-129m	6.02E-04	1.46E-03	3.56E-04	2.05E-05	5.99E-04	1.45E-03	3.56E-04	2.05E-05
Te-132	3.84E-03	2.92E-05	1.49E-17	3.13E-34	3.85E-03	2.93E-05	1.49E-17	3.15E-34
I-131	4.72E-01	1.60E-01	4.03E-06	1.25E-12	4.72E-01	1.60E-01	4.03E-06	1.25E-12
I-132	1.98E-01	1.50E-03	7.66E-16	1.61E-32	1.98E-01	1.51E-03	7.69E-16	1.62E-32
Cs-134	4.44E-04	1.94E-03	7.51E-03	1.65E-02	3.59E-04	1.57E-03	6.08E-03	1.34E-02
Cs-137	5.42E-04	2.43E-03	1.06E-02	2.73E-02	5.40E-04	2.43E-03	1.06E-02	2.73E-02
Ba-140	2.73E-02	2.41E-02	5.23E-05	5.86E-09	2.73E-02	2.41E-02	5.24E-05	5.87E-09
La-140	3.14E-02	2.77E-02	6.02E-05	6.74E-09	3.14E-02	2.77E-02	6.03E-05	6.76E-09
Ce-141	3.50E-02	8.32E-02	1.84E-02	9.32E-04	3.50E-02	8.33E-02	1.85E-02	9.34E-04
Ce-144	1.46E-02	6.12E-02	1.91E-01	3.19E-01	1.46E-02	6.12E-02	1.91E-01	3.19E-01
Pr-143	2.87E-02	2.80E-02	9.62E-05	1.98E-08	2.88E-02	2.81E-02	9.67E-05	1.99E-08
Pr-144	1.46E-02	6.12E-02	1.91E-01	3.19E-01	1.46E-02	6.12E-02	1.91E-01	3.19E-01
Nd-147	8.67E-03	5.87E-03	3.74E-06	8.28E-11	8.76E-03	5.94E-03	3.79E-06	8.38E-11
Pm-147	1.54E-03	7.15E-03	2.87E-02	6.55E-02	1.62E-03	7.52E-03	3.02E-02	6.89E-02
Eu-154	1.37E-05	6.11E-05	2.60E-04	6.53E-04	1.09E-05	4.89E-05	2.08E-04	5.23E-04
Eu-155	7.37E-06	3.28E-05	1.36E-04	3.30E-04	6.65E-06	2.96E-05	1.23E-04	2.98E-04

Table 2-4. Normalized intake fractions for the reduced list of dosimetrically important radionuclides.

	Mk V-B base				Mk 16 base				Mk 16 A1			
Radionuclide	**10 d**	**40 d**	**180 d**	**1 y**	**10 d**	**40 d**	**180 d**	**1 y**	**10 d**	**40 d**	**180 d**	**1 y**
Sr-89	2.05E-02	7.79E-02	8.05E-02	2.43E-02	4.11E-02	9.53E-02	6.37E-02	1.50E-02	3.94E-02	9.81E-02	7.12E-02	1.84E-02
Sr-90	1.88E-04	1.07E-03	7.49E-03	2.82E-02	9.69E-04	3.38E-03	1.53E-02	4.48E-02	6.68E-04	2.50E-03	1.23E-02	3.97E-02
Y-91	2.37E-02	9.51E-02	1.28E-01	5.44E-02	5.10E-02	1.25E-01	1.08E-01	3.60E-02	4.77E-02	1.26E-01	1.18E-01	4.33E-02
Zr-95	2.59E-02	1.07E-01	1.66E-01	8.54E-02	5.64E-02	1.43E-01	1.43E-01	5.73E-02	5.19E-02	1.41E-01	1.53E-01	6.77E-02
Nb-95	1.32E-02	9.77E-02	3.04E-01	1.82E-01	5.80E-02	1.86E-01	2.78E-01	1.23E-01	4.80E-02	1.73E-01	2.95E-01	1.45E-01
Ru-103	2.08E-02	7.01E-02	4.17E-02	6.07E-03	2.68E-02	5.52E-02	2.12E-02	2.41E-03	2.62E-02	5.78E-02	2.42E-02	3.02E-03
Ru-106	9.19E-04	4.98E-03	2.70E-02	7.30E-02	1.68E-03	5.55E-03	1.95E-02	4.10E-02	1.18E-03	4.20E-03	1.60E-02	3.71E-02
I-131	8.12E-01	3.50E-01	1.41E-05	6.39E-12	6.47E-01	1.70E-01	4.44E-06	1.57E-12	6.73E-01	1.90E-01	5.39E-06	2.09E-12
Cs-134	1.94E-05	1.08E-04	6.71E-04	2.16E-03	9.08E-04	3.09E-03	1.24E-02	3.10E-02	3.78E-04	1.38E-03	6.00E-03	1.66E-02
Cs-137	2.11E-04	1.21E-03	8.43E-03	3.18E-02	9.85E-04	3.44E-03	1.55E-02	4.56E-02	6.77E-04	2.54E-03	1.24E-02	4.03E-02
Ce-141	3.46E-02	1.05E-01	3.73E-02	2.75E-03	4.87E-02	8.98E-02	2.07E-02	1.19E-03	4.92E-02	9.74E-02	2.43E-02	1.54E-03
Ce-144	6.34E-03	3.38E-02	1.69E-01	4.12E-01	2.49E-02	8.09E-02	2.62E-01	4.97E-01	1.87E-02	6.54E-02	2.30E-01	4.80E-01
Pr-143	4.13E-02	5.12E-02	2.83E-04	8.50E-08	3.91E-02	2.95E-02	1.05E-04	2.47E-08	4.09E-02	3.32E-02	1.29E-04	3.32E-08
Pm-147	6.62E-04	4.45E-03	2.92E-02	9.74E-02	2.73E-03	9.71E-03	4.03E-02	1.05E-01	2.12E-03	8.23E-03	3.72E-02	1.06E-01

	Mk VI-B base				Mk VI-B A1			
Radionuclide	**10 d**	**40 d**	**180 d**	**1 y**	**10 d**	**40 d**	**180 d**	**1 y**
Sr-89	4.03E-02	9.77E-02	6.91E-02	1.74E-02	4.03E-02	9.77E-02	6.91E-02	1.74E-02
Sr-90	7.52E-04	2.75E-03	1.31E-02	4.13E-02	7.51E-04	2.74E-03	1.31E-02	4.13E-02
Y-91	4.91E-02	1.26E-01	1.16E-01	4.12E-02	4.91E-02	1.26E-01	1.16E-01	4.12E-02
Zr-95	5.37E-02	1.42E-01	1.50E-01	6.46E-02	5.36E-02	1.42E-01	1.50E-01	6.47E-02
Nb-95	5.16E-02	1.78E-01	2.91E-01	1.39E-01	5.15E-02	1.78E-01	2.91E-01	1.39E-01
Ru-103	2.63E-02	5.66E-02	2.31E-02	2.80E-03	2.62E-02	5.65E-02	2.30E-02	2.80E-03
Ru-106	1.28E-03	4.44E-03	1.65E-02	3.72E-02	1.27E-03	4.39E-03	1.63E-02	3.68E-02
I-131	6.63E-01	1.83E-01	5.05E-06	1.91E-12	6.63E-01	1.83E-01	5.06E-06	1.91E-12
Cs-134	6.24E-04	2.22E-03	9.42E-03	2.53E-02	5.05E-04	1.80E-03	7.63E-03	2.05E-02
Cs-137	7.61E-04	2.78E-03	1.33E-02	4.19E-02	7.59E-04	2.77E-03	1.33E-02	4.18E-02
Ce-141	4.92E-02	9.50E-02	2.31E-02	1.43E-03	4.93E-02	9.51E-02	2.32E-02	1.43E-03
Ce-144	2.06E-02	6.99E-02	2.40E-01	4.87E-01	2.05E-02	6.98E-02	2.40E-01	4.87E-01
Pr-143	4.04E-02	3.19E-02	1.21E-04	3.03E-08	4.05E-02	3.21E-02	1.21E-04	3.04E-08
Pm-147	2.16E-03	8.17E-03	3.59E-02	1.00E-01	2.28E-03	8.59E-03	3.78E-02	1.05E-01

Table 2-5. Associated radionuclide activity fractions for assigning intakes relative to ^{90}Sr or ^{137}Cs.

Table 2-5 values: Mark V-B									
	Intake relative to Sr-90					Intake relative to Cs-137			
Nuclide	10 d	40 d	180 d	1 y	Nuclide	10 d	40 d	180 d	1 y
Sr-89	1.09E+02	7.26E+01	1.07E+01	8.61E-01	Sr-89	9.72E+01	6.45E+01	9.55E+00	7.64E-01
Sr-90	1.00E+00	1.00E+00	1.00E+00	1.00E+00	Sr-90	8.89E-01	8.89E-01	8.88E-01	8.88E-01
Y-91	1.26E+02	8.86E+01	1.70E+01	1.93E+00	Y-91	1.12E+02	7.88E+01	1.51E+01	1.71E+00
Zr-95	1.38E+02	9.98E+01	2.21E+01	3.02E+00	Zr-95	1.23E+02	8.88E+01	1.97E+01	2.69E+00
Nb-95	7.05E+01	9.10E+01	4.06E+01	6.45E+00	Nb-95	6.27E+01	8.09E+01	3.61E+01	5.73E+00
Ru-103	1.11E+02	6.53E+01	5.57E+00	2.15E-01	Ru-103	9.84E+01	5.81E+01	4.95E+00	1.91E-01
Ru-106	4.90E+00	4.64E+00	3.61E+00	2.59E+00	Ru-106	4.35E+00	4.12E+00	3.20E+00	2.30E+00
I-131	4.33E+03	3.27E+02	1.89E-03	2.26E-10	I-131	3.85E+03	2.90E+02	1.68E-03	2.01E-10
Cs-134	1.04E-01	1.01E-01	8.96E-02	7.65E-02	Cs-134	9.21E-02	8.98E-02	7.96E-02	6.79E-02
Cs-137	1.12E+00	1.12E+00	1.13E+00	1.13E+00	Cs-137	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Ce-141	1.85E+02	9.76E+01	4.97E+00	9.74E-02	Ce-141	1.64E+02	8.67E+01	4.42E+00	8.65E-02
Ce-144	3.38E+01	3.15E+01	2.26E+01	1.46E+01	Ce-144	3.01E+01	2.80E+01	2.01E+01	1.30E+01
Pr-143	2.20E+02	4.77E+01	3.78E-02	3.01E-06	Pr-143	1.96E+02	4.24E+01	3.36E-02	2.67E-06
Pm-147	3.53E+00	4.15E+00	3.90E+00	3.45E+00	Pm-147	3.14E+00	3.69E+00	3.46E+00	3.06E+00

Table 2-5 values: Mark 16 1									
	Intake relative to Sr-90					Intake relative to Cs-137			
Nuclide	10 d	40 d	180 d	1 y	Nuclide	10 d	40 d	180 d	1 y
Sr-89	4.25E+01	2.82E+01	4.17E+00	3.34E-01	Sr-89	4.18E+01	2.77E+01	4.11E+00	3.29E-01
Sr-90	1.00E+00	1.00E+00	1.00E+00	1.00E+00	Sr-90	9.84E-01	9.84E-01	9.83E-01	9.83E-01
Y-91	5.26E+01	3.70E+01	7.11E+00	8.04E-01	Y-91	5.18E+01	3.64E+01	6.99E+00	7.90E-01
Zr-95	5.82E+01	4.22E+01	9.35E+00	1.28E+00	Zr-95	5.73E+01	4.15E+01	9.20E+00	1.26E+00
Nb-95	5.99E+01	5.51E+01	1.82E+01	2.75E+00	Nb-95	5.89E+01	5.42E+01	1.79E+01	2.70E+00
Ru-103	2.77E+01	1.63E+01	1.39E+00	5.37E-02	Ru-103	2.72E+01	1.61E+01	1.37E+00	5.28E-02
Ru-106	1.73E+00	1.64E+00	1.28E+00	9.15E-01	Ru-106	1.70E+00	1.62E+00	1.26E+00	8.99E-01
I-131	6.67E+02	5.04E+01	2.91E-04	3.49E-11	I-131	6.57E+02	4.96E+01	2.86E-04	3.43E-11
Cs-134	9.37E-01	9.13E-01	8.10E-01	6.92E-01	Cs-134	9.22E-01	8.99E-01	7.97E-01	6.80E-01
Cs-137	1.02E+00	1.02E+00	1.02E+00	1.02E+00	Cs-137	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Ce-141	5.03E+01	2.66E+01	1.35E+00	2.65E-02	Ce-141	4.95E+01	2.61E+01	1.33E+00	2.61E-02
Ce-144	2.57E+01	2.39E+01	1.72E+01	1.11E+01	Ce-144	2.53E+01	2.36E+01	1.69E+01	1.09E+01
Pr-143	4.03E+01	8.74E+00	6.91E-03	5.51E-07	Pr-143	3.97E+01	8.60E+00	6.80E-03	5.41E-07
Pm-147	2.81E+00	2.87E+00	2.64E+00	2.34E+00	Pm-147	2.77E+00	2.83E+00	2.60E+00	2.30E+00

Table 2-5 values: Mark 16 2									
	Intake relative to Sr-90					Intake relative to Cs-137			
Nuclide	10 d	40 d	180 d	1 y	Nuclide	10 d	40 d	180 d	1 y
Sr-89	5.90E+01	3.92E+01	5.80E+00	4.64E-01	Sr-89	5.82E+01	3.87E+01	5.72E+00	4.58E-01
Sr-90	1.00E+00	1.00E+00	1.00E+00	1.00E+00	Sr-90	9.87E-01	9.87E-01	9.87E-01	9.86E-01
Y-91	7.13E+01	5.01E+01	9.63E+00	1.09E+00	Y-91	7.04E+01	4.95E+01	9.51E+00	1.07E+00
Zr-95	7.77E+01	5.62E+01	1.25E+01	1.70E+00	Zr-95	7.67E+01	5.55E+01	1.23E+01	1.68E+00
Nb-95	7.18E+01	6.90E+01	2.40E+01	3.66E+00	Nb-95	7.08E+01	6.81E+01	2.37E+01	3.61E+00
Ru-103	3.91E+01	2.31E+01	1.97E+00	7.60E-02	Ru-103	3.86E+01	2.28E+01	1.94E+00	7.50E-02
Ru-106	1.77E+00	1.68E+00	1.30E+00	9.34E-01	Ru-106	1.75E+00	1.66E+00	1.29E+00	9.21E-01
I-131	1.01E+03	7.60E+01	4.39E-04	5.27E-11	I-131	9.94E+02	7.50E+01	4.34E-04	5.19E-11
Cs-134	5.65E-01	5.51E-01	4.89E-01	4.17E-01	Cs-134	5.58E-01	5.44E-01	4.82E-01	4.12E-01
Cs-137	1.01E+00	1.01E+00	1.01E+00	1.01E+00	Cs-137	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Ce-141	7.36E+01	3.89E+01	1.98E+00	3.88E-02	Ce-141	7.26E+01	3.84E+01	1.96E+00	3.83E-02
Ce-144	2.80E+01	2.61E+01	1.87E+01	1.21E+01	Ce-144	2.77E+01	2.58E+01	1.85E+01	1.19E+01
Pr-143	6.12E+01	1.33E+01	1.05E-02	8.36E-07	Pr-143	6.04E+01	1.31E+01	1.04E-02	8.24E-07
Pm-147	3.17E+00	3.29E+00	3.03E+00	2.68E+00	Pm-147	3.13E+00	3.24E+00	2.99E+00	2.64E+00

Table 2-5 values: Mark VI-B 1									
	Intake relative to Sr-90					Intake relative to Cs-137			
Nuclide	10 d	40 d	180 d	1 y	Nuclide	10 d	40 d	180 d	1 y
Sr-89	5.36E+01	3.56E+01	5.27E+00	4.22E-01	Sr-89	5.30E+01	3.52E+01	5.20E+00	4.16E-01
Sr-90	1.00E+00	1.00E+00	1.00E+00	1.00E+00	Sr-90	9.89E-01	9.88E-01	9.88E-01	9.87E-01
Y-91	6.53E+01	4.59E+01	8.81E+00	9.97E-01	Y-91	6.45E+01	4.53E+01	8.71E+00	9.84E-01
Zr-95	7.14E+01	5.17E+01	1.15E+01	1.56E+00	Zr-95	7.05E+01	5.11E+01	1.13E+01	1.54E+00
Nb-95	6.85E+01	6.48E+01	2.21E+01	3.37E+00	Nb-95	6.77E+01	6.41E+01	2.19E+01	3.32E+00
Ru-103	3.49E+01	2.06E+01	1.76E+00	6.79E-02	Ru-103	3.45E+01	2.04E+01	1.74E+00	6.70E-02
Ru-106	1.71E+00	1.62E+00	1.26E+00	9.01E-01	Ru-106	1.69E+00	1.60E+00	1.24E+00	8.89E-01
I-131	8.82E+02	6.66E+01	3.85E-04	4.61E-11	I-131	8.72E+02	6.58E+01	3.80E-04	4.55E-11
Cs-134	8.30E-01	8.09E-01	7.18E-01	6.13E-01	Cs-134	8.20E-01	7.99E-01	7.09E-01	6.05E-01
Cs-137	1.01E+00	1.01E+00	1.01E+00	1.01E+00	Cs-137	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Ce-141	6.55E+01	3.46E+01	1.76E+00	3.45E-02	Ce-141	6.47E+01	3.42E+01	1.74E+00	3.41E-02
Ce-144	2.73E+01	2.54E+01	1.83E+01	1.18E+01	Ce-144	2.70E+01	2.52E+01	1.81E+01	1.16E+01
Pr-143	5.36E+01	1.16E+01	9.20E-03	7.33E-07	Pr-143	5.30E+01	1.15E+01	9.09E-03	7.24E-07
Pm-147	2.88E+00	2.97E+00	2.74E+00	2.43E+00	Pm-147	2.84E+00	2.94E+00	2.71E+00	2.39E+00

Table 2-5 values: Mark VI-B 2									
	Intake relative to Sr-90					Intake relative to Cs-137			
Nuclide	10 d	40 d	180 d	1 y	Nuclide	10 d	40 d	180 d	1 y
Sr-89	5.36E+01	3.56E+01	5.27E+00	4.22E-01	Sr-89	5.30E+01	3.52E+01	5.21E+00	4.17E-01
Sr-90	1.00E+00	1.00E+00	1.00E+00	1.00E+00	Sr-90	9.89E-01	9.89E-01	9.89E-01	9.88E-01
Y-91	6.53E+01	4.59E+01	8.82E+00	9.98E-01	Y-91	6.46E+01	4.54E+01	8.72E+00	9.86E-01
Zr-95	7.14E+01	5.17E+01	1.15E+01	1.57E+00	Zr-95	7.06E+01	5.11E+01	1.13E+01	1.55E+00
Nb-95	6.85E+01	6.48E+01	2.21E+01	3.37E+00	Nb-95	6.78E+01	6.41E+01	2.19E+01	3.33E+00
Ru-103	3.49E+01	2.06E+01	1.75E+00	6.78E-02	Ru-103	3.45E+01	2.04E+01	1.73E+00	6.69E-02
Ru-106	1.69E+00	1.60E+00	1.24E+00	8.92E-01	Ru-106	1.67E+00	1.58E+00	1.23E+00	8.81E-01
I-131	8.83E+02	6.66E+01	3.85E-04	4.62E-11	I-131	8.74E+02	6.59E+01	3.81E-04	4.56E-11
Cs-134	6.72E-01	6.55E-01	5.81E-01	4.97E-01	Cs-134	6.65E-01	6.48E-01	5.75E-01	4.91E-01
Cs-137	1.01E+00	1.01E+00	1.01E+00	1.01E+00	Cs-137	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Ce-141	6.56E+01	3.46E+01	1.77E+00	3.46E-02	Ce-141	6.49E+01	3.43E+01	1.75E+00	3.42E-02
Ce-144	2.73E+01	2.54E+01	1.83E+01	1.18E+01	Ce-144	2.70E+01	2.52E+01	1.81E+01	1.17E+01
Pr-143	5.39E+01	1.17E+01	9.24E-03	7.37E-07	Pr-143	5.33E+01	1.16E+01	9.14E-03	7.28E-07
Pm-147	3.03E+00	3.13E+00	2.88E+00	2.55E+00	Pm-147	3.00E+00	3.10E+00	2.85E+00	2.52E+00

Table 2-6. Urine activity fractions for raw urine samples.

	Fraction of beta activity in urine: Mk V-B				Fraction of beta activity in urine: Mk 16 1				Fraction of beta activity in urine: Mk 16 2			
Nuclide	10 d	40 d	180 d	1 y	10 d	40 d	180 d	1 y	10 d	40 d	180 d	1 y
Sr-90	1.28E-02	2.05E-02	9.46E-02	2.12E-01	3.19E-02	4.62E-02	1.36E-01	2.10E-01	2.43E-02	3.62E-02	1.28E-01	2.24E-01
	Fraction of gamma activity in urine: Mk V-B				Fraction of gamma activity in urine: Mk 16 1				Fraction of gamma activity in urine: Mk 16 2			
Nuclide	10 d	40 d	180 d	1 y	10 d	40 d	180 d	1 y	10 d	40 d	180 d	1 y
Cs-137	9.02E-02	2.37E-01	6.81E-01	8.27E-01	1.87E-01	2.62E-01	3.51E-01	4.00E-01	1.77E-01	2.94E-01	4.54E-01	5.21E-01

	Fraction of beta activity in urine: Mk VI-B 1				Fraction of beta activity in urine: Mk VI-B 2			
Nuclide	10 d	40 d	180 d	1 y	10 d	40 d	180 d	1 y
Sr-90	2.62E-02	3.87E-02	1.28E-01	2.12E-01	2.64E-02	3.90E-02	1.31E-01	2.20E-01
	Fraction of gamma activity in urine: Mk VI-B 1				Fraction of gamma activity in urine: Mk VI-B 2			
Nuclide	10 d	40 d	180 d	1 y	10 d	40 d	180 d	1 y
Cs-137	1.72E-01	2.61E-01	3.73E-01	4.28E-01	1.82E-01	2.85E-01	4.19E-01	4.78E-01

Table 2-7. Urine activity fractions for urine samples after major chemical processing.

	Fraction of beta activity in urine: Mk V-B				Fraction of beta activity in urine: Mk 16 1				Fraction of beta activity in urine: Mk 16 2			
Nuclide	10 d	40 d	180 d	1 y	10 d	40 d	180 d	1 y	10 d	40 d	180 d	1 y
Sr-90	1.40E-02	2.28E-02	1.26E-01	4.18E-01	3.69E-02	5.60E-02	2.32E-01	5.10E-01	2.70E-02	4.15E-02	1.92E-01	4.83E-01

	Fraction of beta activity in urine: Mk VI-B 1				Fraction of beta activity in urine: Mk VI-B 2			
Nuclide	10 d	40 d	180 d	1 y	10 d	40 d	180 d	1 y
Sr-90	2.96E-02	4.54E-02	2.04E-01	4.92E-01	2.96E-02	4.53E-02	2.04E-01	4.92E-01

Table 2-8. Activity ratios for use if gross beta or gross gamma results are reported for air samples and workplace measurements.

	Fraction of beta activity on air sample: Mk V-B				Fraction of beta activity on air sample: Mk 16 1				Fraction of beta activity on air sample: Mk 16 2			
Nuclide	**10 d**	**40 d**	**180 d**	**1 y**	**10 d**	**40 d**	**180 d**	**1 y**	**10 d**	**40 d**	**180 d**	**1 y**
Sr-90	6.24E-04	1.46E-03	7.02E-03	1.63E-02	2.15E-03	3.86E-03	1.19E-02	2.30E-02	1.57E-03	2.97E-03	1.03E-02	2.11E-02
	Fraction of gamma activity on air sample: Mk V-B				**Fraction of gamma activity on air sample: Mk 16 1**				**Fraction of gamma activity on air sample: Mk 16 2**			
Nuclide	**10 d**	**40 d**	**180 d**	**1 y**	**10 d**	**40 d**	**180 d**	**1 y**	**10 d**	**40 d**	**180 d**	**1 y**
Cs-137	9.22E-04	2.37E-03	1.33E-02	7.18E-02	3.05E-03	5.91E-03	2.58E-02	1.06E-01	2.20E-03	4.43E-03	2.04E-02	9.54E-02

	Fraction of beta activity on air sample: Mk VI-B 1				Fraction of beta activity on air sample: Mk VI-B 2			
Nuclide	**10 d**	**40 d**	**180 d**	**1 y**	**10 d**	**40 d**	**180 d**	**1 y**
Sr-90	1.73E-03	3.22E-03	1.08E-02	2.17E-02	1.73E-03	3.22E-03	1.08E-02	2.17E-02
	Fraction of gamma activity on air sample: Mk VI-B 1				**Fraction of gamma activity on air sample: Mk VI-B 2**			
Nuclide	**10 d**	**40 d**	**180 d**	**1 y**	**10 d**	**40 d**	**180 d**	**1 y**
Cs-137	2.42E-03	4.82E-03	2.17E-02	9.59E-02	2.42E-03	4.82E-03	2.19E-02	9.86E-02

Table 2-9. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross beta urinalysis, minimally processed samples at 10 days decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	FFTF 2 soluble	1.27E-04	Mk V-B soluble	5.64E-05	-55.67%
Urinary bladder	FFTF 2 soluble	2.65E-04	Mk V-B soluble	2.58E-04	-2.71%
Brain	FFTF 2 soluble	1.27E-04	Mk V-B soluble	7.29E-05	-42.79%
Breast	FFTF 2 soluble	1.02E-04	Mk V-B soluble	4.01E-05	-60.81%
Gall bladder	FFTF 2 soluble	1.12E-04	Mk V-B soluble	4.27E-05	-62.03%
Heart wall	FFTF 2 soluble	1.18E-04	Mk V-B soluble	5.15E-05	-56.49%
Kidneys	FFTF 2 soluble	1.17E-04	Mk V-B soluble	4.96E-05	-57.64%
Liver	FFTF 2 soluble	8.81E-04	Mk 16 1 soluble	5.74E-04	-34.84%
Muscle	FFTF 2 soluble	1.24E-04	Mk V-B soluble	6.58E-05	-46.92%
Ovaries	FFTF 2 soluble	1.25E-04	Mk V-B soluble	5.40E-05	-56.64%
Pancreas	FFTF 2 soluble	1.17E-04	Mk V-B soluble	4.72E-05	-59.49%
Testes	FFTF 2 soluble	9.64E-05	Mk V-B soluble	3.19E-05	-66.90%
Thyroid	ATR 2 soluble	1.23E-01	Mk V-B soluble	1.29E-01	5.12%
Red bone marrow	FFTF 2 soluble	4.31E-04	Mk 16 1 soluble	3.32E-04	-22.97%
Bone surface	FFTF 2 soluble	1.32E-03	Mk 16 1 soluble	1.10E-03	-16.54%
Stomach	FFTF 2 soluble	1.29E-04	Mk V-B soluble	6.58E-05	-49.11%
Small intestine	FFTF 2 soluble	1.77E-04	Mk V-B soluble	1.12E-04	-36.41%
Upper large intestine	FFTF 2 soluble	3.18E-04	Mk V-B soluble	2.01E-04	-36.67%
Lower large intestine	FFTF 2 insoluble	7.77E-04	Mk V-B insoluble	5.17E-04	-33.51%
Skin	FFTF 2 soluble	1.02E-04	Mk V-B soluble	4.23E-05	-58.51%
Spleen	FFTF 2 soluble	1.08E-04	Mk V-B soluble	4.06E-05	-62.24%
Thymus	FFTF 2 soluble	1.30E-04	Mk V-B soluble	7.27E-05	-43.86%
Uterus	FFTF 2 soluble	1.16E-04	Mk V-B soluble	4.83E-05	-58.21%
Extrathoracic airways	FFTF 2 insoluble	1.38E-03	Mk V-B insoluble	1.18E-03	-14.80%
Lung	FFTF 2 insoluble	4.88E-03	Mk 16 1 insoluble	2.50E-03	-48.71%
Colon	FFTF 2 insoluble	5.02E-04	Mk V-B insoluble	3.36E-04	-33.11%
Esophagus	FFTF 2 soluble	1.30E-04	Mk V-B soluble	7.27E-05	-43.86%
Gonads	FFTF 2 soluble	1.25E-04	Mk V-B soluble	5.40E-05	-56.64%

Table 2-10. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross beta urinalysis, minimally processed samples at 40 days decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	FFTF 2 soluble	1.33E-04	Mk 16 1 soluble	5.59E-05	-58.02%
Urinary bladder	FFTF 2 soluble	1.41E-04	Mk V-B soluble	6.53E-05	-53.76%
Brain	FFTF 2 soluble	1.15E-04	Mk V-B soluble	4.05E-05	-64.64%
Breast	FFTF 2 soluble	1.06E-04	Mk 16 1 soluble	3.30E-05	-69.01%
Gall bladder	FFTF 2 soluble	1.20E-04	Mk 16 1 soluble	4.10E-05	-65.74%
Heart wall	FFTF 2 soluble	1.20E-04	Mk 16 1 soluble	4.29E-05	-64.40%
Kidneys	FFTF 2 soluble	1.23E-04	Mk 16 1 soluble	4.63E-05	-62.43%
Liver	FFTF 2 soluble	1.04E-03	Mk 16 1 soluble	7.41E-04	-28.59%
Muscle	FFTF 2 soluble	1.15E-04	Mk 16 1 soluble	3.92E-05	-65.99%
Ovaries	FFTF 2 soluble	1.29E-04	Mk 16 1 soluble	5.12E-05	-60.45%
Pancreas	FFTF 2 soluble	1.23E-04	Mk 16 1 soluble	4.41E-05	-64.01%
Testes	FFTF 2 soluble	1.04E-04	Mk 16 1 soluble	2.89E-05	-72.29%
Thyroid	ATR 2 soluble	1.49E-02	Mk V-B soluble	1.57E-02	5.19%
Red bone marrow	FFTF 2 soluble	4.58E-04	Mk 16 1 soluble	3.78E-04	-17.45%
Bone surface	N Rx 2 soluble	1.38E-03	Mk 16 1 soluble	1.23E-03	-11.05%
Stomach	FFTF 2 soluble	1.25E-04	Mk 16 1 soluble	4.61E-05	-63.23%
Small intestine	FFTF 2 soluble	1.59E-04	Mk 16 1 soluble	7.34E-05	-53.72%
Upper large intestine	FFTF 2 soluble	3.25E-04	Mk 16 1 soluble	2.01E-04	-38.26%
Lower large intestine	FFTF 2 insoluble	7.98E-04	Mk 16 1 insoluble	5.24E-04	-34.37%
Skin	FFTF 2 soluble	1.04E-04	Mk 16 1 soluble	3.07E-05	-70.39%
Spleen	FFTF 2 soluble	1.14E-04	Mk 16 1 soluble	3.74E-05	-67.25%
Thymus	FFTF 2 soluble	1.16E-04	Mk 16 1 soluble	3.95E-05	-66.01%
Uterus	FFTF 2 soluble	1.19E-04	Mk 16 1 soluble	4.10E-05	-65.61%
Extrathoracic airways	FFTF 2 insoluble	1.04E-03	Mk V-B insoluble	7.30E-04	-30.06%
Lung	FFTF 2 insoluble	5.26E-03	Mk 16 1 insoluble	2.75E-03	-47.75%
Colon	FFTF 2 insoluble	5.12E-04	Mk 16 1 insoluble	3.35E-04	-34.47%
Esophagus	FFTF 2 soluble	1.16E-04	Mk 16 1 soluble	3.95E-05	-66.01%
Gonads	FFTF 2 soluble	1.29E-04	Mk 16 1 soluble	5.12E-05	-60.45%

Table 2-11. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross beta urinalysis, minimally processed samples at 180 days decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	FFTF 2 soluble	1.43E-04	Mk V-B soluble	8.12E-05	-43.01%
Urinary bladder	FFTF 2 soluble	1.47E-04	Mk V-B soluble	6.45E-05	-56.23%
Brain	FFTF 2 soluble	1.28E-04	Mk V-B soluble	6.04E-05	-52.97%
Breast	FFTF 2 soluble	1.26E-04	Mk V-B soluble	5.53E-05	-55.96%
Gall bladder	FFTF 2 soluble	1.38E-04	Mk V-B soluble	6.54E-05	-52.67%
Heart wall	FFTF 2 soluble	1.37E-04	Mk V-B soluble	6.72E-05	-50.79%
Kidneys	FFTF 2 soluble	1.37E-04	Mk V-B soluble	7.01E-05	-48.84%
Liver	N Rx 2 soluble	1.67E-03	Mk 16 2 soluble	1.53E-03	-8.40%
Muscle	FFTF 2 soluble	1.31E-04	Mk V-B soluble	6.07E-05	-53.59%
Ovaries	FFTF 2 soluble	1.40E-04	Mk V-B soluble	7.57E-05	-45.90%
Pancreas	FFTF 2 soluble	1.38E-04	Mk V-B soluble	6.79E-05	-50.95%
Testes	FFTF 2 soluble	1.26E-04	Mk V-B soluble	4.98E-05	-60.56%
Thyroid	FFTF 2 soluble	1.30E-04	Mk V-B soluble	5.90E-05	-54.76%
Red bone marrow	N Rx 2 soluble	6.32E-04	Mk 16 2 soluble	5.93E-04	-6.19%
Bone surface	TRIGA 2 soluble	1.81E-03	Mk V-B soluble	1.69E-03	-6.93%
Stomach	FFTF 2 soluble	1.42E-04	Mk V-B soluble	7.10E-05	-50.16%
Small intestine	FFTF 2 soluble	1.67E-04	Mk V-B soluble	1.05E-04	-37.41%
Upper large intestine	FFTF 2 soluble	3.31E-04	Mk V-B soluble	2.81E-04	-14.93%
Lower large intestine	FFTF 2 insoluble	7.93E-04	Mk V-B insoluble	7.26E-04	-8.34%
Skin	FFTF 2 soluble	1.23E-04	Mk V-B soluble	5.17E-05	-58.06%
Spleen	FFTF 2 soluble	1.33E-04	Mk V-B soluble	6.01E-05	-54.68%
Thymus	FFTF 2 soluble	1.32E-04	Mk V-B soluble	6.14E-05	-53.43%
Uterus	FFTF 2 soluble	1.35E-04	Mk V-B soluble	6.34E-05	-53.20%
Extrathoracic airways	TRIGA 2 insoluble	1.01E-03	Mk V-B insoluble	9.78E-04	-3.66%
Lung	FFTF 2 insoluble	5.74E-03	Mk V-B insoluble	4.44E-03	-22.72%
Colon	FFTF 2 insoluble	5.08E-04	Mk V-B insoluble	4.63E-04	-8.78%
Esophagus	FFTF 2 soluble	1.32E-04	Mk V-B soluble	6.14E-05	-53.43%
Gonads	FFTF 2 soluble	1.40E-04	Mk V-B soluble	7.57E-05	-45.90%

Table 2-12. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross beta urinalysis, minimally processed samples at 1 year decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	FFTF 2 soluble	1.20E-04	Mk V-B soluble	7.74E-05	-35.35%
Urinary bladder	FFTF 2 soluble	1.29E-04	Mk V-B soluble	7.35E-05	-42.86%
Brain	FFTF 2 soluble	1.10E-04	Mk V-B soluble	6.62E-05	-40.10%
Breast	FFTF 2 soluble	1.09E-04	Mk V-B soluble	6.48E-05	-40.62%
Gall bladder	FFTF 2 soluble	1.20E-04	Mk V-B soluble	7.37E-05	-38.54%
Heart wall	FFTF 2 soluble	1.17E-04	Mk V-B soluble	7.23E-05	-38.41%
Kidneys	FFTF 2 soluble	1.17E-04	Mk V-B soluble	7.24E-05	-38.06%
Liver	TRIGA 2 soluble	2.01E-03	Mk V-B soluble	1.97E-03	-1.83%
Muscle	FFTF 2 soluble	1.13E-04	Mk V-B soluble	6.76E-05	-40.13%
Ovaries	FFTF 2 soluble	1.18E-04	Mk V-B soluble	7.40E-05	-37.31%
Pancreas	FFTF 2 soluble	1.19E-04	Mk V-B soluble	7.30E-05	-38.79%
Testes	FFTF 2 soluble	1.11E-04	Mk V-B soluble	6.34E-05	-43.10%
Thyroid	FFTF 2 soluble	1.13E-04	Mk V-B soluble	6.68E-05	-40.92%
Red bone marrow	TRIGA 2 soluble	7.50E-04	Mk V-B soluble	7.17E-04	-4.45%
Bone surface	TRIGA 2 soluble	1.81E-03	Mk V-B soluble	1.73E-03	-4.69%
Stomach	FFTF 2 soluble	1.23E-04	Mk V-B soluble	7.99E-05	-34.90%
Small intestine	FFTF 2 soluble	1.40E-04	Mk V-B soluble	1.07E-04	-23.45%
Upper large intestine	N Rx 1 soluble	2.82E-04	Mk V-B soluble	2.91E-04	2.96%
Lower large intestine	N Rx 1 insoluble	7.32E-04	Mk V-B insoluble	7.54E-04	2.98%
Skin	FFTF 2 soluble	1.08E-04	Mk V-B soluble	6.27E-05	-41.79%
Spleen	FFTF 2 soluble	1.15E-04	Mk V-B soluble	6.84E-05	-40.58%
Thymus	FFTF 2 soluble	1.14E-04	Mk V-B soluble	6.86E-05	-39.86%
Uterus	FFTF 2 soluble	1.17E-04	Mk V-B soluble	6.98E-05	-40.38%
Extrathoracic airways	TRIGA 2 insoluble	8.95E-04	Mk V-B insoluble	8.97E-04	0.31%
Lung	N Rx 1 insoluble	5.03E-03	Mk V-B insoluble	5.28E-03	4.87%
Colon	N Rx 1 insoluble	4.66E-04	Mk V-B insoluble	4.79E-04	2.80%
Esophagus	FFTF 2 soluble	1.14E-04	Mk V-B soluble	6.86E-05	-39.86%
Gonads	FFTF 2 soluble	1.18E-04	Mk V-B soluble	7.40E-05	-37.31%

Table 2-13. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross beta urinalysis, significantly processed samples at 10 days decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	FFTF 1 soluble	2.83E-04	Mk 16 1 soluble	6.27E-05	-77.80%
Urinary bladder	FFTF 1 soluble	5.17E-04	Mk V-B soluble	2.81E-04	-45.60%
Brain	FFTF 1 soluble	2.75E-04	Mk V-B soluble	7.96E-05	-71.01%
Breast	FFTF 1 soluble	2.31E-04	Mk V-B soluble	4.38E-05	-81.04%
Gall bladder	FFTF 1 soluble	2.58E-04	Mk V-B soluble	4.67E-05	-81.94%
Heart wall	FFTF 1 soluble	2.66E-04	Mk V-B soluble	5.63E-05	-78.84%
Kidneys	FFTF 1 soluble	2.63E-04	Mk V-B soluble	5.42E-05	-79.41%
Liver	FFTF 1 soluble	1.95E-03	Mk 16 1 soluble	6.64E-04	-65.98%
Muscle	FFTF 1 soluble	2.71E-04	Mk V-B soluble	7.19E-05	-73.50%
Ovaries	FFTF 1 soluble	2.77E-04	Mk V-B soluble	5.90E-05	-78.70%
Pancreas	FFTF 1 soluble	2.65E-04	Mk V-B soluble	5.16E-05	-80.51%
Testes	FFTF 1 soluble	2.24E-04	Mk V-B soluble	3.48E-05	-84.43%
Thyroid	FFTF 2 soluble	1.66E-01	Mk V-B soluble	1.41E-01	-14.96%
Red bone marrow	FFTF 1 soluble	9.26E-04	Mk 16 1 soluble	3.84E-04	-58.54%
Bone surface	FFTF 1 soluble	2.64E-03	Mk 16 1 soluble	1.27E-03	-51.90%
Stomach	FFTF 1 soluble	2.85E-04	Mk V-B soluble	7.18E-05	-74.83%
Small intestine	FFTF 1 soluble	3.74E-04	Mk V-B soluble	1.23E-04	-67.23%
Upper large intestine	FFTF 1 soluble	6.69E-04	Mk 16 1 soluble	2.27E-04	-66.10%
Lower large intestine	FFTF 1 insoluble	1.61E-03	Mk 16 1 Insoluble	5.88E-04	-63.44%
Skin	FFTF 1 soluble	2.29E-04	Mk V-B soluble	4.62E-05	-79.82%
Spleen	FFTF 1 soluble	2.46E-04	Mk V-B soluble	4.44E-05	-81.95%
Thymus	FFTF 1 soluble	2.82E-04	Mk V-B soluble	7.94E-05	-71.82%
Uterus	FFTF 1 soluble	2.61E-04	Mk V-B soluble	5.27E-05	-79.83%
Extrathoracic airways	FFTF 1 insoluble	2.64E-03	Mk V-B insoluble	1.28E-03	-51.31%
Lung	FFTF 1 insoluble	1.03E-02	Mk 16 1 insoluble	2.89E-03	-71.96%
Colon	FFTF 1 insoluble	1.04E-03	Mk 16 1 insoluble	3.79E-04	-63.68%
Esophagus	FFTF 1 soluble	2.82E-04	Mk V-B soluble	7.94E-05	-71.82%
Gonads	FFTF 1 soluble	2.77E-04	Mk V-B soluble	5.90E-05	-78.70%

Table 2-14. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross beta urinalysis, significantly processed samples at 40 days decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	FFTF 1 soluble	3.48E-04	Mk 16 1 soluble	6.78E-05	-80.50%
Urinary bladder	FFTF 1 soluble	3.67E-04	Mk V-B soluble	7.26E-05	-80.19%
Brain	FFTF 1 soluble	3.01E-04	Mk 16 1 soluble	4.84E-05	-83.90%
Breast	FFTF 1 soluble	2.83E-04	Mk 16 1 soluble	4.00E-05	-85.89%
Gall bladder	FFTF 1 soluble	3.23E-04	Mk 16 1 soluble	4.97E-05	-84.61%
Heart wall	FFTF 1 soluble	3.21E-04	Mk 16 1 soluble	5.20E-05	-83.80%
Kidneys	FFTF 1 soluble	3.25E-04	Mk 16 1 soluble	5.61E-05	-82.76%
Liver	FFTF 1 soluble	2.61E-03	Mk 16 1 soluble	8.99E-04	-65.54%
Muscle	FFTF 1 soluble	3.05E-04	Mk 16 1 soluble	4.75E-05	-84.43%
Ovaries	FFTF 1 soluble	3.39E-04	Mk 16 1 soluble	6.21E-05	-81.68%
Pancreas	FFTF 1 soluble	3.27E-04	Mk 16 1 soluble	5.34E-05	-83.68%
Testes	FFTF 1 soluble	2.83E-04	Mk 16 1 soluble	3.50E-05	-87.63%
Thyroid	FFTF 2 soluble	1.94E-02	Mk V-B soluble	1.74E-02	-10.19%
Red bone marrow	FFTF 1 soluble	1.15E-03	Mk 16 1 soluble	4.58E-04	-60.08%
Bone surface	FFTF 1 soluble	3.17E-03	Mk 16 1 soluble	1.49E-03	-53.09%
Stomach	FFTF 1 soluble	3.32E-04	Mk 16 1 soluble	5.59E-05	-83.16%
Small intestine	FFTF 1 soluble	4.07E-04	Mk 16 1 soluble	8.90E-05	-78.14%
Upper large intestine	FFTF 1 soluble	8.00E-04	Mk 16 1 soluble	2.44E-04	-69.56%
Lower large intestine	FFTF 1 insoluble	1.92E-03	Mk 16 1 insoluble	6.35E-04	-66.94%
Skin	FFTF 1 soluble	2.76E-04	Mk 16 1 soluble	3.73E-05	-86.52%
Spleen	FFTF 1 soluble	3.06E-04	Mk 16 1 soluble	4.53E-05	-85.21%
Thymus	FFTF 1 soluble	3.09E-04	Mk 16 1 soluble	4.79E-05	-84.49%
Uterus	FFTF 1 soluble	3.19E-04	Mk 16 1 soluble	4.97E-05	-84.43%
Extrathoracic airways	FFTF 1 insoluble	2.40E-03	Mk 16 1 insoluble	8.81E-04	-63.32%
Lung	FFTF 1 insoluble	1.28E-02	Mk 16 1 insoluble	3.33E-03	-74.05%
Colon	FFTF 1 insoluble	1.24E-03	Mk 16 1 insoluble	4.07E-04	-67.19%
Esophagus	FFTF 1 soluble	3.09E-04	Mk 16 1 soluble	4.79E-05	-84.49%
Gonads	FFTF 1 soluble	3.39E-04	Mk 16 1 soluble	6.21E-05	-81.68%

Table 2-15. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross beta urinalysis, significantly processed samples at 180 days decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	FFTF 2 soluble	6.02E-04	Mk 16 1 soluble	1.12E-04	-81.34%
Urinary bladder	FFTF 2 soluble	6.23E-04	Mk 16 1 soluble	9.26E-05	-85.14%
Brain	FFTF 2 soluble	5.43E-04	Mk 16 1 soluble	8.51E-05	-84.32%
Breast	FFTF 2 soluble	5.31E-04	Mk 16 1 soluble	7.96E-05	-85.00%
Gall bladder	FFTF 2 soluble	5.84E-04	Mk 16 1 soluble	9.65E-05	-83.46%
Heart wall	FFTF 2 soluble	5.77E-04	Mk 16 1 soluble	9.71E-05	-83.17%
Kidneys	FFTF 2 soluble	5.79E-04	Mk 16 1 soluble	9.90E-05	-82.89%
Liver	FFTF 2 soluble	5.35E-03	Mk 16 1 soluble	2.54E-03	-52.61%
Muscle	FFTF 2 soluble	5.52E-04	Mk 16 1 soluble	8.70E-05	-84.25%
Ovaries	FFTF 2 soluble	5.91E-04	Mk 16 1 soluble	1.05E-04	-82.16%
Pancreas	FFTF 2 soluble	5.85E-04	Mk 16 1 soluble	9.85E-05	-83.17%
Testes	FFTF 2 soluble	5.34E-04	Mk 16 1 soluble	7.51E-05	-85.93%
Thyroid	FFTF 2 soluble	5.51E-04	Mk 16 1 soluble	8.54E-05	-84.49%
Red bone marrow	FFTF 2 soluble	2.00E-03	Mk 16 1 soluble	9.73E-04	-51.43%
Bone surface	FFTF 2 soluble	4.79E-03	Mk 16 1 soluble	2.56E-03	-46.58%
Stomach	FFTF 2 soluble	6.02E-04	Mk 16 1 soluble	1.04E-04	-82.68%
Small intestine	FFTF 2 soluble	7.06E-04	Mk 16 1 soluble	1.51E-04	-78.59%
Upper large intestine	FFTF 2 soluble	1.40E-03	Mk 16 1 soluble	4.17E-04	-70.18%
Lower large intestine	FFTF 2 insoluble	3.35E-03	Mk 16 1 insoluble	1.07E-03	-67.90%
Skin	FFTF 2 soluble	5.21E-04	Mk 16 1 soluble	7.45E-05	-85.70%
Spleen	FFTF 2 soluble	5.60E-04	Mk 16 1 soluble	8.79E-05	-84.30%
Thymus	FFTF 2 soluble	5.57E-04	Mk 16 1 soluble	8.90E-05	-84.02%
Uterus	FFTF 2 soluble	5.72E-04	Mk 16 1 soluble	9.25E-05	-83.84%
Extrathoracic airways	FFTF 2 insoluble	3.62E-03	Mk 16 1 insoluble	1.39E-03	-61.56%
Lung	FFTF 2 insoluble	2.42E-02	Mk 16 1 insoluble	6.83E-03	-71.85%
Colon	FFTF 2 insoluble	2.15E-03	Mk 16 1 insoluble	6.87E-04	-67.97%
Esophagus	FFTF 2 soluble	5.57E-04	Mk 16 1 soluble	8.90E-05	-84.02%
Gonads	FFTF 2 soluble	5.91E-04	Mk 16 1 soluble	1.05E-04	-82.16%

Table 2-16. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross beta urinalysis significantly processed samples at 1 year decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	FFTF 2 soluble	7.22E-04	Mk V-B soluble	1.52E-04	-78.89%
Urinary bladder	FFTF 2 soluble	7.76E-04	Mk V-B soluble	1.45E-04	-81.35%
Brain	FFTF 2 soluble	6.67E-04	Mk V-B soluble	1.30E-04	-80.44%
Breast	FFTF 2 soluble	6.58E-04	Mk V-B soluble	1.28E-04	-80.61%
Gall bladder	FFTF 2 soluble	7.24E-04	Mk V-B soluble	1.45E-04	-79.93%
Heart wall	FFTF 2 soluble	7.08E-04	Mk V-B soluble	1.42E-04	-79.89%
Kidneys	FFTF 2 soluble	7.05E-04	Mk V-B soluble	1.43E-04	-79.78%
Liver	FFTF 2 soluble	6.23E-03	Mk V-B soluble	3.88E-03	-37.71%
Muscle	FFTF 2 soluble	6.81E-04	Mk V-B soluble	1.33E-04	-80.45%
Ovaries	FFTF 2 soluble	7.12E-04	Mk V-B soluble	1.46E-04	-79.53%
Pancreas	FFTF 2 soluble	7.20E-04	Mk V-B soluble	1.44E-04	-80.02%
Testes	FFTF 2 soluble	6.72E-04	Mk V-B soluble	1.25E-04	-81.42%
Thyroid	FFTF 2 soluble	6.83E-04	Mk V-B soluble	1.32E-04	-80.71%
Red bone marrow	FFTF 2 soluble	2.42E-03	Mk V-B soluble	1.41E-03	-41.72%
Bone surface	FFTF 2 soluble	5.32E-03	Mk V-B soluble	3.40E-03	-35.95%
Stomach	FFTF 2 soluble	7.41E-04	Mk V-B soluble	1.57E-04	-78.74%
Small intestine	FFTF 2 soluble	8.45E-04	Mk V-B soluble	2.11E-04	-75.01%
Upper large intestine	FFTF 2 soluble	1.61E-03	Mk V-B soluble	5.73E-04	-64.49%
Lower large intestine	FFTF 2 insoluble	3.81E-03	Mk V-B insoluble	1.49E-03	-61.05%
Skin	FFTF 2 soluble	6.50E-04	Mk V-B soluble	1.23E-04	-80.99%
Spleen	FFTF 2 soluble	6.94E-04	Mk V-B soluble	1.35E-04	-80.60%
Thymus	FFTF 2 soluble	6.88E-04	Mk V-B soluble	1.35E-04	-80.36%
Uterus	FFTF 2 soluble	7.07E-04	Mk V-B soluble	1.38E-04	-80.54%
Extrathoracic airways	FFTF 2 insoluble	3.82E-03	Mk V-B insoluble	1.77E-03	-53.77%
Lung	FFTF 2 insoluble	2.82E-02	Mk V-B insoluble	1.04E-02	-63.11%
Colon	FFTF 2 insoluble	2.45E-03	Mk V-B insoluble	9.43E-04	-61.53%
Esophagus	FFTF 2 soluble	6.88E-04	Mk V-B soluble	1.35E-04	-80.36%
Gonads	FFTF 2 soluble	7.12E-04	Mk V-B soluble	1.46E-04	-79.53%

Table 2-17. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross gamma urinalysis, minimally processed samples at 10 days decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	TRIGA 2 soluble	2.97E-04	Mk V-B soluble	2.59E-04	-12.81%
Urinary bladder	ATR 2 soluble	9.68E-04	Mk V-B soluble	1.05E-03	8.76%
Brain	TRIGA 2 soluble	2.97E-04	Mk V-B soluble	2.98E-04	0.34%
Breast	TRIGA 2 soluble	1.84E-04	Mk V-B soluble	1.64E-04	-10.99%
Gall bladder	TRIGA 2 soluble	2.11E-04	Mk 16 2 soluble	1.78E-04	-15.68%
Heart wall	TRIGA 2 soluble	2.42E-04	Mk V-B soluble	2.11E-04	-12.89%
Kidneys	TRIGA 2 soluble	2.50E-04	Mk 16 2 soluble	2.07E-04	-16.95%
Liver	N Rx 2 soluble	2.73E-03	Mk 16 2 soluble	2.31E-03	-15.18%
Muscle	TRIGA 2 soluble	2.73E-04	Mk V-B soluble	2.69E-04	-1.45%
Ovaries	TRIGA 2 soluble	2.75E-04	Mk 16 2 soluble	2.29E-04	-16.85%
Pancreas	TRIGA 2 soluble	2.34E-04	Mk 16 2 soluble	1.96E-04	-16.39%
Testes	FFTF 2 soluble	1.61E-04	Mk V-B soluble	1.30E-04	-18.89%
Thyroid	ATR 2 soluble	4.91E-01	Mk V-B soluble	5.28E-01	7.64%
Red bone marrow	TRIGA 2 soluble	1.71E-03	Mk 16 2 soluble	1.46E-03	-14.35%
Bone surface	TRIGA 2 soluble	6.03E-03	Mk 16 2 soluble	4.99E-03	-17.19%
Stomach	TRIGA 2 soluble	2.90E-04	Mk V-B soluble	2.69E-04	-7.21%
Small intestine	TRIGA 2 soluble	4.95E-04	Mk V-B soluble	4.59E-04	-7.20%
Upper large intestine	TRIGA 2 soluble	1.09E-03	Mk 16 2 soluble	9.02E-04	-16.91%
Lower large intestine	TRIGA 2 insoluble	2.82E-03	Mk 16 2 insoluble	2.34E-03	-16.85%
Skin	N Rx 1 soluble	1.85E-04	Mk V-B soluble	1.73E-04	-6.60%
Spleen	TRIGA 2 soluble	1.97E-04	Mk V-B soluble	1.66E-04	-15.52%
Thymus	TRIGA 2 soluble	2.91E-04	Mk V-B soluble	2.97E-04	2.05%
Uterus	TRIGA 2 soluble	2.28E-04	Mk V-B soluble	1.97E-04	-13.37%
Extrathoracic airways	TRIGA 2 insoluble	5.18E-03	Mk V-B insoluble	4.81E-03	-7.26%
Lung	TRIGA 2 insoluble	1.31E-02	Mk 16 2 insoluble	1.11E-02	-14.78%
Colon	TRIGA 2 insoluble	1.82E-03	Mk 16 2 insoluble	1.51E-03	-16.94%
Esophagus	TRIGA 2 soluble	2.91E-04	Mk V-B soluble	2.97E-04	2.05%
Gonads	TRIGA 2 soluble	2.75E-04	Mk 16 2 soluble	2.29E-04	-16.85%

Table 2-18. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross gamma urinalysis, minimally processed samples at 40 days decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	TRIGA 2 Soluble	4.24E-04	Mk V-B Soluble	3.98E-04	-6.04%
Urinary bladder	TRIGA 2 Soluble	3.97E-04	Mk V-B Soluble	4.36E-04	10.06%
Brain	TRIGA 2 Soluble	2.98E-04	Mk V-B Soluble	2.71E-04	-9.07%
Breast	TRIGA 2 Soluble	2.34E-04	Mk V-B Soluble	2.03E-04	-12.90%
Gall bladder	TRIGA 2 Soluble	2.91E-04	Mk V-B Soluble	2.50E-04	-14.31%
Heart wall	TRIGA 2 Soluble	3.10E-04	Mk V-B Soluble	2.65E-04	-14.57%
Kidneys	TRIGA 2 Soluble	3.42E-04	Mk V-B Soluble	2.92E-04	-14.58%
Liver	TRIGA 2 Soluble	4.59E-03	Mk 16 2 Soluble	3.38E-03	-26.46%
Muscle	TRIGA 2 Soluble	2.87E-04	Mk V-B Soluble	2.58E-04	-10.02%
Ovaries	TRIGA 2 Soluble	3.82E-04	Mk V-B Soluble	3.24E-04	-15.23%
Pancreas	TRIGA 2 Soluble	3.20E-04	Mk V-B Soluble	2.74E-04	-14.43%
Testes	TRIGA 2 Soluble	1.96E-04	Mk V-B Soluble	1.76E-04	-9.94%
Thyroid	ATR 2 Soluble	9.19E-02	Mk V-B Soluble	1.05E-01	13.98%
Red bone marrow	TRIGA 2 Soluble	2.73E-03	Mk V-B Soluble	2.06E-03	-24.49%
Bone surface	TRIGA 2 Soluble	9.62E-03	Mk V-B Soluble	7.38E-03	-23.27%
Stomach	TRIGA 2 Soluble	3.35E-04	Mk V-B Soluble	2.95E-04	-11.83%
Small intestine	TRIGA 2 Soluble	5.55E-04	Mk V-B Soluble	4.84E-04	-12.94%
Upper large intestine	TRIGA 2 Soluble	1.53E-03	Mk V-B Soluble	1.27E-03	-16.90%
Lower large intestine	TRIGA 2 Insoluble	4.01E-03	Mk V-B Insoluble	3.35E-03	-16.58%
Skin	TRIGA 2 Soluble	2.18E-04	Mk V-B Soluble	1.95E-04	-10.25%
Spleen	TRIGA 2 Soluble	2.65E-04	Mk V-B Soluble	2.30E-04	-13.32%
Thymus	TRIGA 2 Soluble	2.87E-04	Mk V-B Soluble	2.59E-04	-9.71%
Uterus	TRIGA 2 Soluble	2.95E-04	Mk V-B Soluble	2.58E-04	-12.52%
Extrathoracic airways	TRIGA 2 Insoluble	5.75E-03	Mk V-B Insoluble	4.88E-03	-15.16%
Lung	TRIGA 2 Insoluble	1.99E-02	Mk V-B Insoluble	1.61E-02	-18.78%
Colon	TRIGA 2 Insoluble	2.57E-03	Mk V-B Insoluble	2.14E-03	-16.54%
Esophagus	TRIGA 2 Soluble	2.87E-04	Mk V-B Soluble	2.59E-04	-9.71%
Gonads	TRIGA 2 Soluble	3.82E-04	Mk V-B Soluble	3.24E-04	-15.23%

Table 2-19. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross gamma urinalysis, minimally processed samples at 180 days decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	TRIGA 2 soluble	3.01E-04	Mk V-B soluble	3.81E-04	26.92%
Urinary bladder	N Rx 1 soluble	2.33E-04	Mk V-B soluble	2.69E-04	15.60%
Brain	N Rx 1 soluble	2.17E-04	Mk V-B soluble	2.52E-04	15.87%
Breast	N Rx 1 soluble	2.02E-04	Mk V-B soluble	2.31E-04	14.27%
Gall bladder	TRIGA 2 soluble	2.40E-04	Mk V-B soluble	2.73E-04	13.86%
Heart wall	TRIGA 2 soluble	2.48E-04	Mk V-B soluble	2.80E-04	13.23%
Kidneys	TRIGA 2 soluble	2.55E-04	Mk V-B soluble	2.92E-04	14.53%
Liver	TRIGA 2 soluble	6.41E-03	Mk V-B soluble	5.79E-03	-9.54%
Muscle	N Rx 1 soluble	2.19E-04	Mk V-B soluble	2.53E-04	15.38%
Ovaries	TRIGA 2 soluble	2.76E-04	Mk V-B soluble	3.16E-04	14.48%
Pancreas	TRIGA 2 soluble	2.48E-04	Mk V-B soluble	2.83E-04	14.34%
Testes	N Rx 1 soluble	1.84E-04	Mk V-B soluble	2.08E-04	12.86%
Thyroid	N Rx 1 soluble	2.13E-04	Mk V-B soluble	2.46E-04	15.43%
Red bone marrow	TRIGA 2 soluble	2.54E-03	Mk V-B soluble	2.38E-03	-6.33%
Bone surface	TRIGA 2 soluble	7.32E-03	Mk V-B soluble	7.03E-03	-3.91%
Stomach	TRIGA 2 soluble	2.63E-04	Mk V-B soluble	2.96E-04	12.54%
Small intestine	TRIGA 2 soluble	4.02E-04	Mk V-B soluble	4.36E-04	8.58%
Upper large intestine	TRIGA 2 soluble	1.15E-03	Mk V-B soluble	1.17E-03	1.92%
Lower large intestine	TRIGA 2 insoluble	2.99E-03	Mk V-B insoluble	3.03E-03	1.17%
Skin	N Rx 1 soluble	1.90E-04	Mk V-B soluble	2.16E-04	13.81%
Spleen	N Rx 1 soluble	2.18E-04	Mk V-B soluble	2.50E-04	14.90%
Thymus	TRIGA 2 soluble	2.23E-04	Mk V-B soluble	2.56E-04	14.80%
Uterus	N Rx 1 soluble	2.29E-04	Mk V-B soluble	2.64E-04	15.65%
Extrathoracic airways	TRIGA 2 insoluble	4.10E-03	Mk V-B insoluble	4.08E-03	-0.53%
Lung	TRIGA 2 insoluble	1.83E-02	Mk V-B insoluble	1.85E-02	0.86%
Colon	TRIGA 2 insoluble	1.91E-03	Mk V-B insoluble	1.93E-03	1.15%
Esophagus	TRIGA 2 soluble	2.23E-04	Mk V-B soluble	2.56E-04	14.80%
Gonads	TRIGA 2 soluble	2.76E-04	Mk V-B soluble	3.16E-04	14.48%

Table 2-20. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross gamma urinalysis, minimally processed samples at 1 year decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	N Rx 1 soluble	1.53E-04	Mk V-B soluble	1.97E-04	28.91%
Urinary bladder	FFTF 2 soluble	1.51E-04	Mk V-B soluble	1.66E-04	9.86%
Brain	N Rx 1 soluble	1.31E-04	Mk V-B soluble	1.49E-04	13.88%
Breast	N Rx 1 soluble	1.29E-04	Mk V-B soluble	1.46E-04	13.44%
Gall bladder	N Rx 1 soluble	1.47E-04	Mk V-B soluble	1.66E-04	12.83%
Heart wall	N Rx 1 soluble	1.44E-04	Mk V-B soluble	1.63E-04	13.62%
Kidneys	N Rx 1 soluble	1.43E-04	Mk V-B soluble	1.63E-04	13.97%
Liver	TRIGA 2 soluble	4.71E-03	Mk V-B soluble	4.45E-03	-5.50%
Muscle	N Rx 1 soluble	1.34E-04	Mk V-B soluble	1.53E-04	13.61%
Ovaries	N Rx 1 soluble	1.46E-04	Mk V-B soluble	1.67E-04	14.53%
Pancreas	N Rx 1 soluble	1.45E-04	Mk V-B soluble	1.65E-04	13.47%
Testes	FFTF 2 soluble	1.31E-04	Mk V-B soluble	1.43E-04	9.39%
Thyroid	N Rx 1 soluble	1.33E-04	Mk V-B soluble	1.51E-04	13.40%
Red bone marrow	TRIGA 2 soluble	1.76E-03	Mk V-B soluble	1.62E-03	-8.02%
Bone surface	TRIGA 2 soluble	4.25E-03	Mk V-B soluble	3.90E-03	-8.26%
Stomach	N Rx 1 soluble	1.61E-04	Mk V-B soluble	1.80E-04	12.20%
Small intestine	N Rx 1 soluble	2.16E-04	Mk V-B soluble	2.42E-04	11.76%
Upper large intestine	TRIGA 2 soluble	6.43E-04	Mk V-B soluble	6.56E-04	2.05%
Lower large intestine	TRIGA 2 insoluble	1.69E-03	Mk V-B insoluble	1.70E-03	0.98%
Skin	FFTF 2 soluble	1.26E-04	Mk V-B soluble	1.41E-04	11.93%
Spleen	N Rx 1 soluble	1.36E-04	Mk V-B soluble	1.54E-04	13.35%
Thymus	N Rx 1 soluble	1.36E-04	Mk V-B soluble	1.55E-04	13.54%
Uterus	N Rx 1 soluble	1.39E-04	Mk V-B soluble	1.58E-04	13.51%
Extrathoracic airways	TRIGA 2 insoluble	2.10E-03	Mk V-B insoluble	2.03E-03	-3.44%
Lung	TRIGA 2 insoluble	1.15E-02	Mk V-B insoluble	1.19E-02	3.64%
Colon	TRIGA 2 insoluble	1.07E-03	Mk V-B insoluble	1.08E-03	0.77%
Esophagus	N Rx 1 soluble	1.36E-04	Mk V-B soluble	1.55E-04	13.54%
Gonads	N Rx 1 soluble	1.46E-04	Mk V-B soluble	1.67E-04	14.53%

Table 2-21. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross beta air samples at 10 days decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	FFTF 1 soluble	1.08E-03	Mk 16 1 soluble	5.45E-04	-49.31%
Urinary bladder	FFTF 1 soluble	1.97E-03	Mk V-B soluble	1.87E-03	-4.91%
Brain	FFTF 1 soluble	1.04E-03	Mk V-B soluble	5.29E-04	-49.33%
Breast	FFTF 1 soluble	8.79E-04	Mk 16 1 soluble	3.42E-04	-61.06%
Gall bladder	FFTF 1 soluble	9.84E-04	Mk 16 1 soluble	4.01E-04	-59.21%
Heart wall	FFTF 1 soluble	1.01E-03	Mk 16 1 soluble	4.45E-04	-56.02%
Kidneys	FFTF 1 soluble	1.00E-03	Mk 16 1 soluble	4.60E-04	-54.08%
Liver	TRIGA 1 soluble	9.29E-03	Mk 16 1 soluble	5.77E-03	-37.86%
Muscle	FFTF 1 soluble	1.03E-03	Mk V-B soluble	4.78E-04	-53.67%
Ovaries	FFTF 1 soluble	1.05E-03	Mk 16 1 soluble	5.06E-04	-51.99%
Pancreas	FFTF 1 soluble	1.01E-03	Mk 16 1 soluble	4.37E-04	-56.60%
Testes	FFTF 1 soluble	8.52E-04	Mk 16 1 soluble	2.87E-04	-66.33%
Thyroid	ATR 2 soluble	9.29E-01	Mk V-B soluble	9.39E-01	1.07%
Red bone marrow	TRIGA 1 soluble	5.85E-03	Mk 16 1 soluble	3.34E-03	-42.92%
Bone surface	TRIGA 1 soluble	1.67E-02	Mk 16 1 soluble	1.10E-02	-33.80%
Stomach	FFTF 1 soluble	1.09E-03	Mk 16 1 soluble	5.16E-04	-52.46%
Small intestine	FFTF 1 soluble	1.42E-03	Mk 16 1 soluble	8.55E-04	-40.00%
Upper large intestine	FFTF 1 soluble	2.55E-03	Mk 16 1 soluble	1.97E-03	-22.59%
Lower large intestine	FFTF 1 insoluble	6.12E-03	Mk 16 1 insoluble	5.11E-03	-16.53%
Skin	FFTF 1 soluble	8.71E-04	Mk 16 1 soluble	3.36E-04	-61.41%
Spleen	FFTF 1 soluble	9.35E-04	Mk 16 1 soluble	3.71E-04	-60.30%
Thymus	FFTF 1 soluble	1.07E-03	Mk V-B soluble	5.28E-04	-50.74%
Uterus	FFTF 1 soluble	9.95E-04	Mk 16 1 soluble	4.21E-04	-57.65%
Extrathoracic airways	FFTF 2 insoluble	1.01E-02	Mk 16 1 insoluble	8.71E-03	-13.70%
Lung	FFTF 1 insoluble	3.93E-02	Mk 16 1 insoluble	2.51E-02	-35.97%
Colon	FFTF 1 insoluble	3.97E-03	Mk 16 1 insoluble	3.29E-03	-17.07%
Esophagus	FFTF 1 soluble	1.07E-03	Mk V-B soluble	5.28E-04	-50.74%
Gonads	FFTF 1 soluble	1.05E-03	Mk 16 1 soluble	5.06E-04	-51.99%

Table 2-22. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross beta air samples at 40 days decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	FFTF 1 soluble	1.42E-03	Mk 16 1 soluble	6.97E-04	-50.90%
Urinary bladder	FFTF 1 soluble	1.50E-03	Mk V-B soluble	6.93E-04	-53.68%
Brain	FFTF 1 soluble	1.23E-03	Mk 16 1 soluble	4.98E-04	-59.45%
Breast	FFTF 1 soluble	1.16E-03	Mk 16 1 soluble	4.11E-04	-64.47%
Gall bladder	FFTF 1 soluble	1.32E-03	Mk 16 1 soluble	5.11E-04	-61.25%
Heart wall	FFTF 1 soluble	1.31E-03	Mk 16 1 soluble	5.34E-04	-59.21%
Kidneys	FFTF 1 soluble	1.33E-03	Mk 16 1 soluble	5.76E-04	-56.57%
Liver	TRIGA 1 soluble	1.31E-02	Mk 16 1 soluble	9.24E-03	-29.50%
Muscle	FFTF 1 soluble	1.25E-03	Mk 16 1 soluble	4.88E-04	-60.79%
Ovaries	FFTF 1 soluble	1.38E-03	Mk 16 1 soluble	6.38E-04	-53.87%
Pancreas	FFTF 1 soluble	1.34E-03	Mk 16 1 soluble	5.49E-04	-58.90%
Testes	FFTF 1 soluble	1.16E-03	Mk 16 1 soluble	3.60E-04	-68.85%
Thyroid	ATR 2 soluble	1.68E-01	Mk V-B soluble	1.66E-01	-1.10%
Red bone marrow	TRIGA 1 soluble	8.04E-03	Mk 16 1 soluble	4.71E-03	-41.42%
Bone surface	TRIGA 1 soluble	2.23E-02	Mk 16 1 soluble	1.53E-02	-31.50%
Stomach	FFTF 1 soluble	1.35E-03	Mk 16 1 soluble	5.74E-04	-57.59%
Small intestine	FFTF 1 soluble	1.66E-03	Mk 16 1 soluble	9.14E-04	-44.96%
Upper large intestine	FFTF 1 soluble	3.27E-03	Mk 16 1 soluble	2.50E-03	-23.34%
Lower large intestine	FFTF 1 insoluble	7.83E-03	Mk 16 1 insoluble	6.52E-03	-16.75%
Skin	FFTF 1 soluble	1.13E-03	Mk 16 1 soluble	3.83E-04	-66.04%
Spleen	FFTF 1 soluble	1.25E-03	Mk 16 1 soluble	4.65E-04	-62.75%
Thymus	FFTF 1 soluble	1.26E-03	Mk 16 1 soluble	4.92E-04	-60.95%
Uterus	FFTF 1 soluble	1.30E-03	Mk 16 1 soluble	5.10E-04	-60.78%
Extrathoracic airways	FFTF 1 insoluble	9.81E-03	Mk 16 1 insoluble	9.06E-03	-7.64%
Lung	FFTF 1 insoluble	5.24E-02	Mk 16 1 insoluble	3.43E-02	-34.65%
Colon	FFTF 1 insoluble	5.06E-03	Mk 16 1 insoluble	4.18E-03	-17.36%
Esophagus	FFTF 1 soluble	1.26E-03	Mk 16 1 soluble	4.92E-04	-60.95%
Gonads	FFTF 1 soluble	1.38E-03	Mk 16 1 soluble	6.38E-04	-53.87%

Table 2-23. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross beta air samples at 180 days decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	FFTF 1 soluble	1.99E-03	Mk V-B soluble	8.98E-04	-54.79%
Urinary bladder	FFTF 1 soluble	2.06E-03	Mk V-B soluble	7.14E-04	-65.29%
Brain	FFTF 1 soluble	1.77E-03	Mk V-B soluble	6.68E-04	-62.23%
Breast	FFTF 1 soluble	1.73E-03	Mk V-B soluble	6.12E-04	-64.62%
Gall bladder	FFTF 1 soluble	1.96E-03	Mk 16 1 soluble	7.39E-04	-62.18%
Heart wall	FFTF 1 soluble	1.91E-03	Mk 16 1 soluble	7.44E-04	-61.13%
Kidneys	FFTF 1 soluble	1.91E-03	Mk V-B soluble	7.75E-04	-59.43%
Liver	TRIGA 1 soluble	1.95E-02	Mk 16 1 soluble	1.94E-02	-0.34%
Muscle	FFTF 1 soluble	1.82E-03	Mk V-B soluble	6.71E-04	-63.03%
Ovaries	FFTF 1 soluble	1.95E-03	Mk V-B soluble	8.37E-04	-57.04%
Pancreas	FFTF 1 soluble	1.95E-03	Mk 16 1 soluble	7.54E-04	-61.34%
Testes	FFTF 1 soluble	1.77E-03	Mk 16 1 soluble	5.75E-04	-67.44%
Thyroid	FFTF 1 soluble	1.82E-03	Mk 16 1 soluble	6.54E-04	-64.03%
Red bone marrow	TRIGA 1 soluble	1.27E-02	Mk 16 1 soluble	7.45E-03	-41.49%
Bone surface	TRIGA 1 soluble	3.17E-02	Mk 16 1 soluble	1.96E-02	-38.17%
Stomach	FFTF 1 soluble	1.97E-03	Mk 16 1 soluble	7.98E-04	-59.56%
Small intestine	FFTF 1 soluble	2.28E-03	Mk 16 1 soluble	1.16E-03	-49.31%
Upper large intestine	FFTF 1 soluble	4.29E-03	Mk 16 1 soluble	3.19E-03	-25.67%
Lower large intestine	FFTF 1 insoluble	1.00E-02	Mk 16 1 insoluble	8.23E-03	-17.85%
Skin	FFTF 1 soluble	1.69E-03	Mk V-B soluble	5.72E-04	-66.22%
Spleen	FFTF 1 soluble	1.86E-03	Mk 16 1 soluble	6.73E-04	-63.71%
Thymus	FFTF 1 soluble	1.84E-03	Mk 16 1 soluble	6.82E-04	-62.93%
Uterus	FFTF 1 soluble	1.91E-03	Mk 16 1 soluble	7.08E-04	-62.83%
Extrathoracic airways	TRIGA 2 insoluble	1.10E-02	Mk V-B insoluble	1.08E-02	-1.94%
Lung	FFTF 2 insoluble	7.18E-02	Mk 16 1 insoluble	5.23E-02	-27.16%
Colon	FFTF 1 insoluble	6.49E-03	Mk 16 1 insoluble	5.26E-03	-18.84%
Esophagus	FFTF 1 soluble	1.84E-03	Mk 16 1 soluble	6.82E-04	-62.93%
Gonads	FFTF 1 soluble	1.95E-03	Mk V-B soluble	8.37E-04	-57.04%

Table 2-24. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross beta air samples at 1 year decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	FFTF 1 soluble	2.20E-03	Mk V-B soluble	8.84E-04	-59.79%
Urinary bladder	FFTF 1 soluble	2.32E-03	Mk V-B soluble	8.40E-04	-63.85%
Brain	FFTF 1 soluble	1.97E-03	Mk V-B soluble	7.56E-04	-61.68%
Breast	FFTF 1 soluble	1.94E-03	Mk V-B soluble	7.40E-04	-61.86%
Gall bladder	FFTF 1 soluble	2.22E-03	Mk V-B soluble	8.43E-04	-61.98%
Heart wall	FFTF 1 soluble	2.15E-03	Mk V-B soluble	8.26E-04	-61.51%
Kidneys	FFTF 1 soluble	2.13E-03	Mk V-B soluble	8.27E-04	-61.20%
Liver	ATR 1 soluble	2.40E-02	Mk VI-B 2 soluble	2.40E-02	0.09%
Muscle	FFTF 1 soluble	2.04E-03	Mk V-B soluble	7.73E-04	-62.04%
Ovaries	FFTF 1 soluble	2.16E-03	Mk V-B soluble	8.46E-04	-60.82%
Pancreas	FFTF 1 soluble	2.20E-03	Mk V-B soluble	8.34E-04	-62.00%
Testes	FFTF 1 soluble	2.01E-03	Mk V-B soluble	7.25E-04	-63.90%
Thyroid	FFTF 1 soluble	2.05E-03	Mk V-B soluble	7.64E-04	-62.71%
Red bone marrow	TRIGA 1 soluble	1.67E-02	Mk 16 1 soluble	9.45E-03	-43.40%
Bone surface	TRIGA 1 soluble	4.03E-02	Mk 16 1 soluble	2.18E-02	-45.96%
Stomach	FFTF 1 soluble	2.21E-03	Mk V-B soluble	9.14E-04	-58.65%
Small intestine	FFTF 1 soluble	2.50E-03	Mk V-B soluble	1.22E-03	-51.09%
Upper large intestine	FFTF 1 soluble	4.51E-03	Mk V-B soluble	3.32E-03	-26.36%
Lower large intestine	FFTF 2 insoluble	1.04E-02	Mk V-B insoluble	8.62E-03	-16.79%
Skin	FFTF 1 soluble	1.90E-03	Mk V-B soluble	7.16E-04	-62.38%
Spleen	FFTF 1 soluble	2.09E-03	Mk V-B soluble	7.81E-04	-62.66%
Thymus	FFTF 1 soluble	2.07E-03	Mk V-B soluble	7.84E-04	-62.09%
Uterus	FFTF 1 soluble	2.15E-03	Mk V-B soluble	7.98E-04	-62.83%
Extrathoracic airways	TRIGA 1 insoluble	1.07E-02	Mk V-B insoluble	1.03E-02	-4.47%
Lung	FFTF 2 insoluble	7.65E-02	Mk V-B insoluble	6.03E-02	-21.18%
Colon	FFTF 1 insoluble	6.72E-03	Mk V-B insoluble	5.47E-03	-18.60%
Esophagus	FFTF 1 soluble	2.07E-03	Mk V-B soluble	7.84E-04	-62.09%
Gonads	FFTF 1 soluble	2.16E-03	Mk V-B soluble	8.46E-04	-60.82%

Table 2-25. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross gamma air samples at 10 days decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	FFTF 1 soluble	1.42E-03	Mk 16 1 soluble	7.74E-04	-45.39%
Urinary bladder	FFTF 1 soluble	2.59E-03	Mk V-B soluble	2.46E-03	-5.14%
Brain	FFTF 1 soluble	1.38E-03	Mk 16 1 soluble	7.04E-04	-48.83%
Breast	FFTF 1 soluble	1.16E-03	Mk 16 1 soluble	4.78E-04	-58.72%
Gall bladder	FFTF 1 soluble	1.30E-03	Mk 16 1 soluble	5.60E-04	-56.75%
Heart wall	FFTF 1 soluble	1.33E-03	Mk 16 1 soluble	6.22E-04	-53.37%
Kidneys	FFTF 1 soluble	1.32E-03	Mk 16 1 soluble	6.43E-04	-51.31%
Liver	TRIGA 1 soluble	1.50E-02	Mk 16 1 soluble	8.06E-03	-46.35%
Muscle	FFTF 1 soluble	1.36E-03	Mk 16 1 soluble	6.62E-04	-51.32%
Ovaries	FFTF 1 soluble	1.39E-03	Mk 16 1 soluble	7.07E-04	-49.10%
Pancreas	FFTF 1 soluble	1.33E-03	Mk 16 1 soluble	6.11E-04	-53.99%
Testes	FFTF 1 soluble	1.12E-03	Mk 16 1 soluble	4.00E-04	-64.30%
Thyroid	ATR 2 soluble	1.22E+00	Mk V-B soluble	1.23E+00	1.00%
Red bone marrow	TRIGA 1 soluble	9.46E-03	Mk 16 1 soluble	4.66E-03	-50.72%
Bone surface	TRIGA 1 soluble	2.70E-02	Mk 16 1 soluble	1.54E-02	-42.85%
Stomach	FFTF 1 soluble	1.43E-03	Mk 16 1 soluble	7.21E-04	-49.59%
Small intestine	FFTF 1 soluble	1.88E-03	Mk 16 1 soluble	1.19E-03	-36.39%
Upper large intestine	TRIGA 1 soluble	3.69E-03	Mk 16 1 soluble	2.75E-03	-25.52%
Lower large intestine	TRIGA 1 insoluble	9.43E-03	Mk 16 1 insoluble	7.13E-03	-24.36%
Skin	FFTF 1 soluble	1.15E-03	Mk 16 1 soluble	4.69E-04	-59.08%
Spleen	FFTF 1 soluble	1.23E-03	Mk 16 1 soluble	5.19E-04	-57.91%
Thymus	FFTF 1 soluble	1.41E-03	Mk 16 1 soluble	6.99E-04	-50.51%
Uterus	FFTF 1 soluble	1.31E-03	Mk 16 1 soluble	5.89E-04	-55.10%
Extrathoracic airways	TRIGA 1 insoluble	1.50E-02	Mk 16 1 insoluble	1.22E-02	-19.15%
Lung	FFTF 1 insoluble	5.17E-02	Mk 16 1 insoluble	3.51E-02	-32.12%
Colon	TRIGA 1 insoluble	6.09E-03	Mk 16 1 insoluble	4.60E-03	-24.56%
Esophagus	FFTF 1 soluble	1.41E-03	Mk 16 1 soluble	6.99E-04	-50.51%
Gonads	FFTF 1 soluble	1.39E-03	Mk 16 1 soluble	7.07E-04	-49.10%

Table 2-26. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross gamma air samples at 40 days decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	FFTF 1 soluble	2.17E-03	Mk 16 1 soluble	1.07E-03	-50.95%
Urinary bladder	FFTF 1 soluble	2.29E-03	Mk V-B soluble	9.97E-04	-56.52%
Brain	FFTF 1 soluble	1.88E-03	Mk 16 1 soluble	7.50E-04	-60.13%
Breast	FFTF 1 soluble	1.77E-03	Mk 16 1 soluble	6.19E-04	-65.06%
Gall bladder	FFTF 1 soluble	2.02E-03	Mk 16 1 soluble	7.70E-04	-61.90%
Heart wall	FFTF 1 soluble	2.01E-03	Mk 16 1 soluble	8.05E-04	-59.90%
Kidneys	FFTF 1 soluble	2.03E-03	Mk 16 1 soluble	8.68E-04	-57.30%
Liver	TRIGA 1 soluble	2.46E-02	Mk 16 1 soluble	1.39E-02	-43.40%
Muscle	FFTF 1 soluble	1.91E-03	Mk 16 1 soluble	7.36E-04	-61.45%
Ovaries	FFTF 1 soluble	2.12E-03	Mk 16 1 soluble	9.61E-04	-54.65%
Pancreas	FFTF 1 soluble	2.05E-03	Mk 16 1 soluble	8.28E-04	-59.59%
Testes	FFTF 1 soluble	1.77E-03	Mk 16 1 soluble	5.42E-04	-69.38%
Thyroid	ATR 2 soluble	2.45E-01	Mk V-B soluble	2.39E-01	-2.37%
Red bone marrow	TRIGA 1 soluble	1.51E-02	Mk 16 1 soluble	7.10E-03	-52.97%
Bone surface	TRIGA 1 soluble	4.18E-02	Mk 16 1 soluble	2.30E-02	-45.00%
Stomach	FFTF 1 soluble	2.07E-03	Mk 16 1 soluble	8.65E-04	-58.30%
Small intestine	FFTF 1 soluble	2.55E-03	Mk 16 1 soluble	1.38E-03	-45.88%
Upper large intestine	TRIGA 1 soluble	5.20E-03	Mk 16 1 soluble	3.77E-03	-27.50%
Lower large intestine	TRIGA 1 insoluble	1.33E-02	Mk 16 1 insoluble	9.83E-03	-25.93%
Skin	FFTF 1 soluble	1.73E-03	Mk 16 1 soluble	5.77E-04	-66.61%
Spleen	FFTF 1 soluble	1.91E-03	Mk 16 1 soluble	7.01E-04	-63.38%
Thymus	FFTF 1 soluble	1.93E-03	Mk 16 1 soluble	7.42E-04	-61.60%
Uterus	FFTF 1 soluble	1.99E-03	Mk 16 1 soluble	7.69E-04	-61.44%
Extrathoracic airways	TRIGA 1 insoluble	1.83E-02	Mk 16 1 insoluble	1.37E-02	-25.54%
Lung	FFTF 1 insoluble	8.04E-02	Mk 16 1 insoluble	5.16E-02	-35.75%
Colon	TRIGA 1 insoluble	8.55E-03	Mk 16 1 insoluble	6.30E-03	-26.37%
Esophagus	FFTF 1 soluble	1.93E-03	Mk 16 1 soluble	7.42E-04	-61.60%
Gonads	FFTF 1 soluble	2.12E-03	Mk 16 1 soluble	9.61E-04	-54.65%

Table 2-27. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross gamma air samples at 180 days decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	FFTF 1 soluble	5.06E-03	Mk 16 1 soluble	1.86E-03	-63.21%
Urinary bladder	FFTF 1 soluble	5.23E-03	Mk 16 1 soluble	1.51E-03	-71.18%
Brain	FFTF 1 soluble	4.50E-03	Mk 16 1 soluble	1.38E-03	-69.22%
Breast	FFTF 1 soluble	4.40E-03	Mk 16 1 soluble	1.30E-03	-70.55%
Gall bladder	FFTF 1 soluble	4.98E-03	Mk 16 1 soluble	1.57E-03	-68.41%
Heart wall	FFTF 1 soluble	4.87E-03	Mk 16 1 soluble	1.58E-03	-67.52%
Kidneys	FFTF 1 soluble	4.86E-03	Mk 16 1 soluble	1.61E-03	-66.82%
Liver	TRIGA 1 soluble	5.89E-02	Mk 16 1 soluble	4.13E-02	-29.88%
Muscle	FFTF 1 soluble	4.62E-03	Mk 16 1 soluble	1.42E-03	-69.31%
Ovaries	FFTF 1 soluble	4.96E-03	Mk 16 1 soluble	1.72E-03	-65.35%
Pancreas	FFTF 1 soluble	4.96E-03	Mk 16 1 soluble	1.60E-03	-67.70%
Testes	FFTF 1 soluble	4.49E-03	Mk 16 1 soluble	1.22E-03	-72.79%
Thyroid	FFTF 1 soluble	4.63E-03	Mk 16 1 soluble	1.39E-03	-69.95%
Red bone marrow	TRIGA 1 soluble	3.85E-02	Mk 16 1 soluble	1.58E-02	-58.83%
Bone surface	TRIGA 1 soluble	9.57E-02	Mk 16 1 soluble	4.16E-02	-56.49%
Stomach	FFTF 1 soluble	5.02E-03	Mk 16 1 soluble	1.70E-03	-66.22%
Small intestine	FFTF 1 soluble	5.81E-03	Mk 16 1 soluble	2.46E-03	-57.65%
Upper large intestine	FFTF 1 soluble	1.09E-02	Mk 16 1 soluble	6.78E-03	-37.90%
Lower large intestine	FFTF 1 insoluble	2.55E-02	Mk 16 1 insoluble	1.75E-02	-31.37%
Skin	FFTF 1 soluble	4.31E-03	Mk 16 1 soluble	1.21E-03	-71.84%
Spleen	FFTF 1 soluble	4.72E-03	Mk 16 1 soluble	1.43E-03	-69.69%
Thymus	FFTF 1 soluble	4.68E-03	Mk 16 1 soluble	1.45E-03	-69.03%
Uterus	FFTF 1 soluble	4.85E-03	Mk 16 1 soluble	1.51E-03	-68.94%
Extrathoracic airways	TRIGA 1 insoluble	3.28E-02	Mk 16 1 insoluble	2.26E-02	-30.91%
Lung	FFTF 1 insoluble	1.83E-01	Mk 16 1 insoluble	1.11E-01	-39.11%
Colon	FFTF 1 insoluble	1.65E-02	Mk 16 1 insoluble	1.12E-02	-32.20%
Esophagus	FFTF 1 soluble	4.68E-03	Mk 16 1 soluble	1.45E-03	-69.03%
Gonads	FFTF 1 soluble	4.96E-03	Mk 16 1 soluble	1.72E-03	-65.35%

Table 2-28. Comparisons of organ dose results for the OTIB-0054 representative reactor cases and the SRS cases for gross gamma air samples at 1 year decay.

Organ	Limiting reactor and dose (rem)				Difference (SRS:rep.)
	Representative reactors		SRS cases		
	Limiting reactors and solubility	Dose	Limiting reactors and solubility	Dose	
Adrenals	FFTF 2 soluble	8.39E-03	Mk 16 1 soluble	3.94E-03	-53.07%
Urinary bladder	FFTF 2 soluble	9.01E-03	Mk 16 1 soluble	3.68E-03	-59.14%
Brain	FFTF 2 soluble	7.74E-03	Mk 16 1 soluble	3.23E-03	-58.28%
Breast	FFTF 2 soluble	7.65E-03	Mk 16 1 soluble	3.15E-03	-58.75%
Gall bladder	FFTF 2 soluble	8.41E-03	Mk 16 1 soluble	3.78E-03	-55.02%
Heart wall	FFTF 2 soluble	8.23E-03	Mk 16 1 soluble	3.67E-03	-55.38%
Kidneys	FFTF 2 soluble	8.19E-03	Mk 16 1 soluble	3.62E-03	-55.76%
Liver	N Rx 2 soluble	1.18E-01	Mk 16 1 soluble	1.08E-01	-8.02%
Muscle	FFTF 2 soluble	7.92E-03	Mk 16 1 soluble	3.36E-03	-57.51%
Ovaries	FFTF 2 soluble	8.27E-03	Mk 16 1 soluble	3.72E-03	-54.99%
Pancreas	FFTF 2 soluble	8.36E-03	Mk 16 1 soluble	3.74E-03	-55.23%
Testes	FFTF 2 soluble	7.81E-03	Mk 16 1 soluble	3.21E-03	-58.91%
Thyroid	FFTF 2 soluble	7.93E-03	Mk 16 1 soluble	3.37E-03	-57.45%
Red bone marrow	TRIGA 1 soluble	7.63E-02	Mk 16 1 soluble	4.26E-02	-44.14%
Bone surface	TRIGA 1 soluble	1.84E-01	Mk 16 1 soluble	9.82E-02	-46.67%
Stomach	FFTF 2 soluble	8.61E-03	Mk 16 1 soluble	4.04E-03	-53.04%
Small intestine	FFTF 2 soluble	9.81E-03	Mk 16 1 soluble	5.43E-03	-44.60%
Upper large intestine	FFTF 2 soluble	1.87E-02	Mk 16 1 soluble	1.47E-02	-21.37%
Lower large intestine	N Rx 2 insoluble	4.70E-02	Mk 16 1 insoluble	3.78E-02	-19.59%
Skin	FFTF 2 soluble	7.55E-03	Mk 16 1 soluble	3.03E-03	-59.90%
Spleen	FFTF 2 soluble	8.07E-03	Mk 16 1 soluble	3.47E-03	-56.93%
Thymus	FFTF 2 soluble	7.99E-03	Mk 16 1 soluble	3.45E-03	-56.78%
Uterus	FFTF 2 soluble	8.21E-03	Mk 16 1 soluble	3.60E-03	-56.19%
Extrathoracic airways	N Rx 2 insoluble	5.27E-02	Mk 16 1 insoluble	4.51E-02	-14.50%
Lung	FFTF 2 insoluble	3.27E-01	Mk 16 1 insoluble	2.60E-01	-20.60%
Colon	N Rx 2 insoluble	3.00E-02	Mk 16 1 insoluble	2.42E-02	-19.34%
Esophagus	FFTF 2 soluble	7.99E-03	Mk 16 1 soluble	3.45E-03	-56.78%
Gonads	FFTF 2 soluble	8.27E-03	Mk 16 1 soluble	3.72E-03	-54.99%

Table 3-1. SRS-specific chemical yield values for processed urine samples.

Radionuclide	Chemical yield
Sr-89	1
Sr-90	1
Y-90	1
Y-91	1
Zr-95	1
Nb-95	1
Mo-99	0
Ru-103	0
Ru-106	0
Te-129m	0
Te-132	0
I-131	0
I-132	0
Cs-134	0
Cs-137	0
Ba-140	1
La-140	1
Ce-141	1
Ce-144	1
Pr-143	1
Pr-144	1
Nd-147	1
Pm-147	1
Eu-154	1
Eu-155	1

Table 3-2. IRFs and yield and counting adjustment factors for beta and gamma counts.

Radionuclide	Absorption type	Beta Yield	Gamma Yield	IRF values		
				90 d	2 y	30 y
Sr-89/Y-89m	F	1.0	0.000093	1.900E-01	1.915E-01	1.915E-01
Sr-90	F	1.0	0.0	2.130E-01	2.310E-01	2.490E-01
Y-90	S	1.0	0.0	3.392E-05	3.392E-05	3.392E-05
Y-91	S	1.0	0.003	7.370E-05	8.579E-05	8.579E-05
Zr-95	S	1.0	0.996	5.280E-04	5.805E-04	5.810E-04
Nb-95	S	0.0	0.998	1.930E-03	1.983E-03	1.980E-03
Ru-103	S	1.0	0.9306	1.040E-02	1.056E-02	1.060E-02
Ru-106/Rh-106	S	2.0	0.342	1.330E-02	1.559E-02	1.593E-02
Ba-140	F	1.0	0.404	2.422E-02	2.423E-02	2.423E-02
La-140	M	1.0	2.1542	4.780E-06	4.780E-06	4.780E-06
Ce-141	S	1.0	0.48	5.040E-07	6.472E-07	6.470E-07
Ce-144/Pr-144	S	1.98	0.134	1.120E-06	9.103E-06	1.284E-05
Pr-143	S	1.0	0.0	3.770E-05	3.770E-05	3.770E-05
Pr-144	S	1.0	0.0257	1.435E-09	1.435E-09	1.435E-09
Nd-147	S	1.0	0.2	2.810E-05	2.809E-05	2.810E-05
Pm-147	S	1.0	0.0	5.100E-05	1.884E-04	4.392E-04
Eu-154	M	1.0	1.633	4.605E-03	8.730E-03	1.756E-02
Eu-155	M	0.0	1.4468	4.568E-03	8.488E-03	1.409E-02

Table 3-3. SRS-specific urine activity fractions for ^{90}Sr.

Nuclide and intake duration	Fraction of beta activity in urine: Mk V-B				Fraction of beta activity in urine: Mk 16 1				Fraction of beta activity in urine: Mk 16 2			
	10 d	40 d	180 d	1 y	10 d	40 d	180 d	1 y	10 d	40 d	180 d	1 y
Sr-90, 90 days	1.29E-02	2.12E-02	1.19E-01	4.08E-01	3.43E-02	5.22E-02	2.23E-01	5.04E-01	2.51E-02	3.87E-02	1.83E-01	4.76E-01
Sr-90, 2 years	1.39E-02	2.27E-02	1.19E-01	4.16E-01	3.68E-02	5.57E-02	2.23E-01	5.09E-01	2.69E-02	4.14E-02	1.83E-01	4.82E-01
Sr-90, 30 years	1.50E-02	2.44E-02	1.33E-01	4.25E-01	3.94E-02	5.95E-02	2.41E-01	5.13E-01	2.88E-02	4.43E-02	2.00E-01	4.88E-01

Nuclide and intake duration	Fraction of beta activity in urine: Mk VI-B 1				Fraction of beta activity in urine: Mk VI-B 2			
	10 d	40 d	180 d	1 y	10 d	40 d	180 d	1 y
Sr-90, 90 days	2.75E-02	4.23E-02	1.94E-01	4.85E-01	2.75E-02	4.22E-02	1.94E-01	4.85E-01
Sr-90, 2 years	2.95E-02	4.52E-02	1.94E-01	4.91E-01	2.95E-02	4.52E-02	1.94E-01	4.91E-01
Sr-90, 30 years	3.16E-02	4.83E-02	2.12E-01	4.96E-01	3.16E-02	4.83E-02	2.12E-01	4.96E-01

Table 3-4. SRS-specific urine activity fractions for ^{95}Zr.

Nuclide and intake duration	Fraction of gamma activity in urine: Mk V-B				Fraction of gamma activity in urine: Mk 16 1				Fraction of gamma activity in urine: Mk 16 2			
	10 d	40 d	180 d	1 y	10 d	40 d	180 d	1 y	10 d	40 d	180 d	1 y
Zr-95, 90 days	1.70E-02	5.15E-02	1.42E-01	1.27E-01	3.49E-02	8.34E-02	1.36E-01	1.20E-01	3.18E-02	7.93E-02	1.37E-01	1.24E-01
Zr-95, 2 years	1.87E-02	5.59E-02	1.50E-01	1.33E-01	3.80E-02	8.95E-02	1.42E-01	1.21E-01	3.46E-02	8.52E-02	1.44E-01	1.28E-01
Zr-95, 30 years	1.87E-02	5.60E-02	1.49E-01	1.31E-01	3.80E-02	8.94E-02	1.40E-01	1.10E-01	3.46E-02	8.52E-02	1.43E-01	1.22E-01

Nuclide and intake duration	Fraction of gamma activity in urine: Mk VI-B 1				Fraction of gamma activity in urine: Mk VI-B 2			
	10 d	40 d	180 d	1 y	10 d	40 d	180 d	1 y
Zr-95, 90 days	3.29E-02	8.08E-02	1.37E-01	1.22E-01	3.29E-02	8.08E-02	1.37E-01	1.23E-01
Zr-95, 2 years	3.59E-02	8.69E-02	1.43E-01	1.24E-01	3.58E-02	8.68E-02	1.43E-01	1.26E-01
Zr-95, 30 years	3.59E-02	8.68E-02	1.42E-01	1.17E-01	3.58E-02	8.68E-02	1.42E-01	1.20E-01

Table 3-5. Associated radionuclide activity fractions for assigning intakes relative to ^{95}Zr.

Table 3-5 values: Mark V-B					Table 3-5 values: Mark 16 1				
	Intake relative to Zr-95					Intake relative to Zr-95			
Nuclide	10 d	40 d	180 d	1 y	Nuclide	10 d	40 d	180 d	1 y
Sr-89	7.93E-01	7.27E-01	4.86E-01	2.85E-01	Sr-89	7.29E-01	6.68E-01	4.46E-01	2.62E-01
Sr-90	7.25E-03	1.00E-02	4.52E-02	3.31E-01	Sr-90	1.72E-02	2.37E-02	1.07E-01	7.83E-01
Y-91	9.15E-01	8.87E-01	7.69E-01	6.37E-01	Y-91	9.03E-01	8.76E-01	7.60E-01	6.29E-01
Zr-95	1.00E+00	1.00E+00	1.00E+00	1.00E+00	Zr-95	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Nb-95	5.11E-01	9.11E-01	1.84E+00	2.13E+00	Nb-95	1.03E+00	1.31E+00	1.95E+00	2.15E+00
Ru-103	8.03E-01	6.54E-01	2.52E-01	7.11E-02	Ru-103	4.75E-01	3.87E-01	1.49E-01	4.21E-02
Ru-106	3.55E-02	4.65E-02	1.63E-01	8.55E-01	Ru-106	2.97E-02	3.89E-02	1.36E-01	7.16E-01
I-131	3.14E+01	3.27E+00	8.53E-05	7.49E-11	I-131	1.15E+01	1.19E+00	3.11E-05	2.73E-11
Cs-134	7.51E-04	1.01E-03	4.05E-03	2.53E-02	Cs-134	1.61E-02	2.17E-02	8.67E-02	5.42E-01
Cs-137	8.16E-03	1.13E-02	5.08E-02	3.72E-01	Cs-137	1.74E-02	2.41E-02	1.09E-01	7.96E-01
Ce-141	1.34E+00	9.77E-01	2.25E-01	3.22E-02	Ce-141	8.63E-01	6.30E-01	1.45E-01	2.08E-02
Ce-144	2.45E-01	3.15E-01	1.02E+00	4.83E+00	Ce-144	4.41E-01	5.68E-01	1.84E+00	8.68E+00
Pr-143	1.60E+00	4.78E-01	1.71E-03	9.96E-07	Pr-143	6.92E-01	2.07E-01	7.39E-04	4.31E-07
Pm-147	2.56E-02	4.15E-02	1.76E-01	1.14E+00	Pm-147	4.83E-02	6.81E-02	2.82E-01	1.83E+00

Table 3-5 values: Mark 16 2				
	Intake relative to Zr-95			
Nuclide	10 d	40 d	180 d	1 y
Sr-89	7.59E-01	6.96E-01	4.65E-01	2.73E-01
Sr-90	1.29E-02	1.78E-02	8.02E-02	5.87E-01
Y-91	9.19E-01	8.91E-01	7.73E-01	6.40E-01
Zr-95	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Nb-95	9.24E-01	1.23E+00	1.93E+00	2.15E+00
Ru-103	5.04E-01	4.11E-01	1.58E-01	4.46E-02
Ru-106	2.28E-02	2.98E-02	1.04E-01	5.48E-01
I-131	1.30E+01	1.35E+00	3.52E-05	3.09E-11
Cs-134	7.28E-03	9.80E-03	3.92E-02	2.45E-01
Cs-137	1.30E-02	1.80E-02	8.13E-02	5.95E-01
Ce-141	9.47E-01	6.92E-01	1.59E-01	2.28E-02
Ce-144	3.61E-01	4.64E-01	1.50E+00	7.10E+00
Pr-143	7.88E-01	2.36E-01	8.41E-04	4.91E-07
Pm-147	4.08E-02	5.84E-02	2.43E-01	1.57E+00

Table 3-5 values: Mark VI-B 1				
	Intake relative to Zr-95			
Nuclide	10 d	40 d	180 d	1 y
Sr-89	7.51E-01	6.88E-01	4.60E-01	2.70E-01
Sr-90	1.40E-02	1.94E-02	8.73E-02	6.39E-01
Y-91	9.15E-01	8.88E-01	7.70E-01	6.37E-01
Zr-95	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Nb-95	9.60E-01	1.25E+00	1.93E+00	2.15E+00
Ru-103	4.90E-01	3.99E-01	1.53E-01	4.34E-02
Ru-106	2.39E-02	3.13E-02	1.10E-01	5.76E-01
I-131	1.24E+01	1.29E+00	3.36E-05	2.95E-11
Cs-134	1.16E-02	1.57E-02	6.27E-02	3.92E-01
Cs-137	1.42E-02	1.96E-02	8.84E-02	6.47E-01
Ce-141	9.17E-01	6.69E-01	1.54E-01	2.21E-02
Ce-144	3.83E-01	4.93E-01	1.60E+00	7.54E+00
Pr-143	7.52E-01	2.25E-01	8.03E-04	4.69E-07
Pm-147	4.03E-02	5.76E-02	2.39E-01	1.55E+00

Table 3-5 values: Mark VI-B 2				
	Intake relative to Zr-95			
Nuclide	10 d	40 d	180 d	1 y
Sr-89	7.51E-01	6.89E-01	4.60E-01	2.70E-01
Sr-90	1.40E-02	1.94E-02	8.73E-02	6.39E-01
Y-91	9.15E-01	8.88E-01	7.70E-01	6.37E-01
Zr-95	1.00E+00	1.00E+00	1.00E+00	1.00E+00
Nb-95	9.60E-01	1.25E+00	1.93E+00	2.15E+00
Ru-103	4.89E-01	3.98E-01	1.53E-01	4.33E-02
Ru-106	2.37E-02	3.10E-02	1.09E-01	5.70E-01
I-131	1.24E+01	1.29E+00	3.36E-05	2.95E-11
Cs-134	9.42E-03	1.27E-02	5.07E-02	3.17E-01
Cs-137	1.42E-02	1.96E-02	8.83E-02	6.47E-01
Ce-141	9.19E-01	6.70E-01	1.54E-01	2.21E-02
Ce-144	3.83E-01	4.92E-01	1.59E+00	7.54E+00
Pr-143	7.55E-01	2.26E-01	8.07E-04	4.71E-07
Pm-147	4.25E-02	6.06E-02	2.51E-01	1.63E+00

Table 4-1. SRS-specific committed organ doses for 1 Bq/d in urine by gross beta at 10 days decay.

Organ	Limiting case and dose (mSv) for 1 Bq beta in urine			
	90-day chronic intake		30-year chronic intake	
	Limiting case and solubility	Dose	Limiting case and solubility	Dose
Adrenals	Mk 16 1 soluble	4.57E-05	Mk 16 1 soluble	4.49E-05
Urinary bladder	Mk V-B soluble	2.06E-04	Mk V-B soluble	2.04E-04
Bone surface	Mk 16 1 soluble	9.35E-04	Mk 16 1 soluble	9.18E-04
Brain	Mk V-B soluble	5.69E-05	Mk V-B soluble	5.63E-05
Breast	Mk V-B soluble	3.21E-05	Mk V-B soluble	3.18E-05
Esophagus	Mk V-B soluble	5.73E-05	Mk V-B soluble	5.67E-05
Stomach	Mk V-B soluble	5.20E-05	Mk V-B soluble	5.15E-05
Small intestine	Mk 16 1 soluble	5.89E-05	Mk 16 1 soluble	5.79E-05
Upper large intestine	Mk 16 1 soluble	1.66E-04	Mk 16 1 soluble	1.63E-04
Lower large intestine	Mk 16 1 insoluble	4.31E-04	Mk 16 1 insoluble	4.23E-04
Colon	Mk 16 1 insoluble	2.79E-04	Mk 16 1 insoluble	2.74E-04
Kidneys	Mk V-B soluble	3.87E-05	Mk V-B soluble	3.83E-05
Liver	Mk 16 1 soluble	4.83E-04	Mk 16 1 soluble	4.75E-04
Muscle	Mk V-B soluble	5.27E-05	Mk V-B soluble	5.22E-05
Ovaries	Mk 16 1 soluble	4.18E-05	Mk 16 1 soluble	4.11E-05
Pancreas	Mk V-B soluble	3.76E-05	Mk V-B soluble	3.72E-05
Red marrow	Mk 16 1 soluble	2.80E-04	Mk 16 1 soluble	2.75E-04
Extrathoracic airways	Mk V-B insoluble	9.36E-04	Mk V-B insoluble	9.27E-04
Lungs	Mk 16 1 insoluble	2.13E-03	Mk 16 1 insoluble	2.09E-03
Skin	Mk V-B soluble	3.37E-05	Mk V-B soluble	3.33E-05
Spleen	Mk V-B soluble	3.25E-05	Mk V-B soluble	3.22E-05
Testes	Mk V-B soluble	2.53E-05	Mk V-B soluble	2.50E-05
Thymus	Mk V-B soluble	5.73E-05	Mk V-B soluble	5.67E-05
Thyroid	Mk V-B soluble	1.03E-01	Mk V-B soluble	1.01E-01
Uterus	Mk V-B soluble	3.66E-05	Mk V-B soluble	3.62E-05

Table 4-2. SRS-specific committed organ doses for 1 Bq/d in urine by gross beta at 180 days decay.

Organ	Limiting case and dose (mSv) for 1 Bq beta in urine			
	90-day chronic intake		30-year chronic intake	
	Limiting case and solubility	Dose	Limiting case And solubility	Dose
Adrenals	Mk 16 1 soluble	8.46E-05	Mk 16 1 soluble	7.83E-05
Urinary bladder	Mk 16 1 soluble	6.92E-05	Mk 16 1 soluble	6.40E-05
Bone surface	Mk 16 1 soluble	1.93E-03	Mk 16 1 soluble	1.78E-03
Brain	Mk 16 1 soluble	6.38E-05	Mk 16 1 soluble	5.90E-05
Breast	Mk 16 1 soluble	6.08E-05	Mk 16 1 soluble	5.62E-05
Esophagus	Mk 16 1 soluble	6.73E-05	Mk 16 1 soluble	6.22E-05
Stomach	Mk 16 1 soluble	7.86E-05	Mk 16 1 soluble	7.27E-05
Small intestine	Mk 16 1 soluble	1.14E-04	Mk 16 1 soluble	1.05E-04
Upper large intestine	Mk 16 1 soluble	3.17E-04	Mk 16 1 soluble	2.93E-04
Lower large intestine	Mk 16 1 insoluble	8.10E-04	Mk 16 1 insoluble	7.49E-04
Colon	Mk 16 1 insoluble	5.23E-04	Mk 16 1 insoluble	4.84E-04
Kidneys	Mk 16 1 soluble	7.39E-05	Mk 16 1 soluble	6.84E-05
Liver	Mk 16 1 soluble	1.90E-03	Mk 16 1 soluble	1.76E-03
Muscle	Mk 16 1 soluble	6.43E-05	Mk 16 1 soluble	5.95E-05
Ovaries	Mk 16 1 soluble	7.96E-05	Mk 16 1 soluble	7.37E-05
Pancreas	Mk 16 1 soluble	7.49E-05	Mk 16 1 soluble	6.93E-05
Red marrow	Mk 16 1 soluble	7.26E-04	Mk 16 1 soluble	6.72E-04
Extrathoracic airways	Mk 16 1 insoluble	1.04E-03	Mk 16 1 insoluble	9.65E-04
Lungs	Mk 16 1 insoluble	5.18E-03	Mk 16 1 insoluble	4.80E-03
Skin	Mk 16 1 soluble	5.59E-05	Mk 16 1 soluble	5.17E-05
Spleen	Mk 16 1 soluble	6.73E-05	Mk 16 1 soluble	6.22E-05
Testes	Mk 16 1 soluble	5.64E-05	Mk 16 1 soluble	5.22E-05
Thymus	Mk 16 1 soluble	6.73E-05	Mk 16 1 soluble	6.22E-05
Thyroid	Mk 16 1 soluble	6.45E-05	Mk 16 1 soluble	5.96E-05
Uterus	Mk 16 1 soluble	6.82E-05	Mk 16 1 soluble	6.31E-05

Table 4-3. SRS-specific committed organ doses for 1 Bq/d in urine by gross beta at 1 year decay.

Organ	Limiting case and dose (mSv) for 1 Bq beta in urine			
	90-day chronic intake		30-year chronic intake	
	Limiting case and solubility	Dose	Limiting case and solubility	Dose
Adrenals	Mk V-B soluble	1.17E-04	Mk V-B soluble	1.05E-04
Urinary bladder	Mk V-B soluble	1.11E-04	Mk V-B soluble	9.86E-05
Bone surface	Mk V-B soluble	2.61E-03	Mk V-B soluble	2.33E-03
Brain	Mk V-B soluble	9.98E-05	Mk V-B soluble	8.90E-05
Breast	Mk V-B soluble	9.92E-05	Mk V-B soluble	8.85E-05
Esophagus	Mk V-B soluble	1.05E-04	Mk V-B soluble	9.33E-05
Stomach	Mk V-B soluble	1.21E-04	Mk V-B soluble	1.08E-04
Small intestine	Mk V-B soluble	1.62E-04	Mk V-B soluble	1.44E-04
Upper large intestine	Mk V-B soluble	4.43E-04	Mk V-B soluble	3.95E-04
Lower large intestine	Mk V-B insoluble	1.14E-03	Mk V-B insoluble	1.02E-03
Colon	Mk V-B insoluble	7.34E-04	Mk V-B insoluble	6.55E-04
Kidneys	Mk V-B soluble	1.09E-04	Mk V-B soluble	9.69E-05
Liver	Mk V-B soluble	2.97E-03	Mk V-B soluble	2.65E-03
Muscle	Mk V-B soluble	1.01E-04	Mk V-B soluble	8.98E-05
Ovaries	Mk V-B soluble	1.13E-04	Mk V-B soluble	1.01E-04
Pancreas	Mk V-B soluble	1.12E-04	Mk V-B soluble	9.96E-05
Red marrow	Mk 16 1 soluble	1.08E-03	Mk V-B soluble	9.57E-04
Extrathoracic airways	Mk V-B insoluble	1.35E-03	Mk V-B insoluble	1.21E-03
Lungs	Mk V-B insoluble	8.05E-03	Mk V-B insoluble	7.18E-03
Skin	Mk V-B soluble	9.44E-05	Mk V-B soluble	8.42E-05
Spleen	Mk V-B soluble	1.05E-04	Mk V-B soluble	9.33E-05
Testes	Mk V-B soluble	9.55E-05	Mk V-B soluble	8.52E-05
Thymus	Mk V-B soluble	1.05E-04	Mk V-B soluble	9.33E-05
Thyroid	Mk V-B soluble	1.01E-04	Mk V-B soluble	9.00E-05
Uterus	Mk V-B soluble	1.04E-04	Mk V-B soluble	9.30E-05

Table 4-4. Associated radionuclide activity fractions for assigning intakes, particulates only (no ^{131}I).

	Mk V-B base				Mk 16 base				Mk 16 A1			
Radionuclide	**10 d**	**40 d**	**180 d**	**1 y**	**10 d**	**40 d**	**180 d**	**1 y**	**10 d**	**40 d**	**180 d**	**1 y**
Sr-89	1.09E-01	1.20E-01	8.05E-02	2.43E-02	1.16E-01	1.15E-01	6.37E-02	1.50E-02	1.21E-01	1.21E-01	7.12E-02	1.84E-02
Sr-90	9.96E-04	1.65E-03	7.49E-03	2.82E-02	2.74E-03	4.07E-03	1.53E-02	4.48E-02	2.04E-03	3.09E-03	1.23E-02	3.97E-02
Y-91	1.26E-01	1.46E-01	1.28E-01	5.44E-02	1.44E-01	1.51E-01	1.08E-01	3.60E-02	1.46E-01	1.55E-01	1.18E-01	4.33E-02
Zr-95	1.37E-01	1.65E-01	1.66E-01	8.54E-02	1.60E-01	1.72E-01	1.43E-01	5.73E-02	1.59E-01	1.74E-01	1.53E-01	6.77E-02
Nb-95	7.02E-02	1.50E-01	3.04E-01	1.82E-01	1.64E-01	2.24E-01	2.78E-01	1.23E-01	1.47E-01	2.13E-01	2.95E-01	1.45E-01
Ru-103	1.10E-01	1.08E-01	4.17E-02	6.07E-03	7.59E-02	6.65E-02	2.12E-02	2.41E-03	8.00E-02	7.14E-02	2.42E-02	3.02E-03
Ru-106	4.88E-03	7.67E-03	2.70E-02	7.30E-02	4.75E-03	6.69E-03	1.95E-02	4.10E-02	3.62E-03	5.18E-03	1.60E-02	3.71E-02
Cs-134	1.03E-04	1.67E-04	6.71E-04	2.16E-03	2.57E-03	3.72E-03	1.24E-02	3.10E-02	1.16E-03	1.70E-03	6.00E-03	1.66E-02
Cs-137	1.12E-03	1.86E-03	8.43E-03	3.18E-02	2.79E-03	4.14E-03	1.55E-02	4.56E-02	2.07E-03	3.13E-03	1.24E-02	4.03E-02
Ce-141	1.84E-01	1.61E-01	3.73E-02	2.75E-03	1.38E-01	1.08E-01	2.07E-02	1.19E-03	1.50E-01	1.20E-01	2.43E-02	1.54E-03
Ce-144	3.37E-02	5.20E-02	1.69E-01	4.12E-01	7.05E-02	9.75E-02	2.62E-01	4.97E-01	5.73E-02	8.07E-02	2.30E-01	4.80E-01
Pr-143	2.19E-01	7.89E-02	2.83E-04	8.50E-08	1.11E-01	3.56E-02	1.05E-04	2.47E-08	1.25E-01	4.10E-02	1.29E-04	3.32E-08
Pm-147	3.51E-03	6.85E-03	2.92E-02	9.74E-02	7.71E-03	1.17E-02	4.03E-02	1.05E-01	6.48E-03	1.02E-02	3.72E-02	1.06E-01

	Mk VI-B base				Mk VI-B A1			
Radionuclide	**10 d**	**40 d**	**180 d**	**1 y**	**10 d**	**40 d**	**180 d**	**1 y**
Sr-89	1.20E-01	1.20E-01	6.91E-02	1.74E-02	1.20E-01	1.20E-01	6.91E-02	1.74E-02
Sr-90	2.23E-03	3.36E-03	1.31E-02	4.13E-02	2.23E-03	3.36E-03	1.31E-02	4.13E-02
Y-91	1.46E-01	1.54E-01	1.16E-01	4.12E-02	1.46E-01	1.54E-01	1.16E-01	4.12E-02
Zr-95	1.59E-01	1.74E-01	1.50E-01	6.46E-02	1.59E-01	1.74E-01	1.50E-01	6.47E-02
Nb-95	1.53E-01	2.18E-01	2.91E-01	1.39E-01	1.53E-01	2.18E-01	2.91E-01	1.39E-01
Ru-103	7.81E-02	6.93E-02	2.31E-02	2.80E-03	7.79E-02	6.91E-02	2.30E-02	2.80E-03
Ru-106	3.81E-03	5.43E-03	1.65E-02	3.72E-02	3.77E-03	5.38E-03	1.63E-02	3.68E-02
Cs-134	1.85E-03	2.72E-03	9.42E-03	2.53E-02	1.50E-03	2.20E-03	7.63E-03	2.05E-02
Cs-137	2.26E-03	3.40E-03	1.33E-02	4.19E-02	2.26E-03	3.40E-03	1.33E-02	4.18E-02
Ce-141	1.46E-01	1.16E-01	2.31E-02	1.43E-03	1.46E-01	1.16E-01	2.32E-02	1.43E-03
Ce-144	6.10E-02	8.55E-02	2.40E-01	4.87E-01	6.10E-02	8.55E-02	2.40E-01	4.87E-01
Pr-143	1.20E-01	3.91E-02	1.21E-04	3.03E-08	1.20E-01	3.92E-02	1.21E-04	3.04E-08
Pm-147	6.43E-03	1.00E-02	3.59E-02	1.00E-01	6.77E-03	1.05E-02	3.78E-02	1.05E-01

Table 4-5. Committed organ doses for a 4,400 dpm/d chronic intake rate at 10 days decay.

Organ	Limiting case and dose (mSv) for a 4,400 dpm/d intake rate			
	90-day chronic intake		30-year chronic intake	
	Limiting case and solubility	Dose	Limiting case and solubility	Dose
Adrenals	Mk 16 1 soluble	5.13E-03	Mk 16 1 soluble	6.25E-01
Urinary bladder	Mk V-B soluble	2.23E-02	Mk V-B soluble	2.71E+00
Bone surface	Mk 16 1 soluble	1.05E-01	Mk 16 1 soluble	1.28E+01
Brain	Mk V-B soluble	6.16E-03	Mk V-B soluble	7.50E-01
Breast	Mk V-B soluble	3.47E-03	Mk V-B soluble	4.23E-01
Esophagus	Mk V-B soluble	6.20E-03	Mk V-B soluble	7.55E-01
Stomach	Mk V-B soluble	5.63E-03	Mk V-B soluble	6.86E-01
Small intestine	Mk 16 1 soluble	6.62E-03	Mk 16 1 soluble	8.06E-01
Upper large intestine	Mk 16 1 soluble	1.87E-02	Mk 16 1 soluble	2.27E+00
Lower large intestine	Mk 16 1 insoluble	4.84E-02	Mk 16 1 insoluble	5.89E+00
Colon	Mk 16 1 insoluble	3.14E-02	Mk 16 1 insoluble	3.82E+00
Kidneys	Mk 16 1 soluble	4.28E-03	Mk 16 1 soluble	5.21E-01
Liver	Mk 16 1 soluble	5.43E-02	Mk 16 1 soluble	6.61E+00
Muscle	Mk V-B soluble	5.71E-03	Mk V-B soluble	6.95E-01
Ovaries	Mk 16 1 soluble	4.70E-03	Mk 16 1 soluble	5.72E-01
Pancreas	Mk 16 1 soluble	4.16E-03	Mk 16 1 soluble	5.07E-01
Red marrow	Mk 16 1 soluble	3.14E-02	Mk 16 1 soluble	3.83E+00
Extrathoracic airways	Mk V-B insoluble	1.01E-01	Mk V-B insoluble	1.23E+01
Lungs	Mk 16 1 insoluble	2.39E-01	Mk 16 1 insoluble	2.91E+01
Skin	Mk V-B soluble	3.64E-03	Mk V-B soluble	4.44E-01
Spleen	Mk 16 1 soluble	3.56E-03	Mk 16 1 soluble	4.33E-01
Testes	Mk V-B soluble	2.73E-03	Mk V-B soluble	3.33E-01
Thymus	Mk V-B soluble	6.20E-03	Mk V-B soluble	7.55E-01
Thyroid	Mk V-B soluble	1.11E+01	Mk V-B soluble	1.35E+03
Uterus	Mk V-B soluble	3.96E-03	Mk V-B soluble	4.82E-01

Table 4-6. Committed organ doses for a 4,400 dpm/d chronic intake rate at 180 days decay.

Organ	Limiting case and dose (mSv) for a 4,400 dpm/d intake rate			
	90-day chronic intake		30-year chronic intake	
	Limiting case and solubility	Dose	Limiting case and solubility	Dose
Adrenals	Mk 16 1 Soluble	8.16E-03	Mk 16 1 Soluble	9.93E-01
Urinary bladder	Mk 16 1 Soluble	6.67E-03	Mk 16 1 Soluble	8.12E-01
Bone surface	Mk 16 1 Soluble	1.86E-01	Mk 16 1 Soluble	2.26E+01
Brain	Mk 16 1 Soluble	6.15E-03	Mk 16 1 Soluble	7.49E-01
Breast	Mk 16 1 Soluble	5.86E-03	Mk 16 1 Soluble	7.13E-01
Esophagus	Mk 16 1 Soluble	6.49E-03	Mk 16 1 Soluble	7.90E-01
Stomach	Mk 16 1 Soluble	7.58E-03	Mk 16 1 Soluble	9.22E-01
Small intestine	Mk 16 1 Soluble	1.10E-02	Mk 16 1 Soluble	1.34E+00
Upper large intestine	Mk 16 1 Soluble	3.05E-02	Mk 16 1 Soluble	3.72E+00
Lower large intestine	Mk 16 1 Insoluble	7.81E-02	Mk 16 1 Insoluble	9.51E+00
Colon	Mk 16 1 Insoluble	5.04E-02	Mk 16 1 Insoluble	6.14E+00
Kidneys	Mk 16 1 Soluble	7.12E-03	Mk 16 1 Soluble	8.67E-01
Liver	Mk 16 1 Soluble	1.83E-01	Mk 16 1 Soluble	2.23E+01
Muscle	Mk 16 1 Soluble	6.20E-03	Mk 16 1 Soluble	7.55E-01
Ovaries	Mk 16 1 Soluble	7.68E-03	Mk 16 1 Soluble	9.35E-01
Pancreas	Mk 16 1 Soluble	7.22E-03	Mk 16 1 Soluble	8.79E-01
Red marrow	Mk 16 1 Soluble	7.00E-02	Mk 16 1 Soluble	8.52E+00
Extrathoracic airways	Mk 16 1 Insoluble	1.01E-01	Mk 16 1 Insoluble	1.22E+01
Lungs	Mk 16 1 Insoluble	5.00E-01	Mk 16 1 Insoluble	6.09E+01
Skin	Mk 16 1 Soluble	5.39E-03	Mk 16 1 Soluble	6.56E-01
Spleen	Mk 16 1 Soluble	6.49E-03	Mk 16 1 Soluble	7.90E-01
Testes	Mk 16 1 Soluble	5.44E-03	Mk 16 1 Soluble	6.63E-01
Thymus	Mk 16 1 Soluble	6.49E-03	Mk 16 1 Soluble	7.90E-01
Thyroid	Mk 16 1 Soluble	6.22E-03	Mk 16 1 Soluble	7.57E-01
Uterus	Mk 16 1 Soluble	6.58E-03	Mk 16 1 Soluble	8.01E-01

Table 4-7. Committed organ doses for a 4,400 dpm/d chronic intake rate at 1 year decay.

Organ	Limiting case and dose (mSv) for a 4,400 dpm/d intake rate			
	90-day chronic intake		30-year chronic intake	
	Limiting case and solubility	Dose	Limiting case and solubility	Dose
Adrenals	Mk 16 1 soluble	1.24E-02	Mk 16 1 soluble	1.51E+00
Urinary bladder	Mk 16 1 soluble	1.17E-02	Mk 16 1 soluble	1.43E+00
Bone surface	Mk 16 1 soluble	3.15E-01	Mk 16 1 soluble	3.83E+01
Brain	Mk 16 1 soluble	1.03E-02	Mk 16 1 soluble	1.26E+00
Breast	Mk 16 1 soluble	1.03E-02	Mk 16 1 soluble	1.25E+00
Esophagus	Mk 16 1 soluble	1.12E-02	Mk 16 1 soluble	1.36E+00
Stomach	Mk 16 1 soluble	1.30E-02	Mk 16 1 soluble	1.58E+00
Small intestine	Mk 16 1 soluble	1.73E-02	Mk 16 1 soluble	2.11E+00
Upper large intestine	Mk 16 1 soluble	4.78E-02	Mk 16 1 soluble	5.82E+00
Lower large intestine	Mk 16 1 insoluble	1.22E-01	Mk 16 1 insoluble	1.48E+01
Colon	Mk 16 1 insoluble	7.87E-02	Mk 16 1 insoluble	9.58E+00
Kidneys	Mk 16 1 soluble	1.16E-02	Mk 16 1 soluble	1.41E+00
Liver	Mk 16 1 soluble	3.46E-01	Mk 16 1 soluble	4.21E+01
Muscle	Mk 16 1 soluble	1.06E-02	Mk 16 1 soluble	1.29E+00
Ovaries	Mk 16 1 soluble	1.20E-02	Mk 16 1 soluble	1.46E+00
Pancreas	Mk 16 1 soluble	1.21E-02	Mk 16 1 soluble	1.47E+00
Red marrow	Mk 16 1 soluble	1.35E-01	Mk 16 1 soluble	1.65E+01
Extrathoracic airways	Mk 16 1 insoluble	1.44E-01	Mk 16 1 insoluble	1.76E+01
Lungs	Mk 16 1 insoluble	8.42E-01	Mk 16 1 insoluble	1.02E+02
Skin	Mk 16 1 soluble	9.67E-03	Mk 16 1 soluble	1.18E+00
Spleen	Mk 16 1 soluble	1.13E-02	Mk 16 1 soluble	1.37E+00
Testes	Mk 16 1 soluble	1.03E-02	Mk 16 1 soluble	1.25E+00
Thymus	Mk 16 1 soluble	1.12E-02	Mk 16 1 soluble	1.36E+00
Thyroid	Mk 16 1 soluble	1.08E-02	Mk 16 1 soluble	1.31E+00
Uterus	Mk 16 1 soluble	1.13E-02	Mk 16 1 soluble	1.37E+00

Table 5-1. Comparisons of committed organ doses computed using the SRS Site Profile assumptions with those determined using the OTIB-0054 method for 1 Bq/d in urine by gross beta at 10 days decay.

Organ	Committed organ dose (mSv)							
	90-day intake period				30-year intake period			
	TBD 1	TBD 2	TBD 3	This report	TBD 1	TBD 2	TBD 3	This report
Adrenals	1.39E-02			4.57E-05	1.45E+00			4.49E-05
Urinary bladder	1.59E-02			2.06E-04	1.66E+00			2.04E-04
Bone surface	2.08E-01			9.35E-04	2.17E+01			9.18E-04
Brain	1.32E-02			5.69E-05	1.38E+00			5.63E-05
Breast	1.30E-02			3.21E-05	1.35E+00			3.18E-05
Esophagus	1.36E-02			5.73E-05	1.42E+00			5.67E-05
Stomach			7.58E+00	5.20E-05			1.36E+02	5.15E-05
Small intestine			1.05E+01	5.89E-05			1.89E+02	5.79E-05
Upper large intestine			3.80E+01	1.66E-04			6.83E+02	1.63E-04
Lower large intestine			9.76E+01	4.31E-04			1.75E+03	4.23E-04
Colon			6.47E+01	2.79E-04			1.16E+03	2.74E-04
Kidneys	1.37E-02			3.87E-05	1.43E+00			3.83E-05
Liver		1.71E+02		4.83E-04		3.07E+03		4.75E-04
Muscle	1.35E-02			5.27E-05	1.41E+00			5.22E-05
Ovaries	1.40E-02			4.18E-05	1.46E+00			4.11E-05
Pancreas	1.40E-02			3.76E-05	1.46E+00			3.72E-05
Red marrow	9.78E-02			2.80E-04	1.02E+01			2.75E-04
Extrathoracic airways			6.40E+01	9.36E-04			1.15E+03	9.27E-04
Lungs			5.63E+02	2.13E-03			1.01E+04	2.09E-03
Skin	1.29E-02			3.37E-05	1.34E+00			3.33E-05
Spleen	1.37E-02			3.25E-05	1.43E+00			3.22E-05
Testes	1.34E-02			2.53E-05	1.39E+00			2.50E-05
Thymus	1.36E-02			5.73E-05	1.42E+00			5.67E-05
Thyroid	1.36E-02			1.03E-01	1.42E+00			1.01E-01
Uterus	1.40E-02			3.66E-05	1.46E+00			3.62E-05

Table 5-2. Comparisons of committed organ doses computed using the SRS Site Profile assumptions with those determined using the OTIB-0054 method for 1 Bq/d in urine by gross beta at 180 days decay.

	Committed organ dose (mSv)							
	90-day intake period				30-year intake period			
Organ	TBD 1	TBD 2	TBD 3	This report	TBD 1	TBD 2	TBD 3	This report
Adrenals	1.39E-02			8.46E-05	1.45E+00			7.83E-05
Urinary bladder	1.59E-02			6.92E-05	1.66E+00			6.40E-05
Bone surface	2.08E-01			1.93E-03	2.17E+01			1.78E-03
Brain	1.32E-02			6.38E-05	1.38E+00			5.90E-05
Breast	1.30E-02			6.08E-05	1.35E+00			5.62E-05
Esophagus	1.36E-02			6.73E-05	1.42E+00			6.22E-05
Stomach			7.58E+00	7.86E-05			1.36E+02	7.27E-05
Small intestine			1.05E+01	1.14E-04			1.89E+02	1.05E-04
Upper large intestine			3.80E+01	3.17E-04			6.83E+02	2.93E-04
Lower large intestine			9.76E+01	8.10E-04			1.75E+03	7.49E-04
Colon			6.47E+01	5.23E-04			1.16E+03	4.84E-04
Kidneys	1.37E-02			7.39E-05	1.43E+00			6.84E-05
Liver		1.71E+02		1.90E-03		3.07E+03		1.76E-03
Muscle	1.35E-02			6.43E-05	1.41E+00			5.95E-05
Ovaries	1.40E-02			7.96E-05	1.46E+00			7.37E-05
Pancreas	1.40E-02			7.49E-05	1.46E+00			6.93E-05
Red marrow	9.78E-02			7.26E-04	1.02E+01			6.72E-04
Extrathoracic airways			6.40E+01	1.04E-03			1.15E+03	9.65E-04
Lungs			5.63E+02	5.18E-03			1.01E+04	4.80E-03
Skin	1.29E-02			5.59E-05	1.34E+00			5.17E-05
Spleen	1.37E-02			6.73E-05	1.43E+00			6.22E-05
Testes	1.34E-02			5.64E-05	1.39E+00			5.22E-05
Thymus	1.36E-02			6.73E-05	1.42E+00			6.22E-05
Thyroid	1.36E-02			6.45E-05	1.42E+00			5.96E-05
Uterus	1.40E-02			6.82E-05	1.46E+00			6.31E-05

Table 5-3. Comparisons of committed organ doses computed using the SRS Site Profile assumptions with those determined using the OTIB-0054 method for 1 Bq/d in urine by gross beta at 1 year decay.

	Committed organ dose (mSv)							
	90-day intake period				30-year intake period			
Organ	TBD 1	TBD 2	TBD 3	This report	TBD 1	TBD 2	TBD 3	This report
Adrenals	1.39E-02			1.17E-04	1.45E+00			1.05E-04
Urinary bladder	1.59E-02			1.11E-04	1.66E+00			9.86E-05
Bone surface	2.08E-01			2.61E-03	2.17E+01			2.33E-03
Brain	1.32E-02			9.98E-05	1.38E+00			8.90E-05
Breast	1.30E-02			9.92E-05	1.35E+00			8.85E-05
Esophagus	1.36E-02			1.05E-04	1.42E+00			9.33E-05
Stomach			7.58E+00	1.21E-04			1.36E+02	1.08E-04
Small intestine			1.05E+01	1.62E-04			1.89E+02	1.44E-04
Upper large intestine			3.80E+01	4.43E-04			6.83E+02	3.95E-04
Lower large intestine			9.76E+01	1.14E-03			1.75E+03	1.02E-03
Colon			6.47E+01	7.34E-04			1.16E+03	6.55E-04
Kidneys	1.37E-02			1.09E-04	1.43E+00			9.69E-05
Liver		1.71E+02		2.97E-03		3.07E+03		2.65E-03
Muscle	1.35E-02			1.01E-04	1.41E+00			8.98E-05
Ovaries	1.40E-02			1.13E-04	1.46E+00			1.01E-04
Pancreas	1.40E-02			1.12E-04	1.46E+00			9.96E-05
Red marrow	9.78E-02			1.08E-03	1.02E+01			9.57E-04
Extrathoracic airways			6.40E+01	1.35E-03			1.15E+03	1.21E-03
Lungs			5.63E+02	8.05E-03			1.01E+04	7.18E-03
Skin	1.29E-02			9.44E-05	1.34E+00			8.42E-05
Spleen	1.37E-02			1.05E-04	1.43E+00			9.33E-05
Testes	1.34E-02			9.55E-05	1.39E+00			8.52E-05
Thymus	1.36E-02			1.05E-04	1.42E+00			9.33E-05
Thyroid	1.36E-02			1.01E-04	1.42E+00			9.00E-05
Uterus	1.40E-02			1.04E-04	1.46E+00			9.30E-05

Table 5-4. Comparisons of committed organ doses computed using the SRS Site Profile assumptions with those determined using the OTIB-0054 method for a 4,400 dpm/d chronic intake rate at 10 days decay.

Organ	Committed organ dose (mSv)			
	90-day intake period		30-year intake period	
	TBD	This report	TBD	This report
Adrenals	4.92E-02	5.13E-03	5.99E+00	6.25E-01
Urinary bladder	4.40E-02	2.23E-02	5.36E+00	2.71E+00
Bone surface	1.58E+00	1.05E-01	1.92E+02	1.28E+01
Brain	3.75E-02	6.16E-03	4.56E+00	7.50E-01
Breast	4.74E-02	3.47E-03	5.77E+00	4.23E-01
Esophagus	5.12E-02	6.20E-03	6.23E+00	7.55E-01
Stomach	4.53E-02	5.63E-03	5.52E+00	6.86E-01
Small intestine	4.51E-02	6.62E-03	5.49E+00	8.06E-01
Upper large intestine	7.16E-02	1.87E-02	8.72E+00	2.27E+00
Lower large intestine	1.72E-01	4.84E-02	2.10E+01	5.89E+00
Colon	1.15E-01	3.14E-02	1.40E+01	3.82E+00
Kidneys	4.21E-02	4.28E-03	5.13E+00	5.21E-01
Liver	3.57E-01	5.44E-02	4.35E+01	6.62E+00
Muscle	4.20E-02	5.71E-03	5.11E+00	6.95E-01
Ovaries	4.07E-02	4.70E-03	4.96E+00	5.72E-01
Pancreas	4.66E-02	4.16E-03	5.67E+00	5.07E-01
Red marrow	6.96E-01	3.14E-02	8.48E+01	3.83E+00
Extrathoracic airways	1.84E-01	1.01E-01	2.24E+01	1.23E+01
Lungs	1.09E+00	2.40E-01	1.33E+02	2.92E+01
Skin	3.80E-02	3.64E-03	4.62E+00	4.44E-01
Spleen	4.58E-02	3.56E-03	5.58E+00	4.33E-01
Testes	3.72E-02	2.73E-03	4.53E+00	3.33E-01
Thymus	5.12E-02	6.20E-03	6.23E+00	7.55E-01
Thyroid	4.23E-02	1.11E+01	5.15E+00	1.35E+03
Uterus	3.98E-02	3.96E-03	4.85E+00	4.82E-01

Table 5-5. Comparisons of committed organ doses computed using the SRS Site Profile assumptions with those determined using the OTIB-0054 method for a 4,400 dpm/d chronic intake rate at 180 days decay.

Organ	Committed organ dose (mSv)			
	90-day intake period		30-year intake period	
	TBD	This report	TBD	This report
Adrenals	4.92E-02	8.16E-03	5.99E+00	9.93E-01
Urinary bladder	4.40E-02	6.68E-03	5.36E+00	8.13E-01
Bone surface	1.58E+00	1.86E-01	1.92E+02	2.27E+01
Brain	3.75E-02	6.15E-03	4.56E+00	7.49E-01
Breast	4.74E-02	5.86E-03	5.77E+00	7.14E-01
Esophagus	5.12E-02	6.49E-03	6.23E+00	7.90E-01
Stomach	4.53E-02	7.58E-03	5.52E+00	9.23E-01
Small intestine	4.51E-02	1.10E-02	5.49E+00	1.34E+00
Upper large intestine	7.16E-02	3.05E-02	8.72E+00	3.72E+00
Lower large intestine	1.72E-01	7.81E-02	2.10E+01	9.51E+00
Colon	1.15E-01	5.05E-02	1.40E+01	6.14E+00
Kidneys	4.21E-02	7.13E-03	5.13E+00	8.68E-01
Liver	3.57E-01	1.83E-01	4.35E+01	2.23E+01
Muscle	4.20E-02	6.20E-03	5.11E+00	7.55E-01
Ovaries	4.07E-02	7.68E-03	4.96E+00	9.35E-01
Pancreas	4.66E-02	7.22E-03	5.67E+00	8.79E-01
Red marrow	6.96E-01	7.00E-02	8.48E+01	8.53E+00
Extrathoracic airways	1.84E-01	1.01E-01	2.24E+01	1.22E+01
Lungs	1.09E+00	5.00E-01	1.33E+02	6.09E+01
Skin	3.80E-02	5.39E-03	4.62E+00	6.57E-01
Spleen	4.58E-02	6.49E-03	5.58E+00	7.90E-01
Testes	3.72E-02	5.45E-03	4.53E+00	6.63E-01
Thymus	5.12E-02	6.49E-03	6.23E+00	7.90E-01
Thyroid	4.23E-02	6.22E-03	5.15E+00	7.57E-01
Uterus	3.98E-02	6.58E-03	4.85E+00	8.01E-01

Table 5-6. Comparisons of committed organ doses computed using the SRS Site Profile assumptions with those determined using the OTIB-0054 method for a 4,400 dpm/d chronic intake rate at 1 year decay.

Organ	Committed organ dose (mSv)			
	90-day intake period		30-year intake period	
	TBD	This report	TBD	This report
Adrenals	4.92E-02	1.24E-02	5.99E+00	1.51E+00
Urinary bladder	4.40E-02	1.17E-02	5.36E+00	1.43E+00
Bone surface	1.58E+00	3.15E-01	1.92E+02	3.83E+01
Brain	3.75E-02	1.03E-02	4.56E+00	1.26E+00
Breast	4.74E-02	1.03E-02	5.77E+00	1.25E+00
Esophagus	5.12E-02	1.12E-02	6.23E+00	1.36E+00
Stomach	4.53E-02	1.30E-02	5.52E+00	1.58E+00
Small intestine	4.51E-02	1.73E-02	5.49E+00	2.11E+00
Upper large intestine	7.16E-02	4.78E-02	8.72E+00	5.82E+00
Lower large intestine	1.72E-01	1.22E-01	2.10E+01	1.48E+01
Colon	1.15E-01	7.87E-02	1.40E+01	9.58E+00
Kidneys	4.21E-02	1.16E-02	5.13E+00	1.41E+00
Liver	3.57E-01	3.46E-01	4.35E+01	4.21E+01
Muscle	4.20E-02	1.06E-02	5.11E+00	1.29E+00
Ovaries	4.07E-02	1.20E-02	4.96E+00	1.46E+00
Pancreas	4.66E-02	1.21E-02	5.67E+00	1.47E+00
Red marrow	6.96E-01	1.35E-01	8.48E+01	1.65E+01
Extrathoracic airways	1.84E-01	1.44E-01	2.24E+01	1.76E+01
Lungs	1.09E+00	8.42E-01	1.33E+02	1.02E+02
Skin	3.80E-02	9.67E-03	4.62E+00	1.18E+00
Spleen	4.58E-02	1.13E-02	5.58E+00	1.37E+00
Testes	3.72E-02	1.03E-02	4.53E+00	1.25E+00
Thymus	5.12E-02	1.12E-02	6.23E+00	1.36E+00
Thyroid	4.23E-02	1.08E-02	5.15E+00	1.31E+00
Uterus	3.98E-02	1.13E-02	4.85E+00	1.37E+00

ATTACHMENT A
SRS RPRT-0047 EVALUATION
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INTRODUCTION

For SRS, most of the WBC data available for the era from about 1979 through about 1989 were reported in units of activity. For other periods, only limited data were reported in units of activity, usually ^{40}K and ^{137}Cs. Therefore, during this period, comparison of the measured quantities of various radionuclides can be made. The objective of this evaluation is to assess the reasonableness of the radionuclide ratios in the text of this report by comparing predicted body burdens with positive *in vivo* counts from SRS workers.

Individuals who worked in the separations or waste management areas at SRS with positive ^{137}Cs WBC results during the period from 1979 to 1989 were selected for evaluation. One additional worker from the reactor area was chosen. A fitted dose assessment using standard dose reconstruction techniques was made of the positive ^{137}Cs results. Any ^{137}Cs results above 1 nCi were treated as positive measurements because this is the minimum detectable activity (MDA) stated in the SRS Site Profile. In actuality, the MDA varied and was likely higher. The intake amount and/or rates thus determined were used to determine corresponding intakes of other fission and activation products using the ratios in this report applicable to the individual's work location. The highest intake ratio for each radionuclide and decay time out of the 5 reactor types was used. For this evaluation, intake rates of ^{144}Ce, ^{106}Ru, and ^{95}Zr/Nb were calculated. The whole-body burdens associated with these intakes were projected using IMBA's "Intakes to Bioassay" function and compared to the reported WBC results for these radionuclides. For ^{95}Zr/Nb, the intake ratios from this report were used for each radionuclide separately, and then the predicted body burdens were summed for comparison to the MDAs.

Often, ^{144}Ce, ^{106}Ru, and ^{95}Zr/Nb were not detected (i.e., <MDA) and only the MDA was reported. However, in some instances the raw WBC data permit the determination of the actual <MDA result. Values reported on the form titled "In Vivo Count Report" (IVCR) include "DIFF," "MDA in counts," and "MDA in nCi" for each radionuclide. The DIFF value is the result, after subtraction of the contribution of the Compton continuum, in units of counts. By comparing that value to the MDA in both counts and nanocuries, a body burden result in nanocuries can be determined. Earlier forms used to record the WBC results reported the DIFF value but not the MDAs. For these results, generic conversion factors from "Evaluation of a Whole Body Count" (DuPont undated) were used to convert the DIFF value to a body burden in nanocuries. DIFF values less than zero were set to zero to calculate body burdens.

WBC results on the form titled "Whole Body Counter Data" do not provide DIFF values but report net count rates (cpm). In this case, the ^{40}K and ^{137}Cs net counts were used to account for the contribution of the Compton continuum. The following equations were used to calculate the ^{144}Ce, ^{106}Ru, and ^{95}Zr/Nb body burdens based on calibration factors from the Watts laboratory book (Watts 1962–1967) for WBCs before February 1964:

$$^{144}\text{Ce, nCi} = (0.766)[(^{144}\text{Ce net cpm}) - (0.824)(^{40}\text{K net cpm}) - (0.909)(^{137}\text{Cs net cpm})]$$
$$^{106}\text{Ru, nCi} = (0.543)[(^{106}\text{Ru net cpm}) - (0.204)(^{40}\text{K cpm}) - (0.217)(^{137}\text{Cs net cpm})]$$
$$^{95}\text{Zr/Nb, nCi} = (0.215)[(\text{Zr-95 net cpm}) - (0.107)(^{40}\text{K cpm}) - (0.175)(^{137}\text{Cs net cpm})]$$

For after January 1964, the following equations were used:

$$^{144}\text{Ce, nCi} = (0.766)[(^{144}\text{Ce net cpm}) - (1.050)(^{40}\text{K net cpm}) - (0.627)(^{137}\text{Cs net cpm})]$$
$$^{106}\text{Ru, nCi} = (0.543)[(^{106}\text{Ru net cpm}) - (0.222)(^{40}\text{K cpm}) - (0.235)(^{137}\text{Cs net cpm})]$$
$$^{95}\text{Zr/Nb, nCi} = (0.215)[(\text{Zr-95 net cpm}) - (0.173)(^{40}\text{K cpm}) - (0.071)(^{137}\text{Cs net cpm})]$$

The reported MDAs for ^{144}Ce, ^{106}Ru, and ^{95}Zr/Nb and the actual unreported result, where determinable, were used for the comparison. Where not reported, assumed MDAs based on other reported MDAs for that individual were used for the comparison. In the plots, the MDAs, assumed MDAs, unreported results, and reported results are marked as such for comparison to the predicted body burden lines for each applicable solubility type for each radionuclide. It should be noted that unreported results often exceed the assumed MDA. In these cases, the unreported result is still assumed to be a <MDA result.

It is not possible to determine unreported results for all WBCs. In particular, WBCs performed on the hyperpure germanium (HPGe) and lithium-drifted germanium [Ge(Li)] systems in the 1980s were reported with the ABACOS system. The provided printout in the claimant files does not permit the determination of <MDA results or the MDAs where such are not explicitly provided.

Worker 1
This individual is listed as a front line supervisor and manager in the separations area. From 1978 through 1989, he had 19 WBCs, half of which reported ^{137}Cs activities above the Site Profile-listed MDA of 1 nCi. A high (4.8 nCi) measurement on May 11, 1987, was noted in the individual's DOE records as being reported at the MDA and was therefore treated as a <MDA result. The remaining six positive measurements, three in a row and four isolated positives, were fit with four acute intakes occurring on 06/17/1979, 03/04/1982, 06/21/1984, and 12/23/1985 and two chronic intakes from 02/16/1977 through 10/19/1978 and from 05/12/1987 through 05/12/1989.

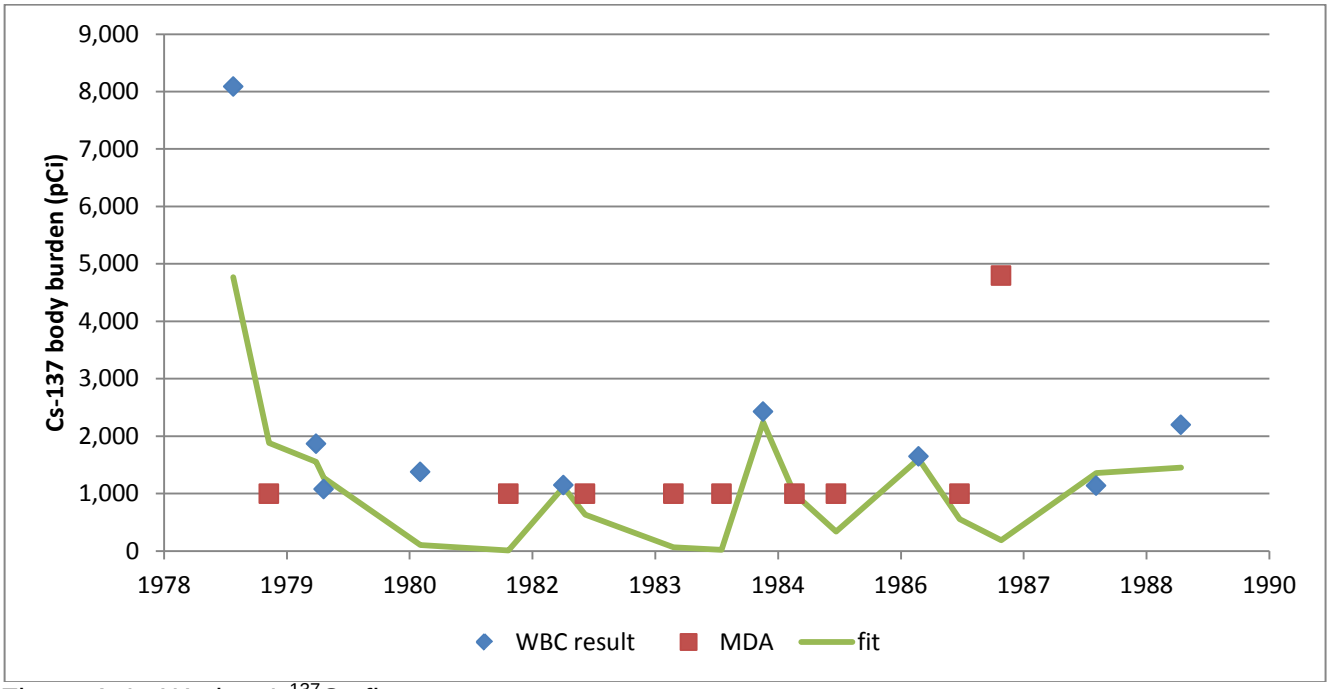

Figure A-1. Worker 1 ^{137}Cs fit.

These intakes result in predicted ^{144}Ce body burdens that are all less than the reported MDAs. The predicted body burdens are also less than the assumed MDAs for Type S material, but not for Type M material. The predicted body burdens are also in general agreement with the unreported results except for one unreported result on 03/13/1979, which is above the assumed MDA and has a value of 47 nCi. Although above the assumed MDA, the fact that this result was not reported indicates that it

was below the actual MDA for that WBC. This WBC is also the first one after the end of the first chronic intake. The ^{137}Cs fit was done according to normal procedures and is within the normal range of expected fit quality, but does underestimate the first positive ^{137}Cs result. Due to the relatively high actual ^{144}Ce MDA that must be associated with this WBC and the underestimate of the ^{137}Cs fit, the fit of the ^{144}Ce predicted body burden is reasonable.

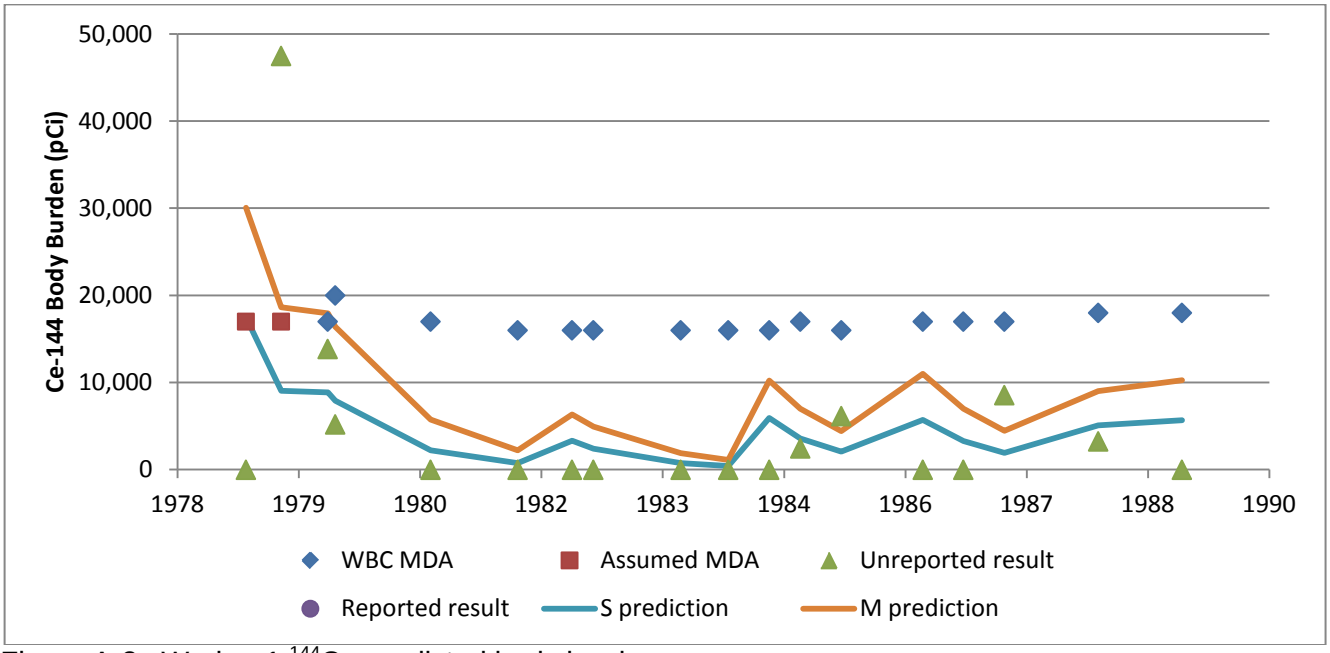

Figure A-2. Worker 1 ^{144}Ce predicted body burdens.

The ^{106}Ru predicted body burdens are all less than the reported or assumed MDAs and exceed the unreported results two-thirds of the time for all absorption types. The unreported results that are higher than the predicted body burdens generally trend in a similar manner and are within the expected uncertainty for <MDA measurements.

The ^{95}Zr/Nb predicted body burdens are all less than the reported or assumed MDAs except for the first WBC, where the actual MDA is not known. The unreported results display a similar trend as the predicted body burdens and are within the expected uncertainty for <MDA measurements. The one positive reported measurement, on 09/14/1984, was followed up with a count of the individual with a Ge(Li) detector and was determined to be a false positive most likely due to surface contamination.

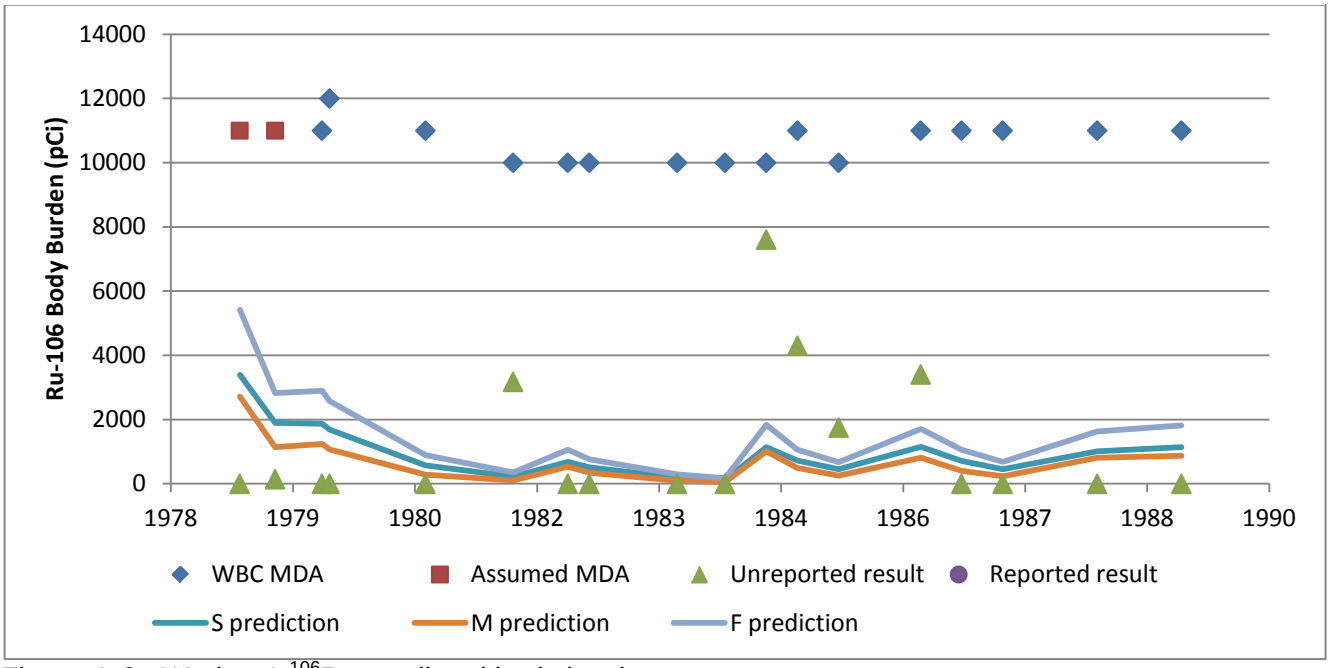

Figure A-3. Worker 1 ^{106}Ru predicted body burdens.

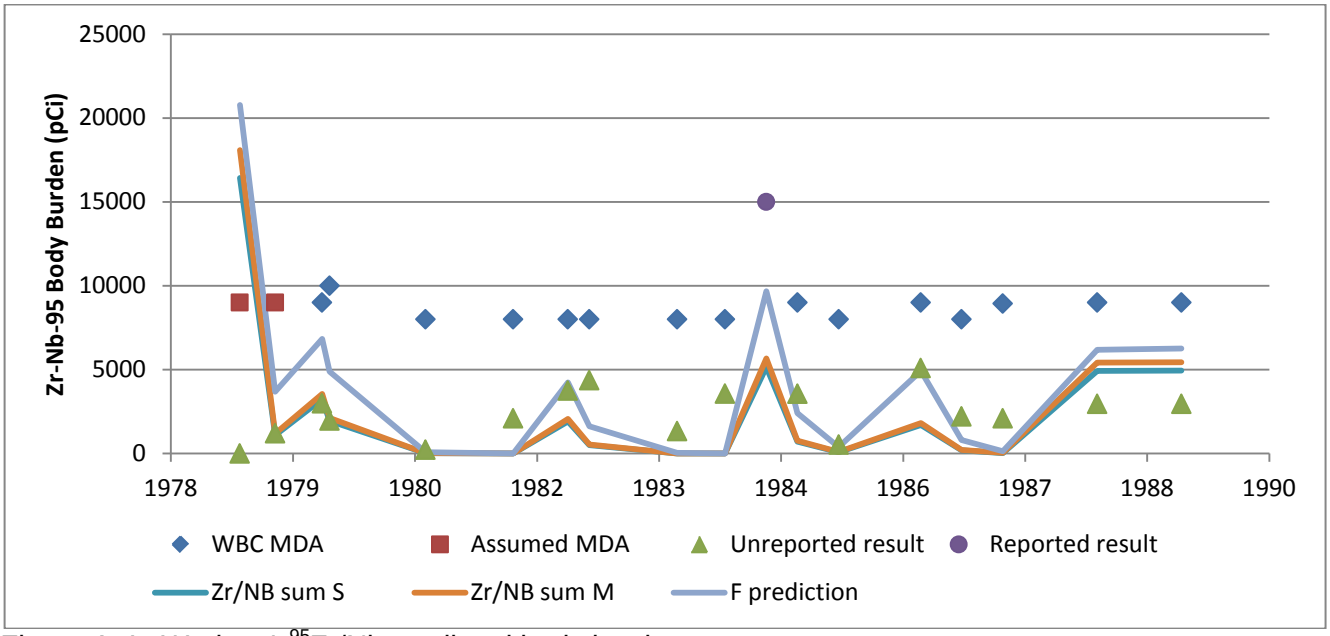

Figure A-4. Worker 1 ^{95}Zr/Nb predicted body burdens.

Worker 2
This individual is listed as a process operator and crane supervisor in the separations area. From 1962 through 1987, he had 20 WBCs, 16 of which reported ^{137}Cs activities above the Site Profile-listed MDA of 1 nCi. The positive measurements in 1986 were associated with a Zr/Nb skin contamination incident and were not used because there was no ^{137}Cs intake associated with the incident. The contemporaneous MDAs were higher than the documented results. The remaining positive measurements were fit with two chronic and three acute intakes. Two positive measurements

were excluded because they were lower than contemporaneous measurements during chronic intake periods. The chronic intakes ran from 08/16/1954 (start of work) through 03/30/1978 and from 11/14/1979 through 07/31/1981. The acute intakes occurred on 12/12/1975, 01/19/1979, and 03/12/1983.

The ^{144}Ce predicted body burdens are consistent with or exceed most of the unreported results, the exceptions being the WBCs associated with the ^{95}Zr/Nb contamination incident and one count on 09/15/1978 that is above the assumed MDA but was not quantified by SRS. As an unquantified measurement, it was assumed to be <MDA for that WBC.

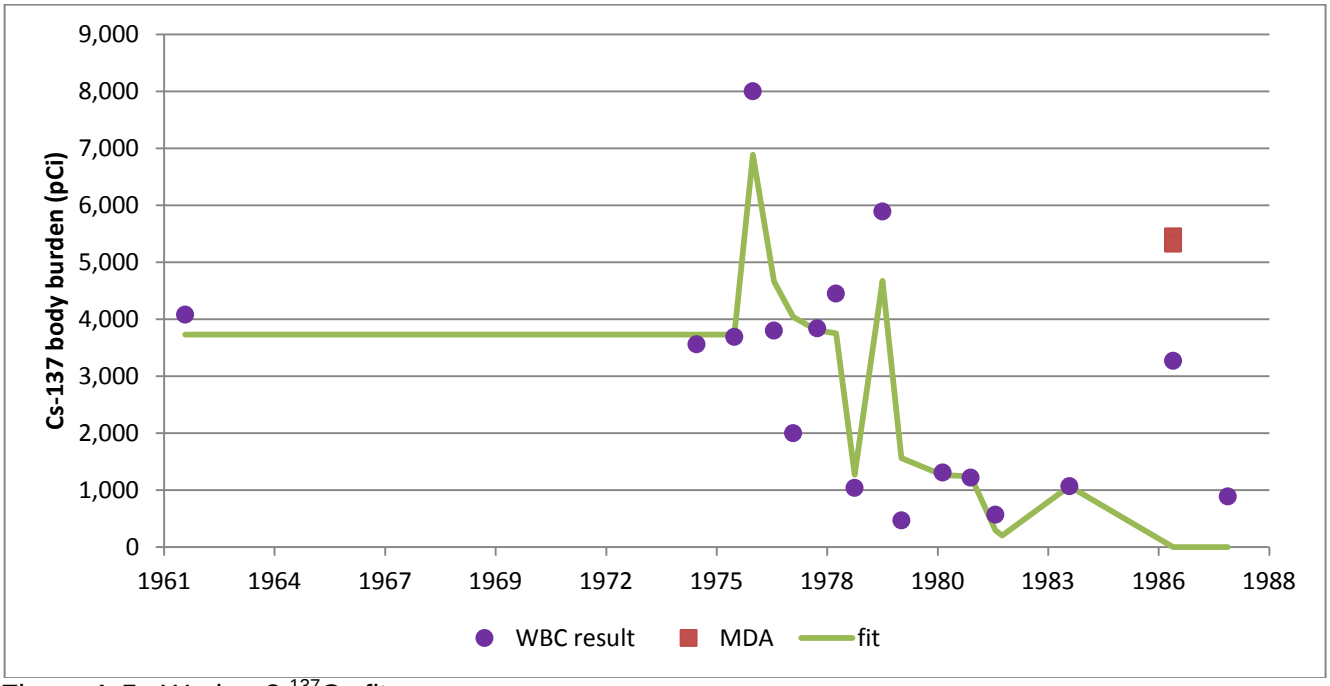

Figure A-5. Worker 2 ^{137}Cs fit.

The ^{106}Ru predicted body burdens are consistent with or exceed most of the unreported results. As with ^{144}Ce, the exceptions are the WBCs associated with the ^{95}Zr/Nb contamination incident and the count on 09/15/1978. In this instance, the unreported result is less than the assumed MDA and the difference is within the expected uncertainty for <MDA measurements.

The ^{95}Zr/Nb predicted body burdens exceed most of the unreported results, with the exception of the ^{95}Zr/Nb contamination incident. Predicted body burdens that are less than the unreported results are within the expected uncertainty for <MDA measurements.

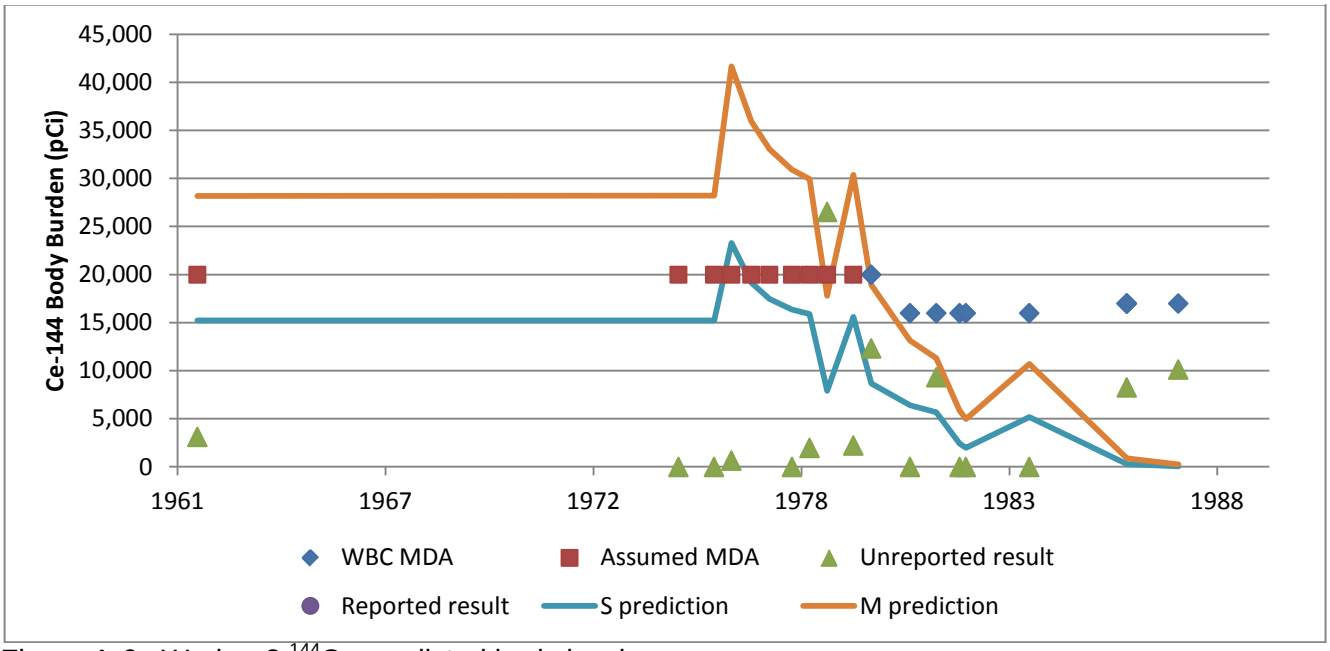

Figure A-6. Worker 2 ^{144}Ce predicted body burdens.

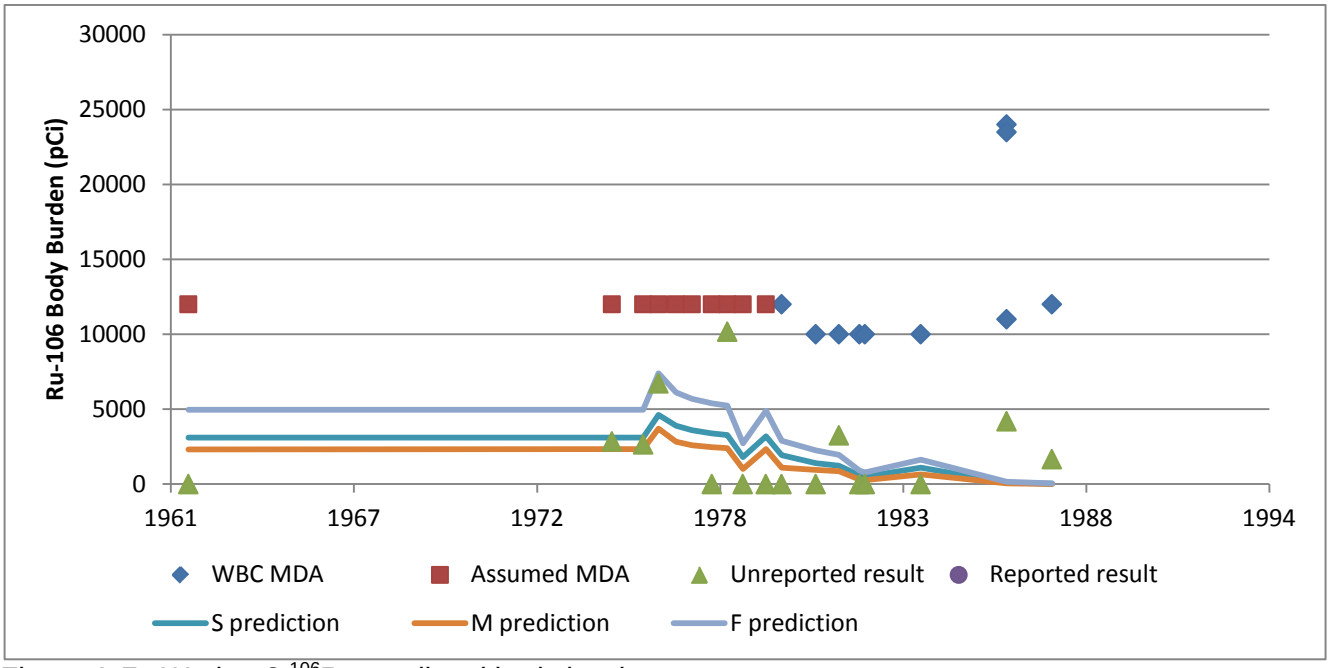

Figure A-7. Worker 2 ^{106}Ru predicted body burdens.

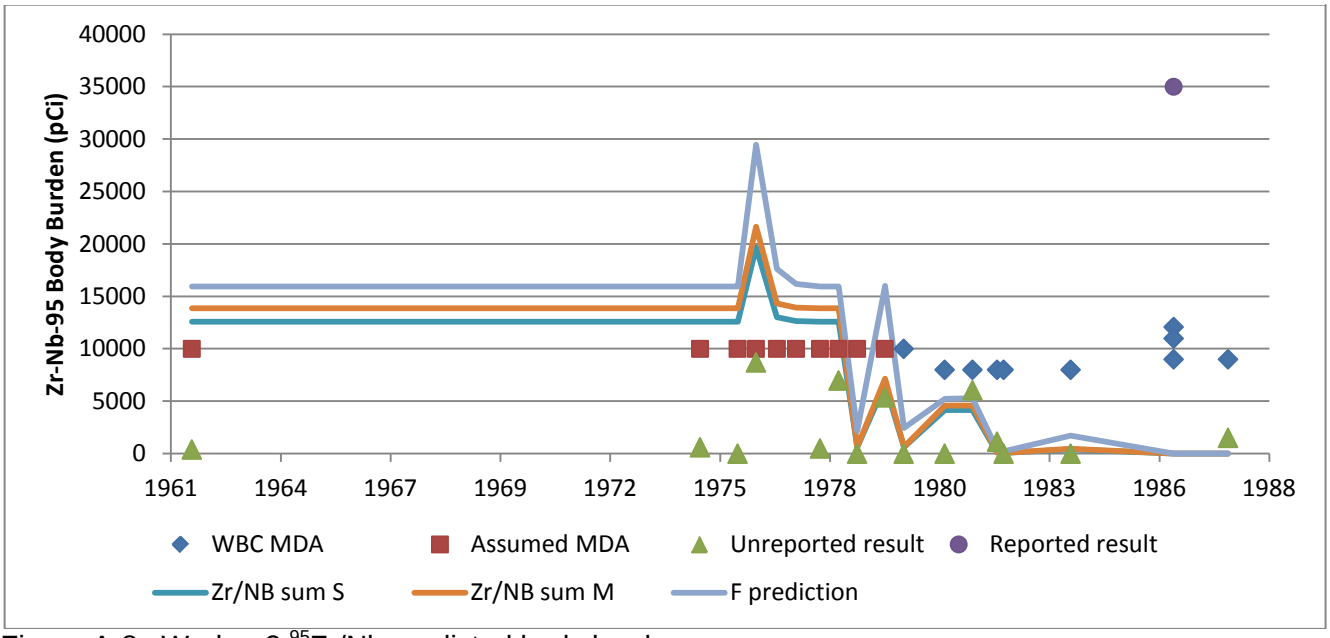

Figure A-8. Worker 2 ^{95}Zr/Nb predicted body burdens.

Worker 3

This individual was a production specialist in the separations area. From 1968 through 1990 he had 21 WBCs, of which 10 had reported positive ^{137}Cs results. The data were fit with two chronic intakes from 04/07/1961 through 08/06/1975 and 08/07/1976 through 05/16/1978 and one acute intake on 12/13/1983.

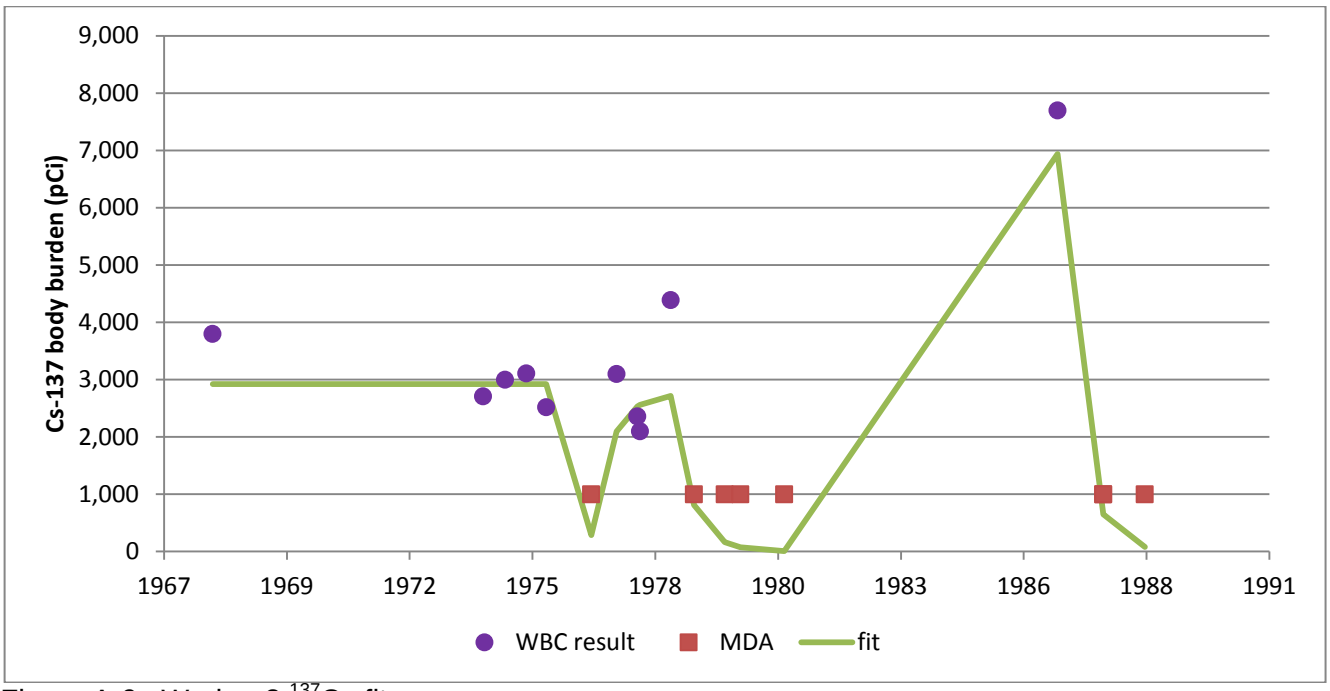

Figure A-9. Worker 3 ^{137}Cs fit.

These intakes resulted in predicted ^{144}Ce body burdens that are all less than the reported or assumed MDAs except for after the acute intake on 12/13/1983. After the acute intake, the predicted body burdens for ^{144}Ce grossly exceeded the assumed MDAs by a factor of 10 or more. This intake is unrealistically large (19 µCi ^{137}Cs) because it is assumed to have occurred 3 years before the WBC date due to using the default assumption of an acute intake occurring midway between the positive measurement and the previous measurement, which was 6 years earlier. The predicted body burdens generally exceed the unreported results. The unreported results that are higher than the predicted body burdens generally trend in a similar manner and are within the expected uncertainty for <MDA measurements. Unreported results that exceed the assumed MDA are still assumed to be <MDA values.

The ^{106}Ru predicted body burdens exhibit the same pattern as those of ^{144}Ce.

The ^{95}Zr/Nb body burdens exceed the assumed MDAs during the chronic intakes for Types F and M material. The large acute intake does not affect the ^{95}Zr/Nb body burdens on the dates of the WBCs due to the long assumed delay between the intake and the WBC.

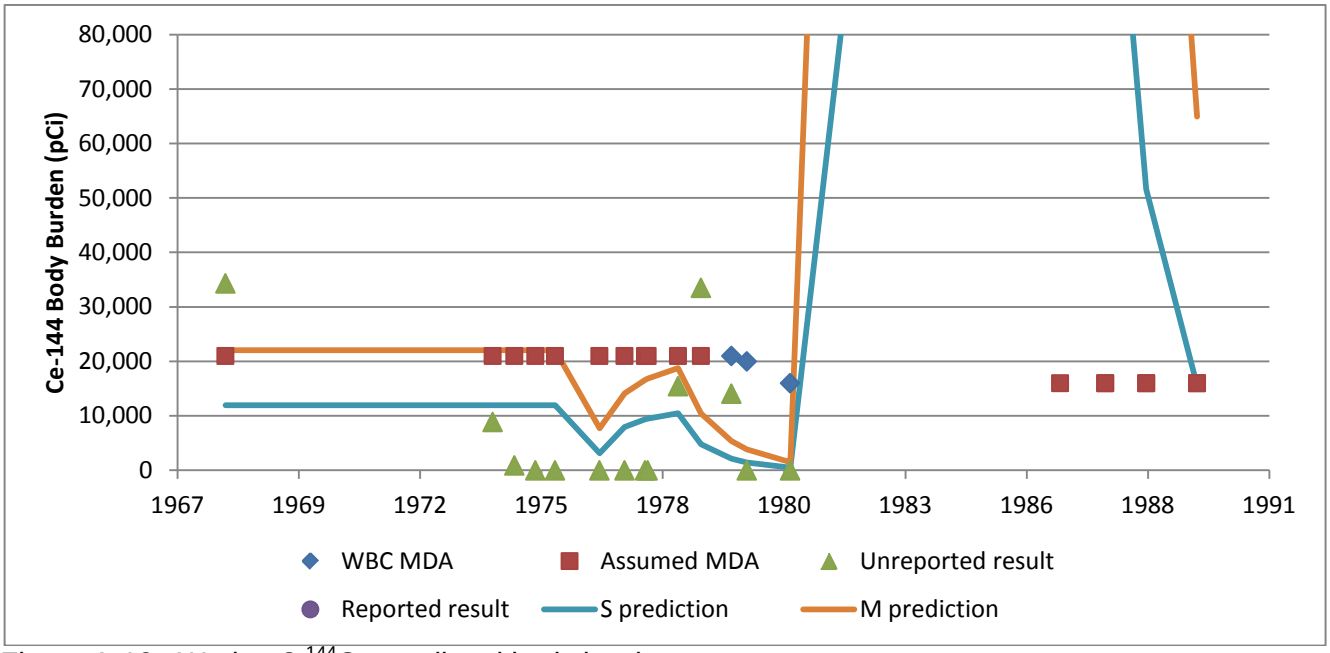

Figure A-10. Worker 3 ^{144}Ce predicted body burdens.

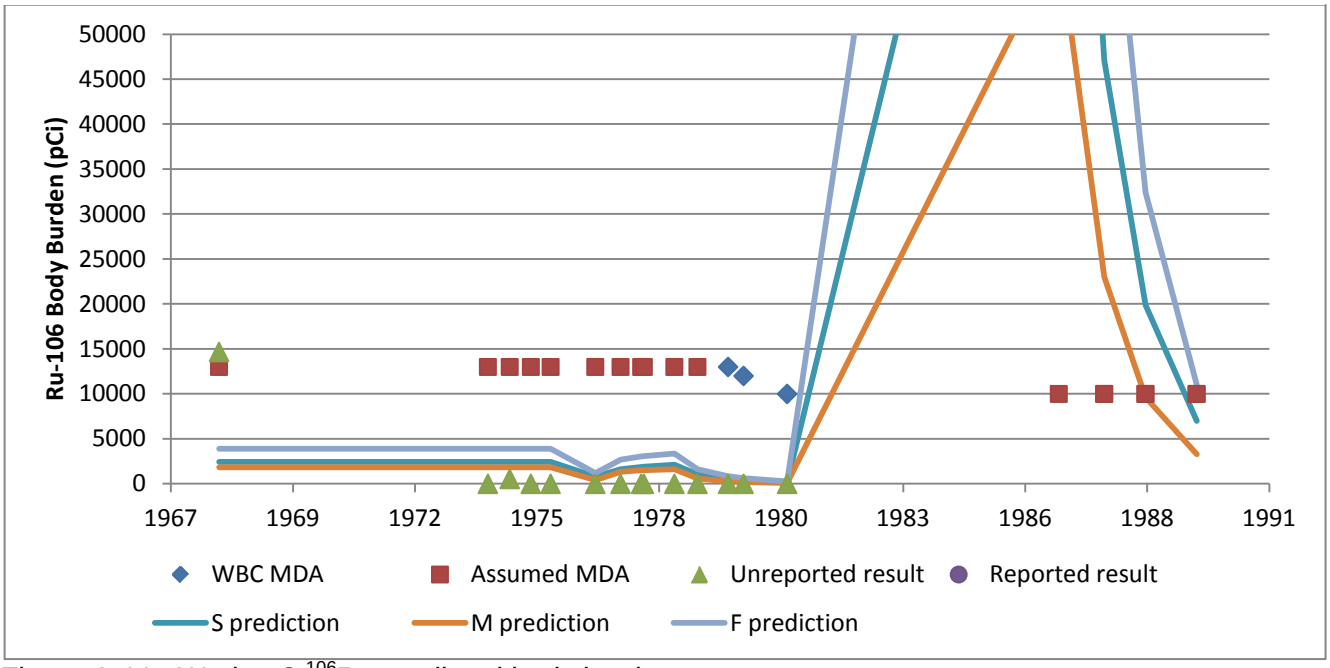

Figure A-11. Worker 3 ^{106}Ru predicted body burdens.

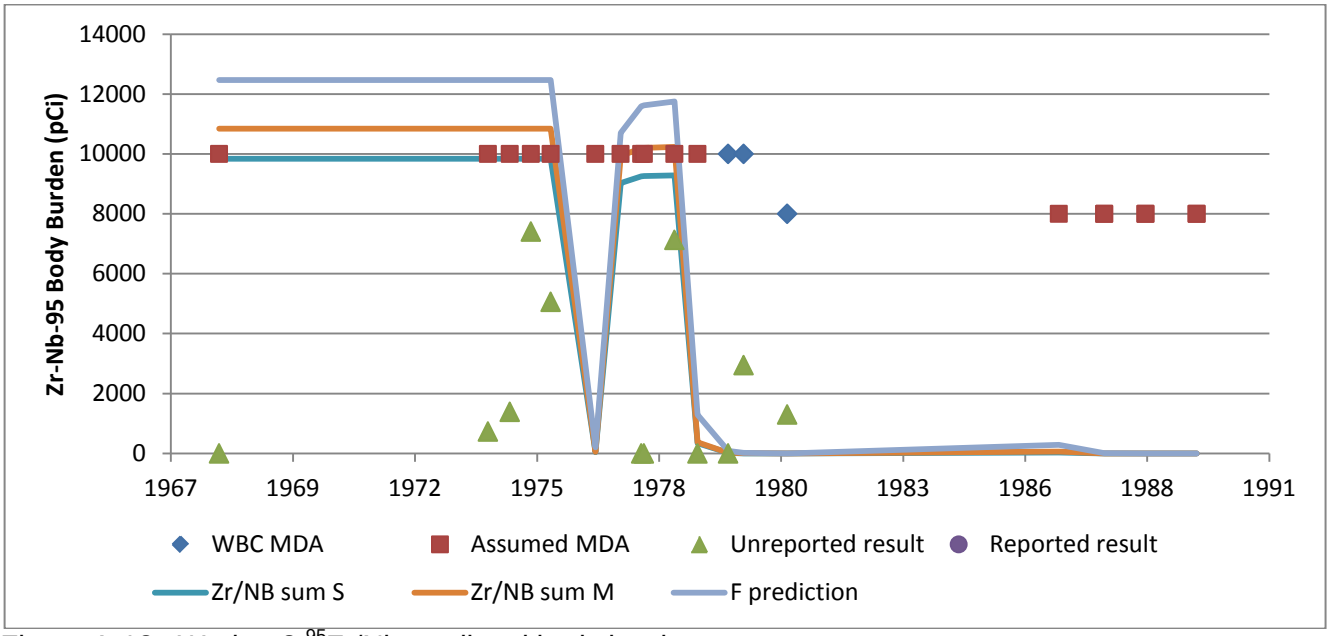

Figure A-12. Worker 3 ^{95}Zr/Nb predicted body burdens.

Worker 4

This individual worked in construction and had 15 WBCs, all but three of which were above 1 nCi of ^{137}Cs. The positive measurements were fit with three chronic intakes from 09/07/1954 through 06/13/1962, 06/14/1962 through 07/01/1976, and 02/25/1978 through 03/20/1987.

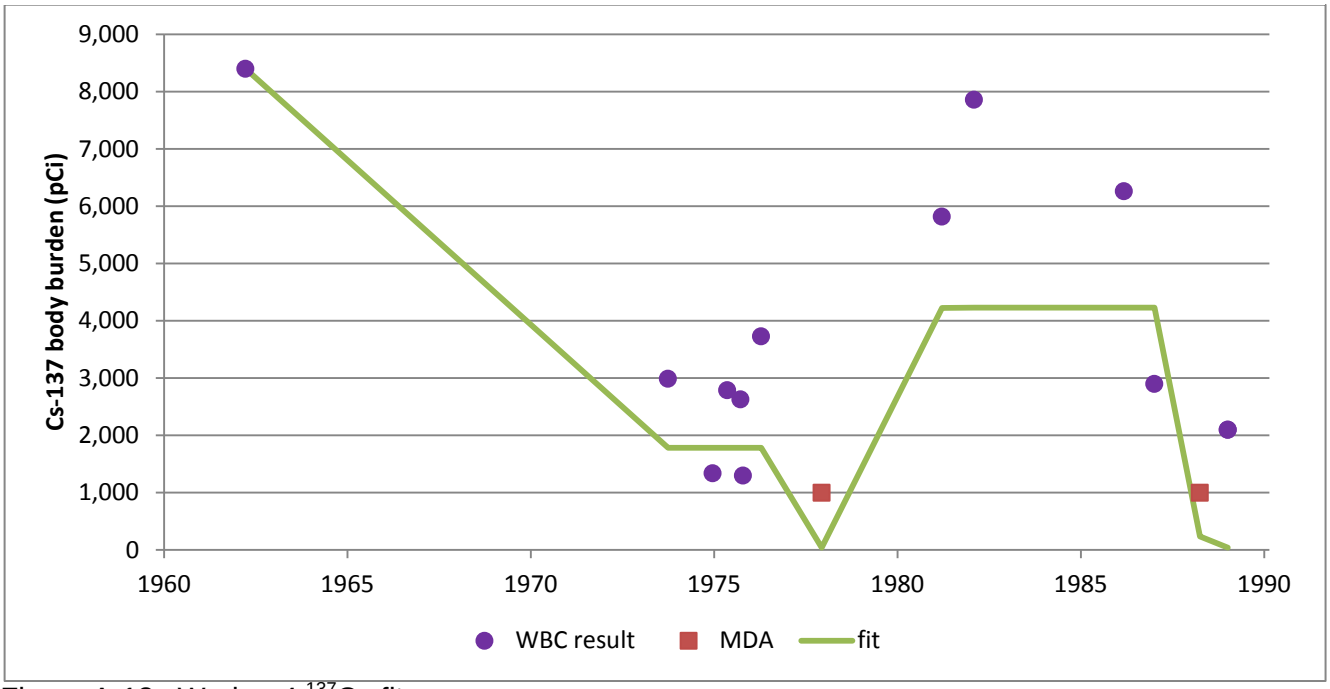

Figure A-13. Worker 4 ^{137}Cs fit.

The predicted body burdens for ^{144}Ce are consistent with or exceed the unreported results. All predicted body burdens also are less than or consistent with reported MDAs. The first assumed MDA is exceeded for both solubility types, and three of the reported MDAs are exceeded for Type M material.

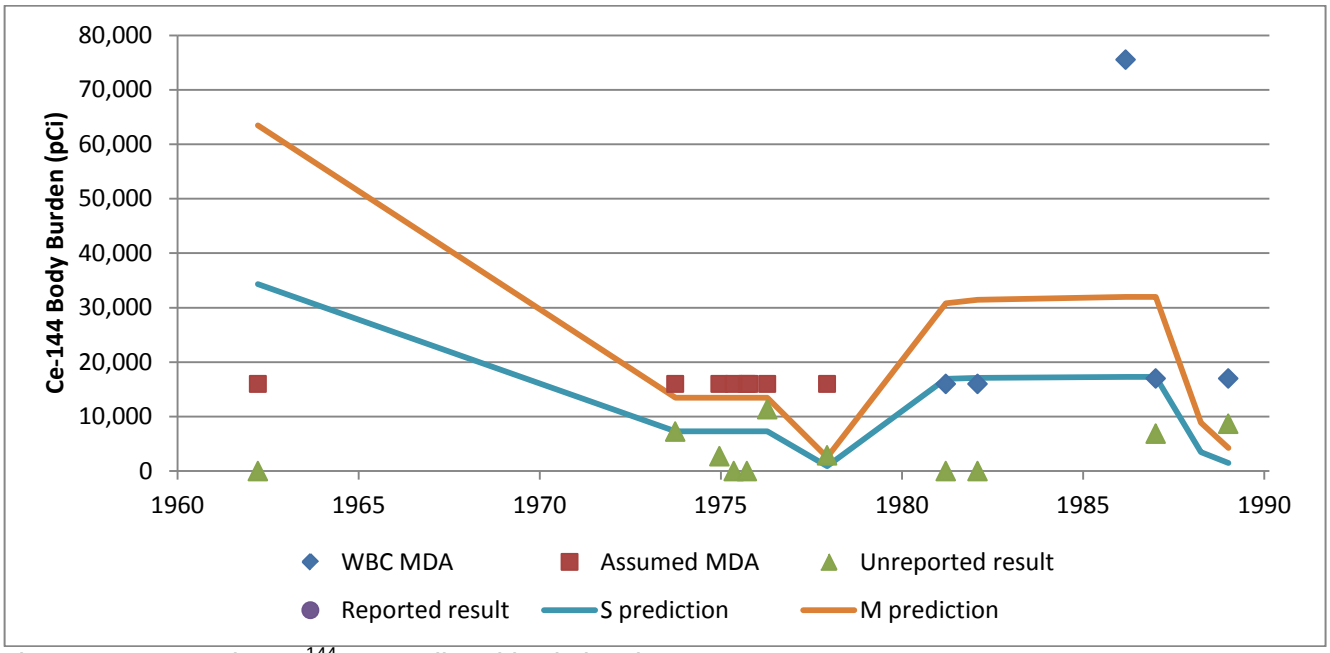

Figure A-14. Worker 4 ^{144}Ce predicted body burdens.

The predicted body burdens for ^{106}Ru are consistent with or exceed the unreported results. Three unreported results from 1975 through 1978 exceed the predicted body burdens but trend down the same as the predicted body burden and are within the expected uncertainty for <MDA measurements. Only the first assumed MDA is exceeded and only for absorption Type F.

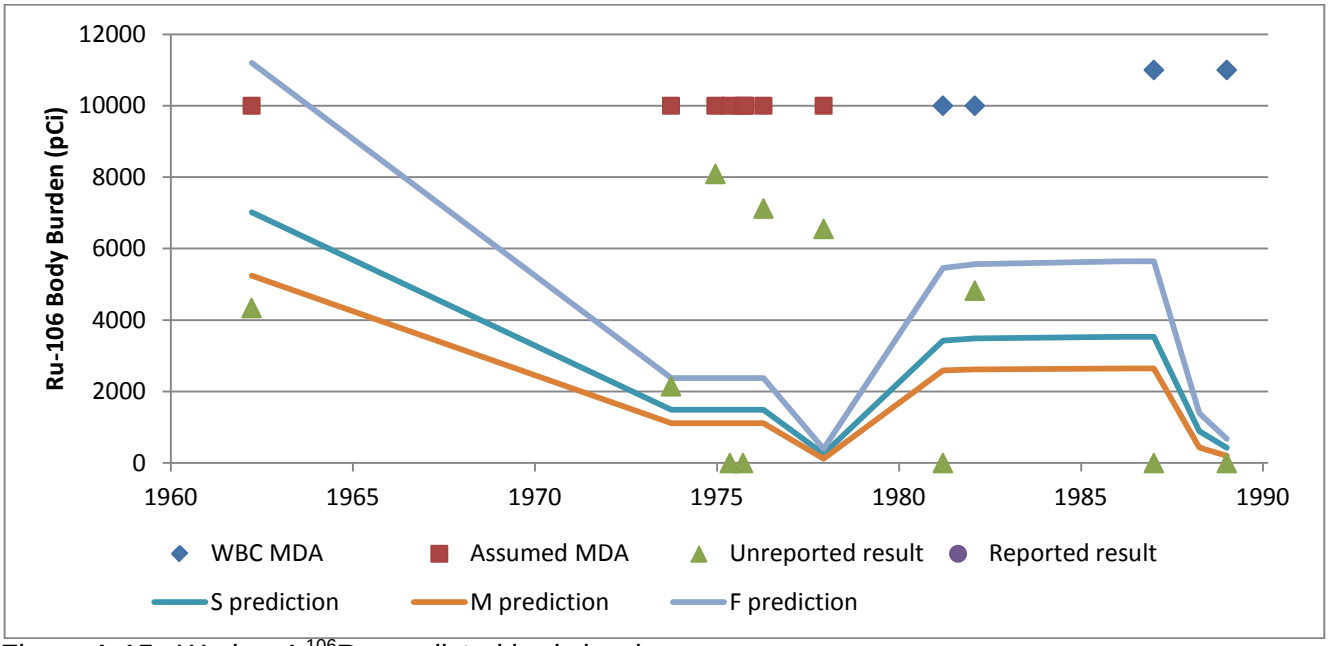

Figure A-15. Worker 4 ^{106}Ru predicted body burdens.

The predicted body burdens for ^{95}Zr/Nb are consistent with or exceed the unreported results and the assumed or reported MDAs except for the last measurement due to the rapid elimination of ^{95}Zr/Nb from the body.

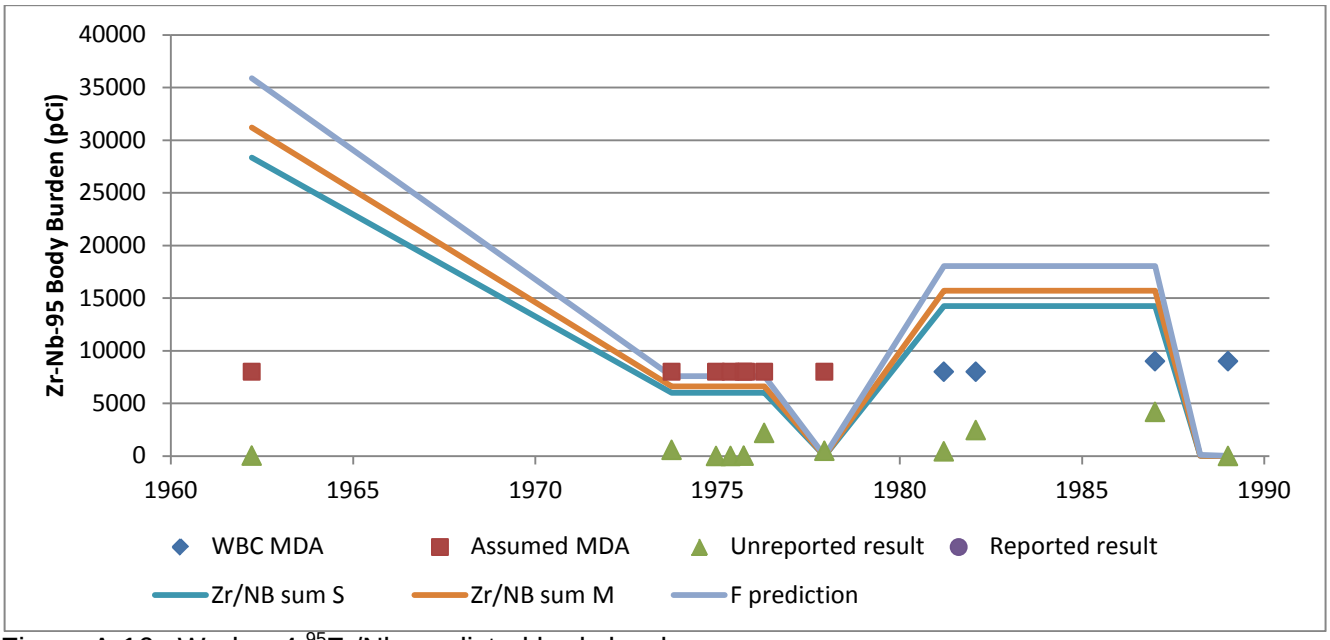

Figure A-16. Worker 4 ^{95}Zr/Nb predicted body burdens.

Worker 5

This individual was a reactor operator/supervisor and had five WBCs, four of which were positive for ^{137}Cs. Three of those results were on the same day. The highest measurement was used because there was no indication of whether it was before or after showering. The data were fit with one chronic intake from 03/24/1953 through 06/15/1987.

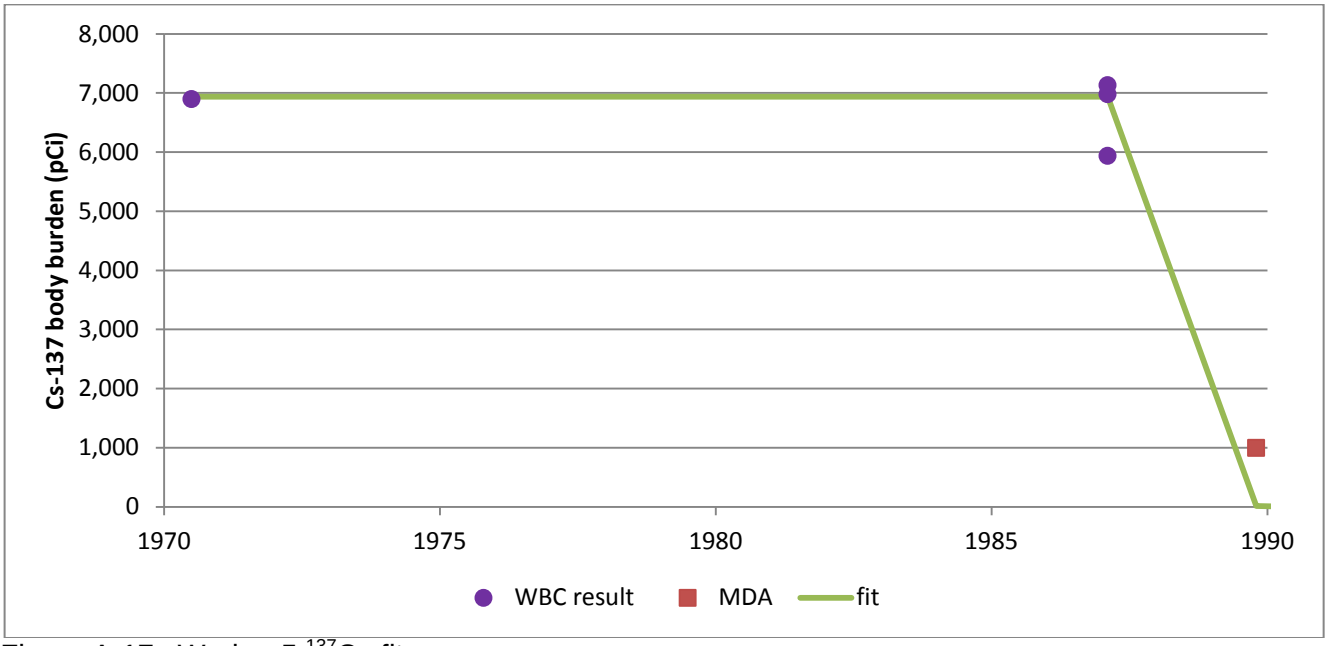

Figure A-17. Worker 5 ^{137}Cs fit.

The predicted body burdens for ^{144}Ce exceed both the unreported results and the reported and assumed MDAs by a factor of 2 or more. The ^{137}Cs fit was performed with a chronic intake for the claimant's entire employment period up to the date of the positive measurements, which is very favorable to the claimant.

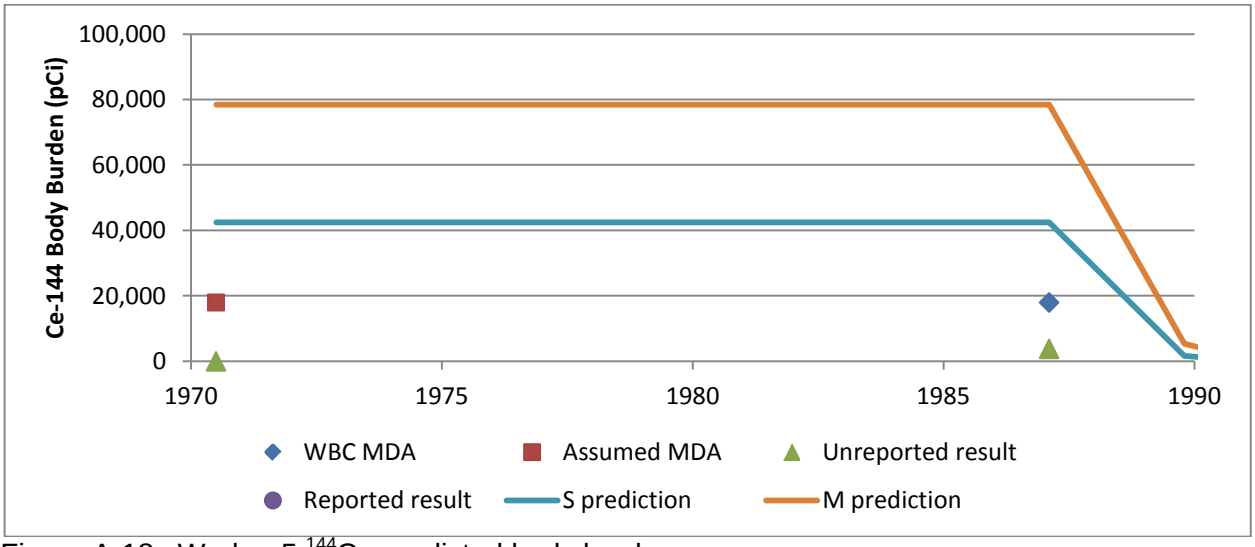

Figure A-18. Worker 5 ^{144}Ce predicted body burden.

For ^{106}Ru, the predicted body burdens also exceed the unreported results for all solubility types, with Type F exceeding the reported and assumed MDAs as well.

^{95}Zr/Nb shows the same pattern as ^{144}Ce, with all solubility types exceeding the unreported results and reported and assumed MDAs.

The overprediction probably results from an interruption in the chronic intake. Because of the shorter half-lives of ^{144}Ce, ^{106}Ru, and ^{95}Zr/Nb relative to ^{137}Cs, any interruption in the chronic intake, especially near the 1987 WBCs, would result in less actual activity of the ^{144}Ce, ^{106}Ru, and ^{95}Zr/Nb in the body than predicted using the ^{137}Cs fit. The lack of data between 1970 and 1987 makes it difficult to make an accurate fit during that period.

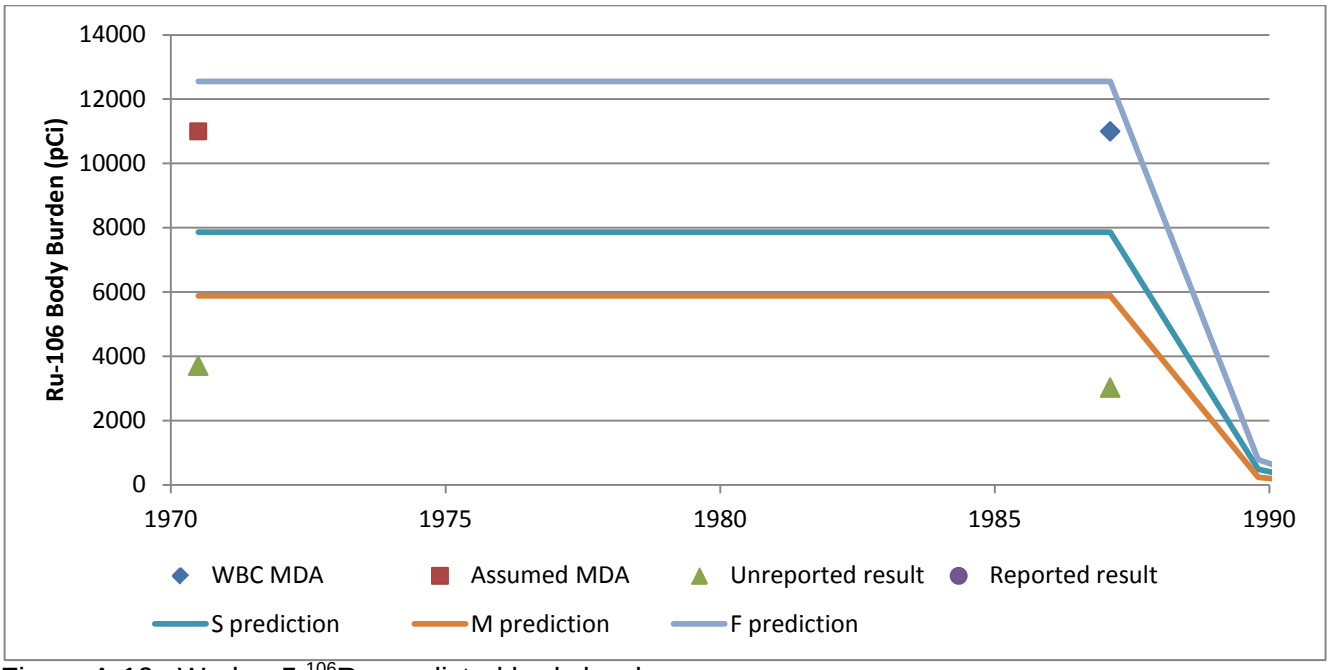

Figure A-19. Worker 5 ^{106}Ru predicted body burden.

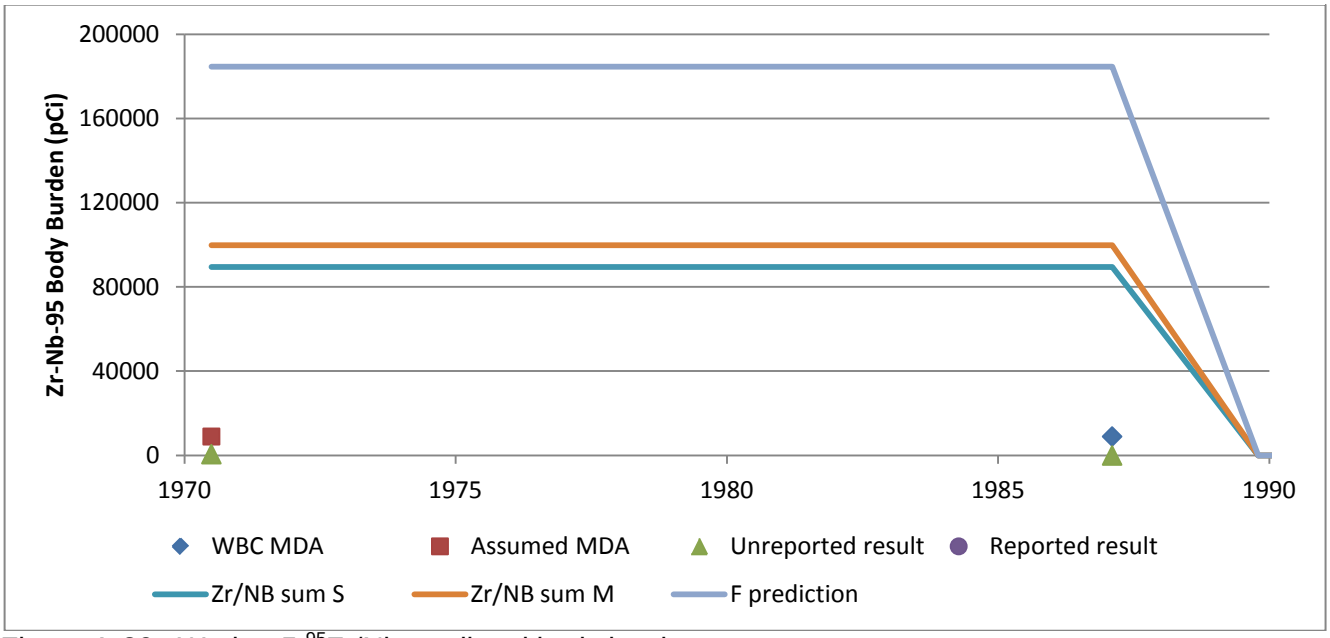

Figure A-20. Worker 5 ^{95}Zr/Nb predicted body burden.

Worker 6

This individual worked in the decontamination and decommissioning department and had 15 WBCs, 5 of which were less than 1 nCi for ^{137}Cs and one other noted as being reported as <MDA. On 05/19/1986, he had three WBCs, each after showering. One reported only an MDA; therefore, the other two, which show as being counted at the same time but with different results, were averaged. The positive measurements were fit as a series of acute intakes due to a lack of a pattern in the data. The acute intakes were on 04/05/1983, 01/09/1984, 07/02/1984, 06/14/1986, 01/30/1987, and 02/26/1988.

The predicted body burdens for ^{144}Ce are all consistent with or greater than the unreported results. In addition, all predicted body burdens are less than the reported MDAs. Ruthenium-106 followed the same pattern as ^{144}Ce. For ^{95}Zr/Nb, some unreported results exceed the predicted body burdens but are within the expected uncertainty for <MDA measurements. The predicted body burdens after the largest acute intake on 06/14/1986 exceed the reported and assumed MDAs.

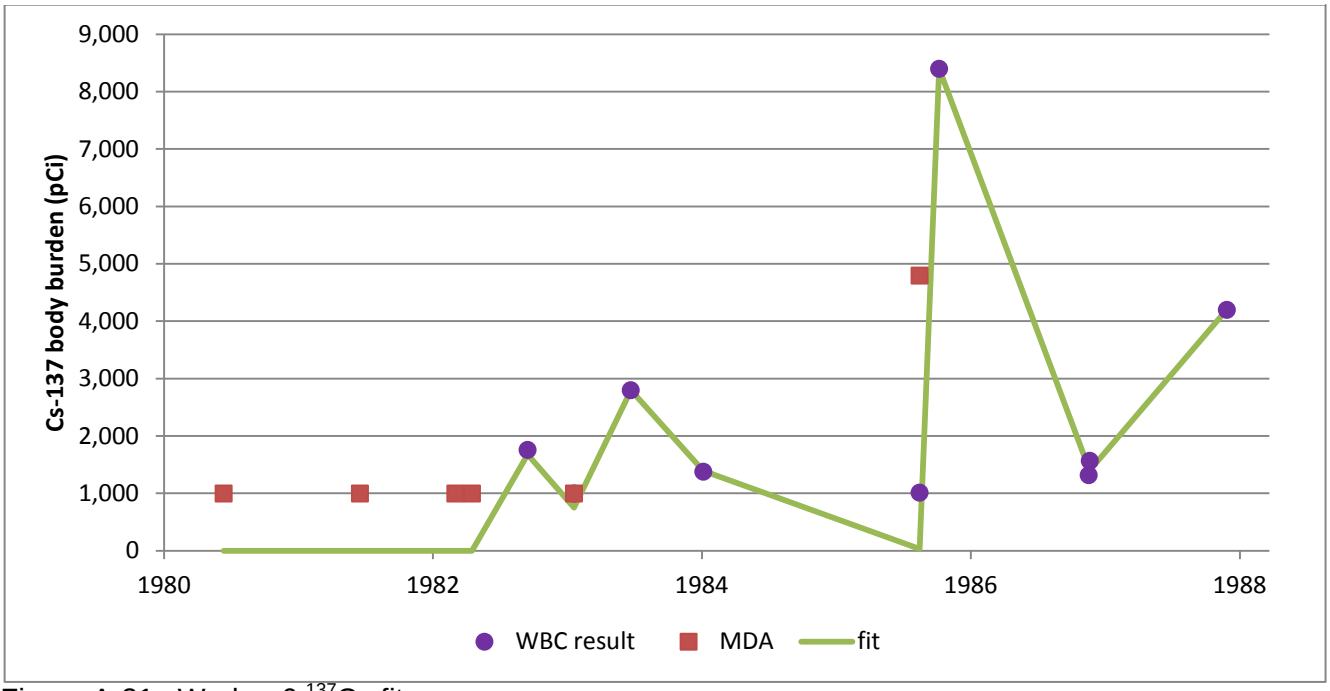

Figure A-21. Worker 6 ^{137}Cs fit.

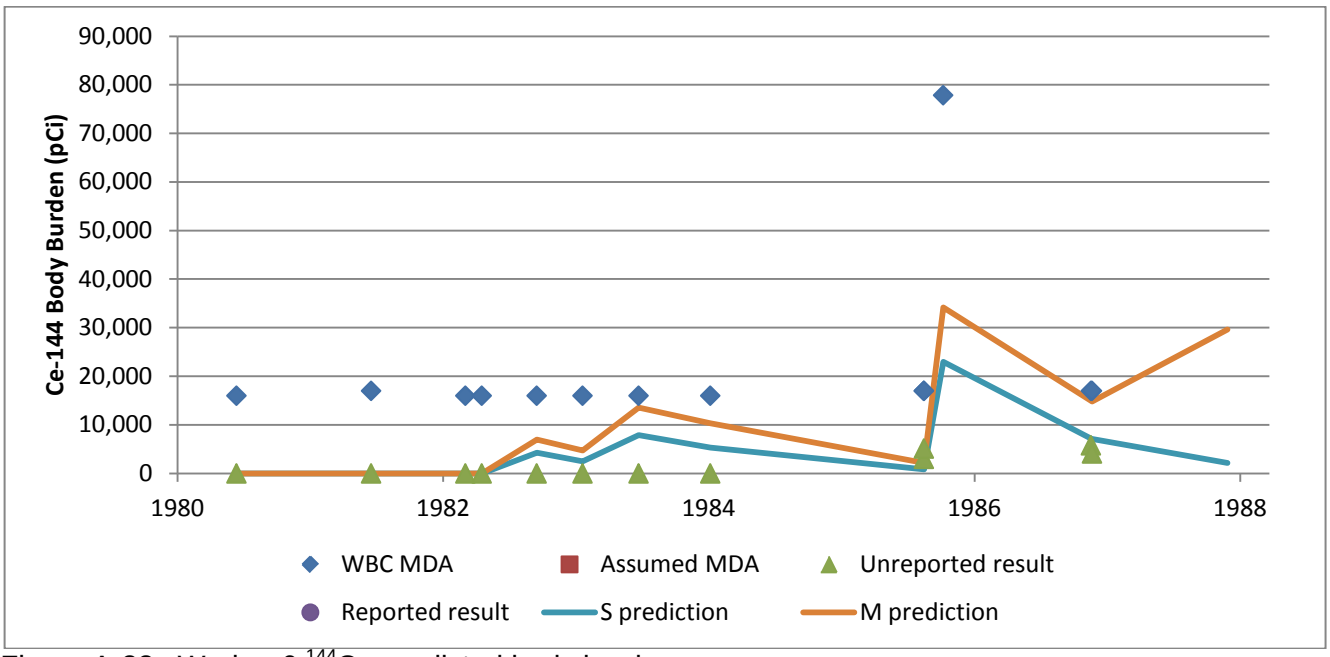

Figure A-22. Worker 6 ^{144}Ce predicted body burden.

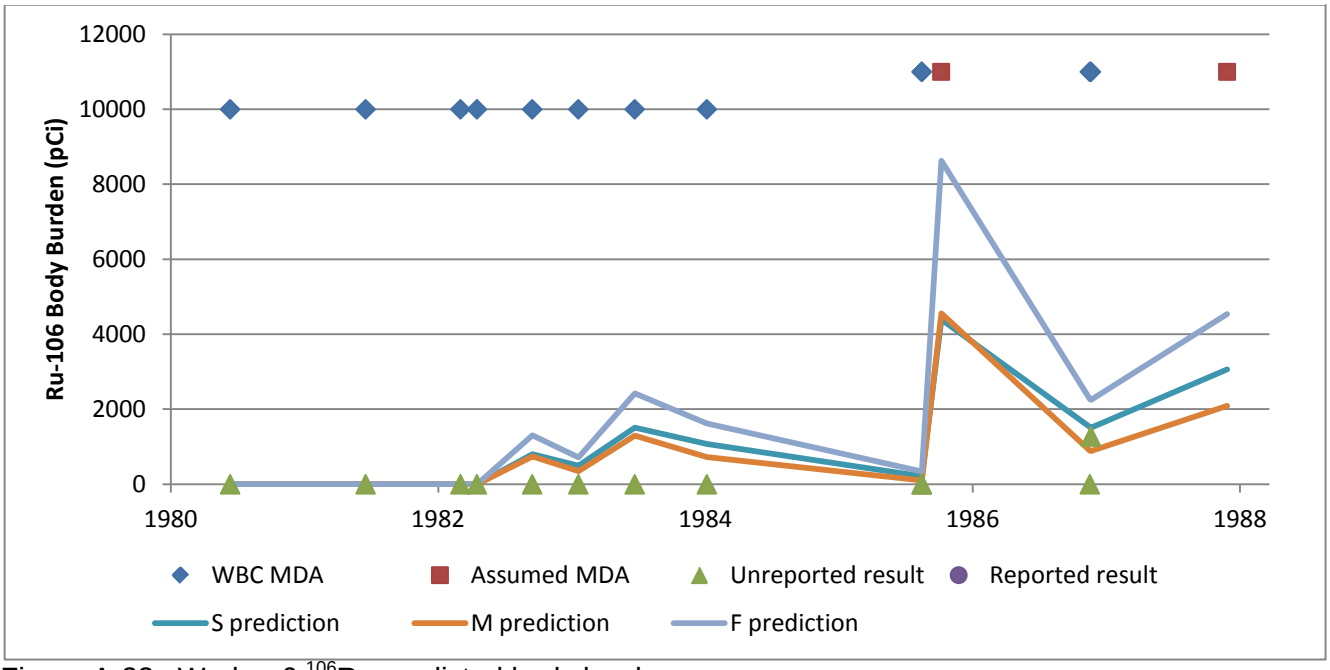

Figure A-23. Worker 6 ^{106}Ru predicted body burden.

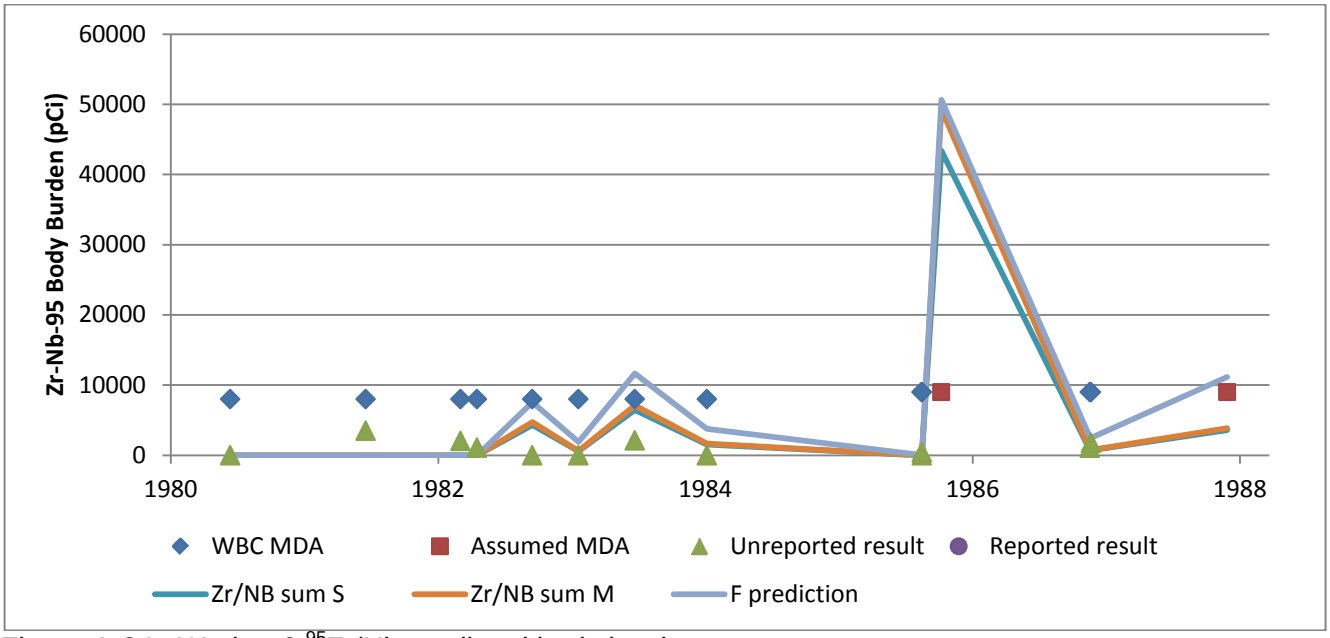

Figure A-24. Worker 6 ^{95}Zr/Nb predicted body burden.

Worker 7
This individual was a maintenance technician with four WBCs, two of which were positive for ^{137}Cs and occurred on the same day (with the result of one of them reported twice). Both measurements were after showering and thus the average was used. The other two WBCs had ^{137}Cs results <MDA. The positive measurement was fit with a single acute intake on 11/09/1988.

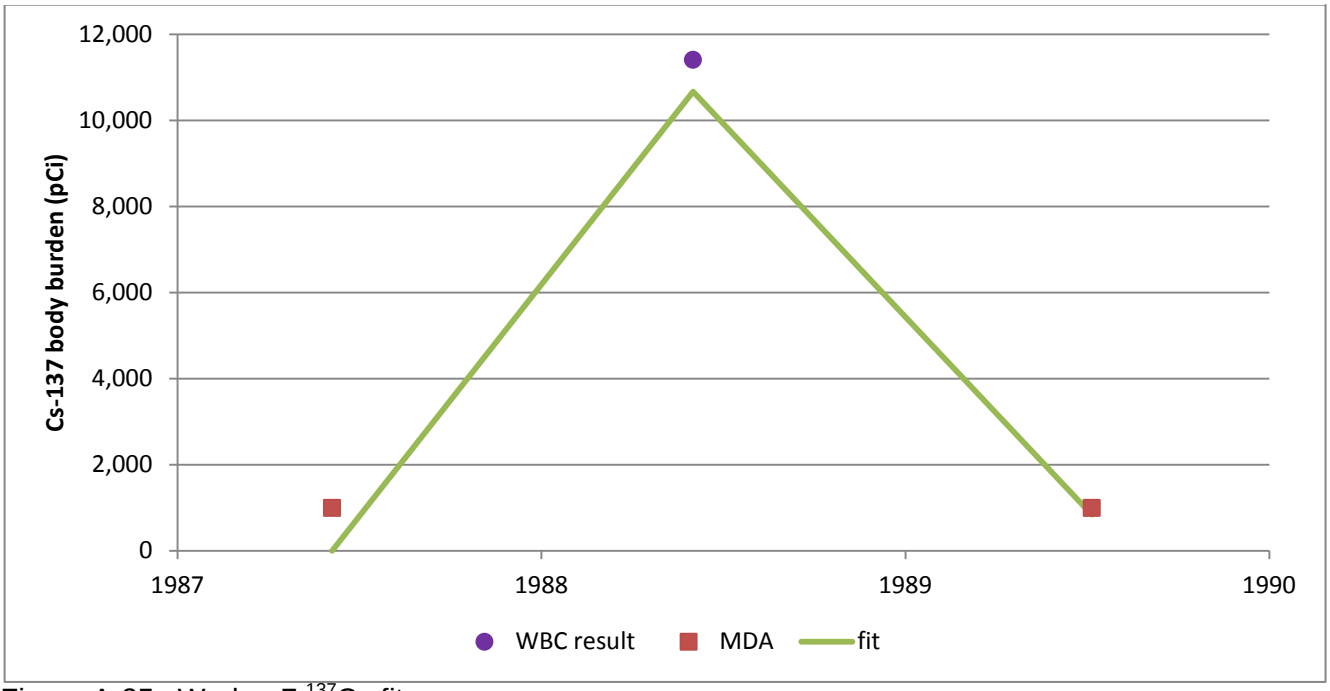

Figure A-25. Worker 7 ^{137}Cs fit.

The ^{144}Ce predicted body burdens exceed the unreported result and MDA values on the date of the positive ^{137}Cs WBCs. No unreported results could be determined for the other dates. For ^{106}Ru, the unreported result was also exceeded on the date of the positive ^{137}Cs WBCs. The predicted body burden for ^{95}Zr/Nb on the date of the positive ^{137}Cs WBCs is consistent with the unreported result for solubility Types M and S and exceeds both the unreported result and reported MDA for solubility Type F.

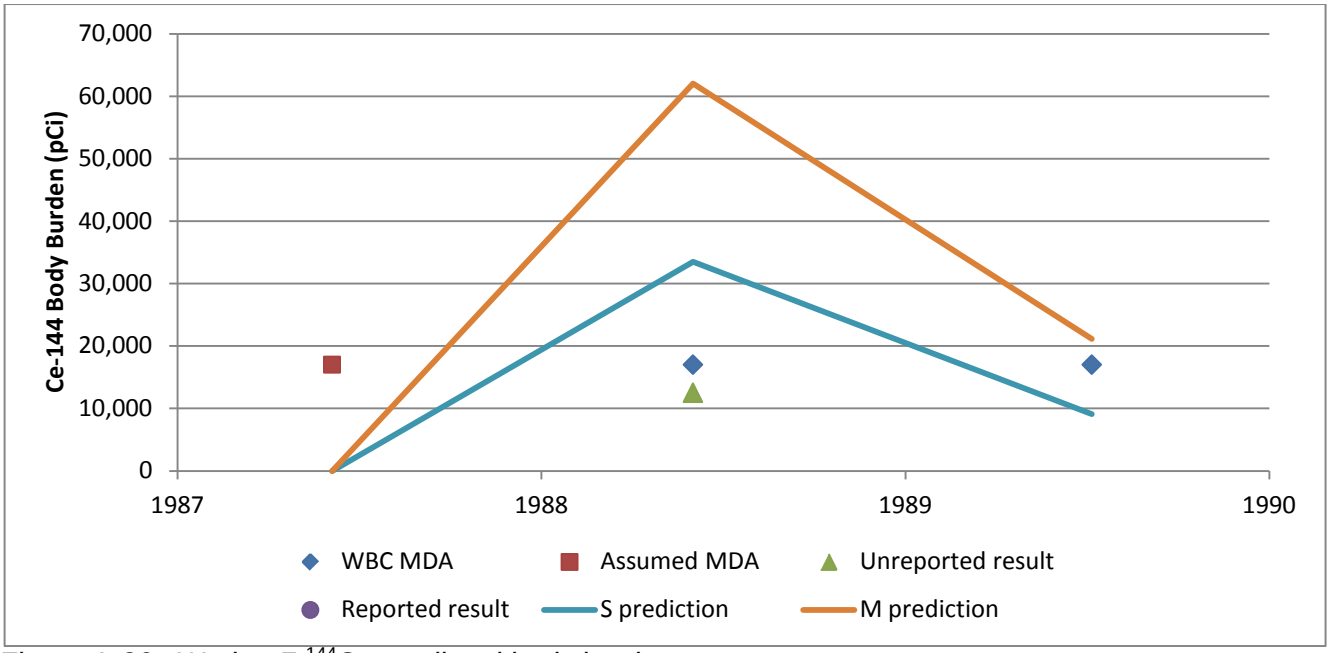

Figure A-26. Worker 7 ^{144}Ce predicted body burdens.

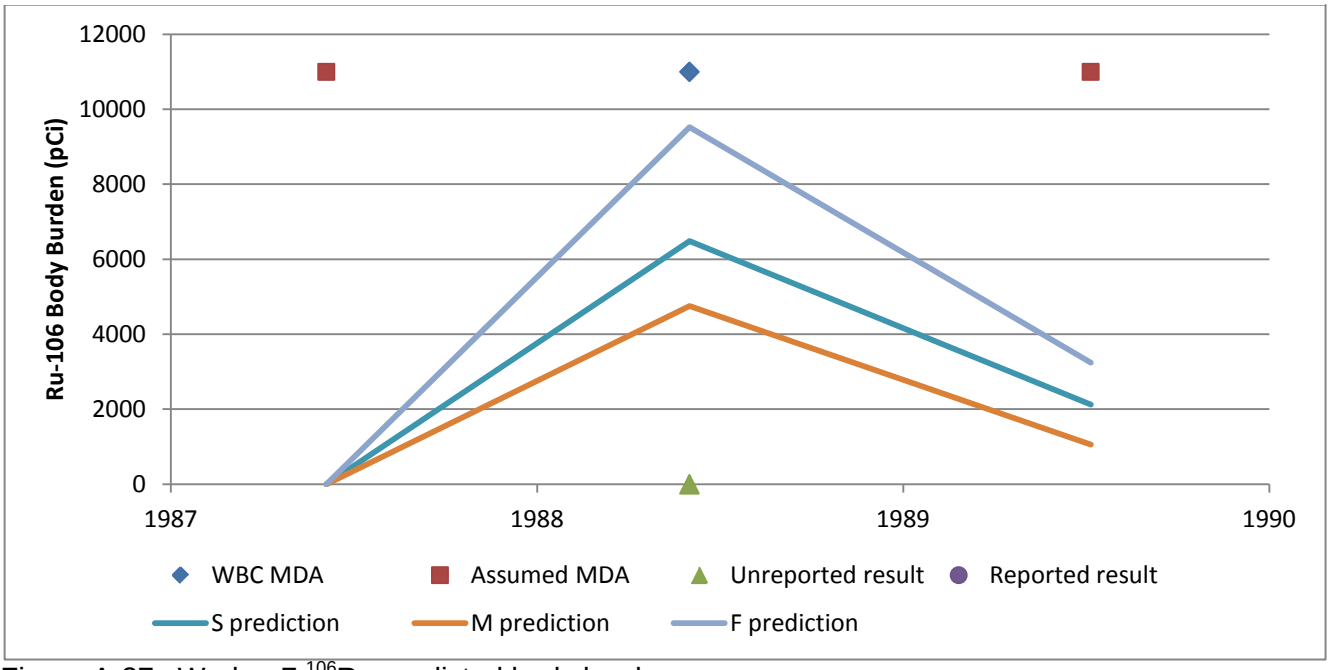

Figure A-27. Worker 7 ^{106}Ru predicted body burdens.

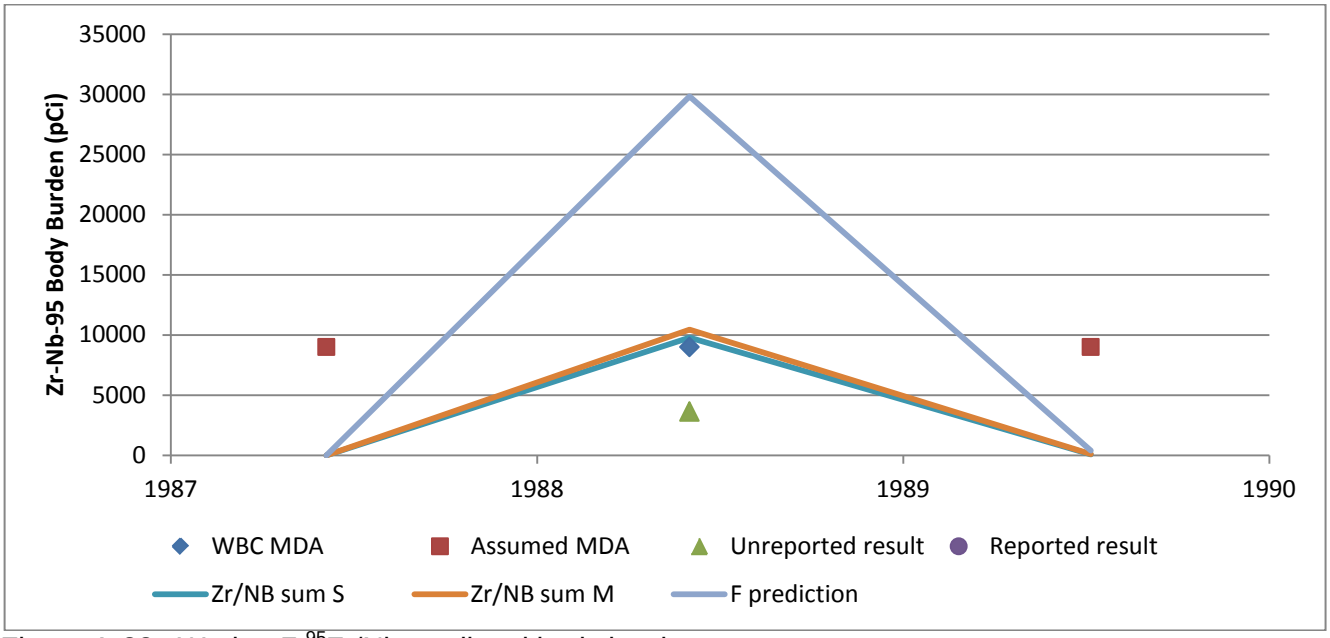

Figure A-28. Worker 7 ^{95}Zr/Nb predicted body burdens.

Worker 8
This individual is listed as a laborer, laboratory technician, and separations area operator. He had WBCs on 31 different dates. Six of the WBCs were less than 1 nCi for ^{137}Cs and two others were noted as <MDA measurements. Only the third employment period beginning in 1965 was evaluated. On 09/22/1986, the first WBC was before showering. The second count was a Fastscan count and only reported an MDA value. The third measurement was a 30-minute count and had the lowest quantified result. The third (3.8 nCi) result was used. On 06/01/1988, the higher of the two

measurements is noted as being taken before showering and was not used. The data were fit with two chronic intakes from 08/16/1965 through 11/08/1985 and 11/09/1985 through 06/16/1989 and one acute intake on 07/25/1988. All measurements <MDA were excluded as an overestimate.

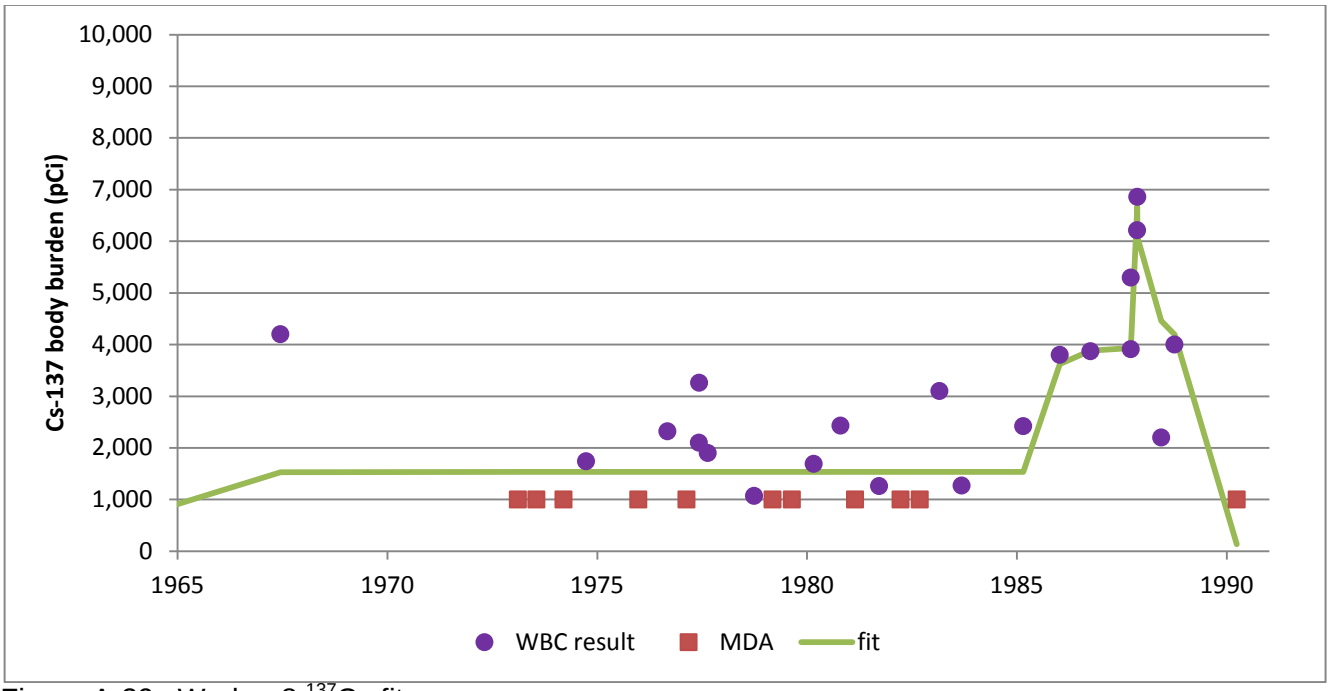

Figure A-29. Worker 8 ^{137}Cs fit.

Predicted body burdens for ^{144}Ce are consistent with or exceed the unreported results after 1978. Before 1979, the unreported results exceed the predicted body burdens but are within the expected uncertainty for <MDA measurements. For ^{106}Ru and ^{95}Zr/Nb, the predicted body burdens exceed or are consistent with the unreported results. All predicted body burdens are less than the assumed or reported MDAs except immediately after the acute intake.

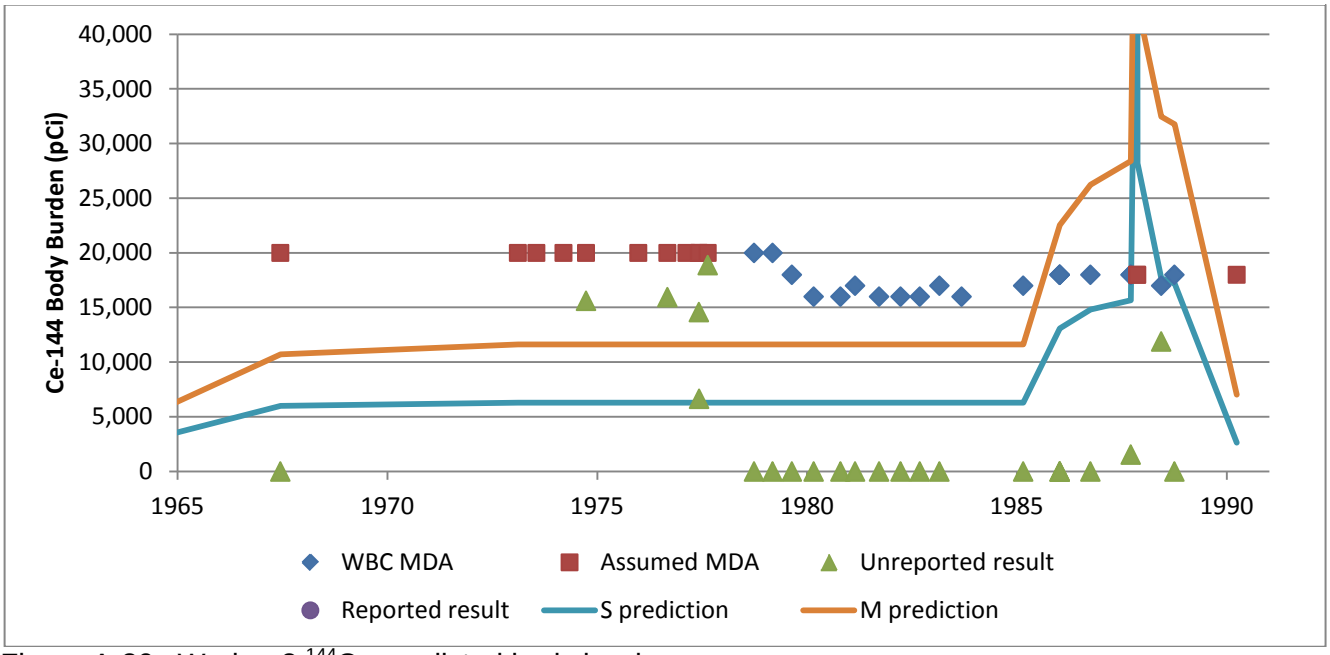

Figure A-30. Worker 8 ^{144}Ce predicted body burdens.

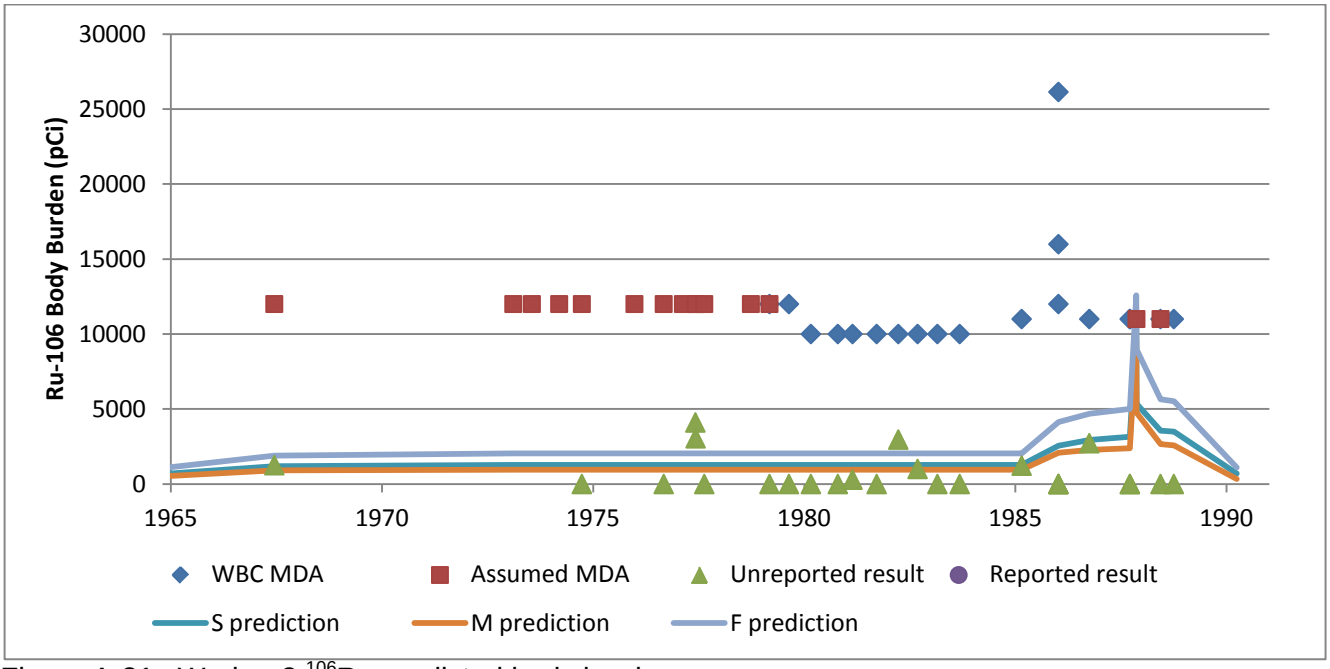

Figure A-31. Worker 8 ^{106}Ru predicted body burdens.

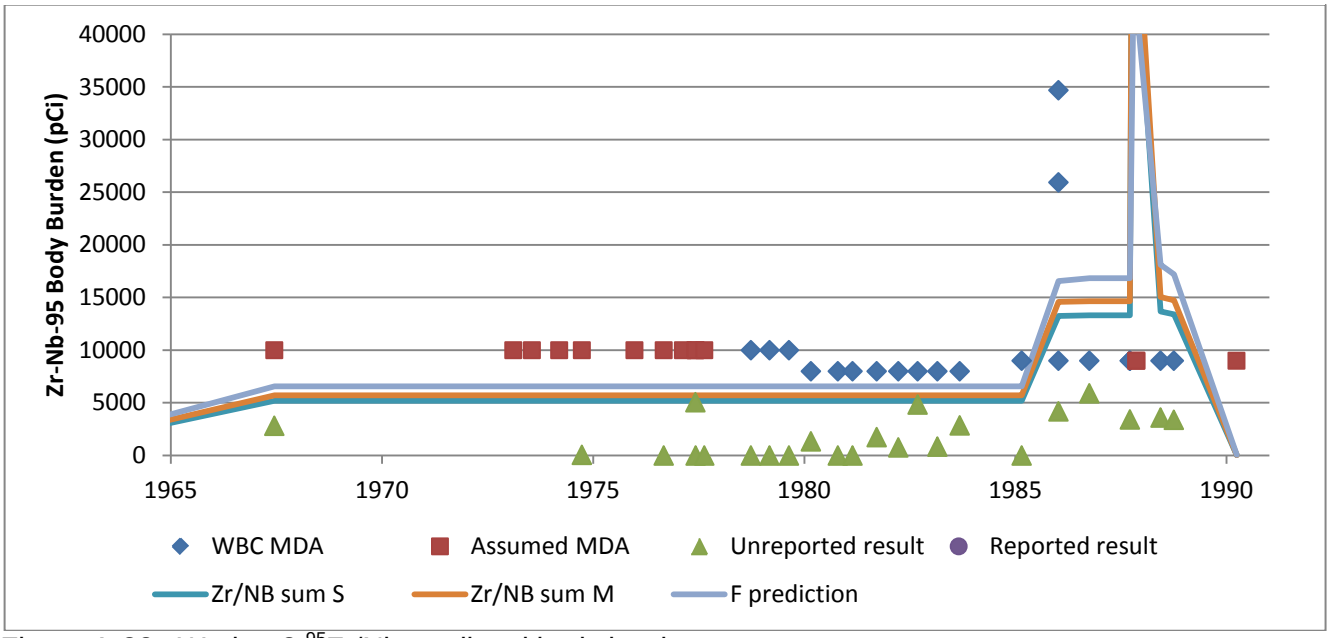

Figure A-32. Worker 8 ^{95}Zr/Nb predicted body burdens.

Worker 9

This individual worked as an emergency duty officer and had 21 WBCs, all but one of which reported ^{137}Cs values greater than 1 nCi, including the baseline measurement on the first day of work. This baseline measurement was excluded. The positive measurements were fit with three chronic intakes from 01/08/1962 through 07/14/1964, 07/15/1964 through 08/04/1982, and 09/15/1983 through 10/05/1988. On 03/31/1987, he had two WBCs, the first of which only reported the MDA. The second WBC reported an actual result and was used.

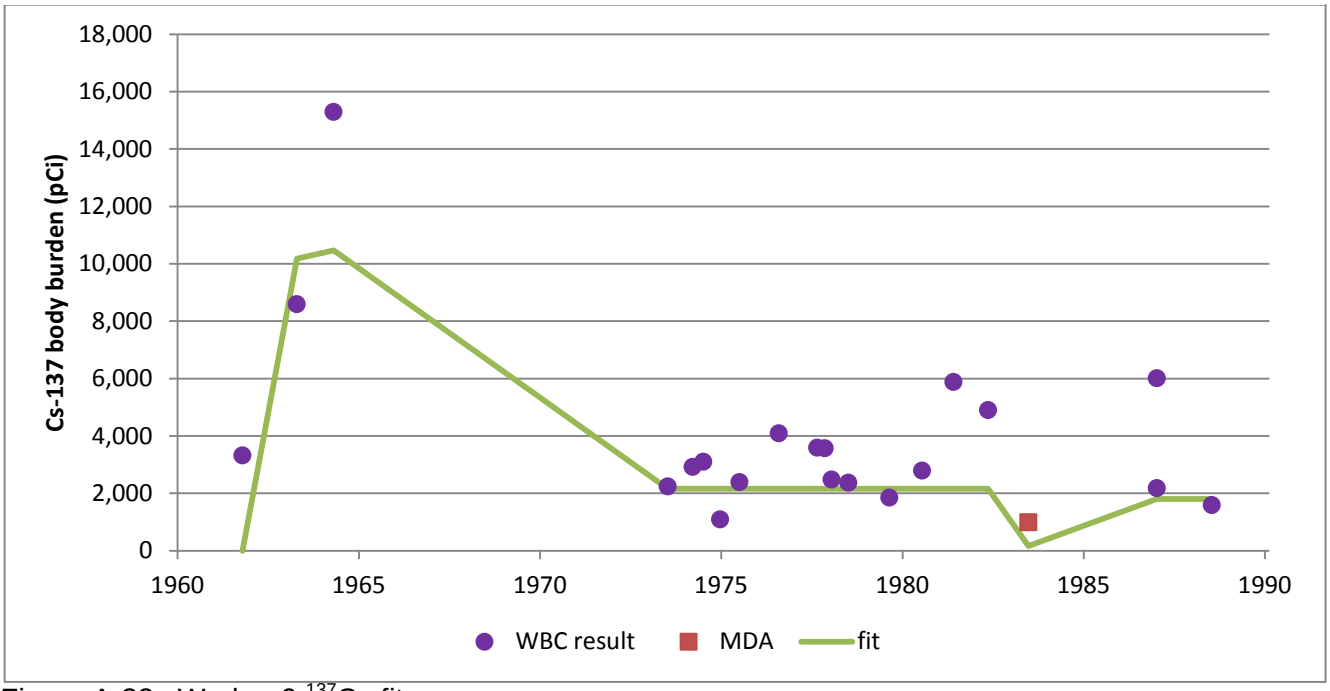

Figure A-33. Worker 9 ^{137}Cs fit.

The ^{144}Ce predicted body burdens exceed all the unreported results and are less than the reported or assumed MDAs except in the 1960s. For ^{106}Ru, the predicted body burdens exceed or are consistent with the unreported results. Like ^{144}Ce, the ^{106}Ru predicted body burdens are less than the reported or assumed MDAs except in the 1960s. For ^{95}Zr/Nb, the predicted body burdens exceed the unreported result and are consistent with the assumed or reported MDAs except in the 1960s.

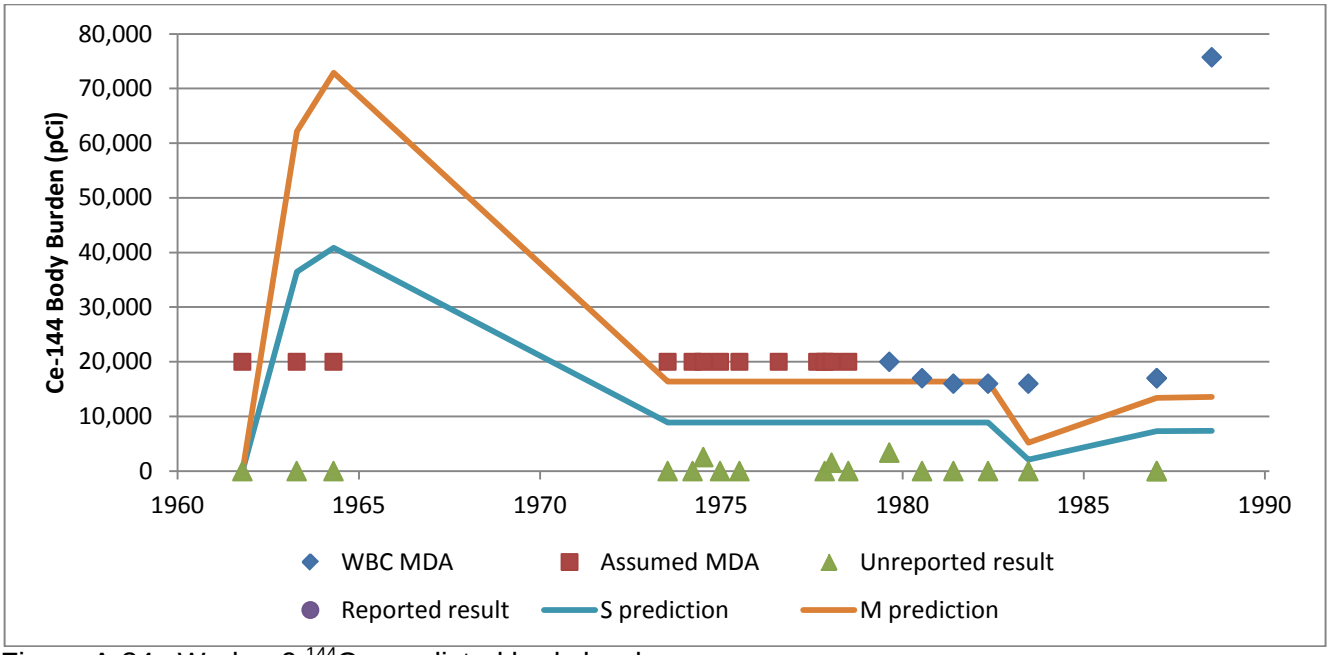

Figure A-34. Worker 9 ^{144}Ce predicted body burdens.

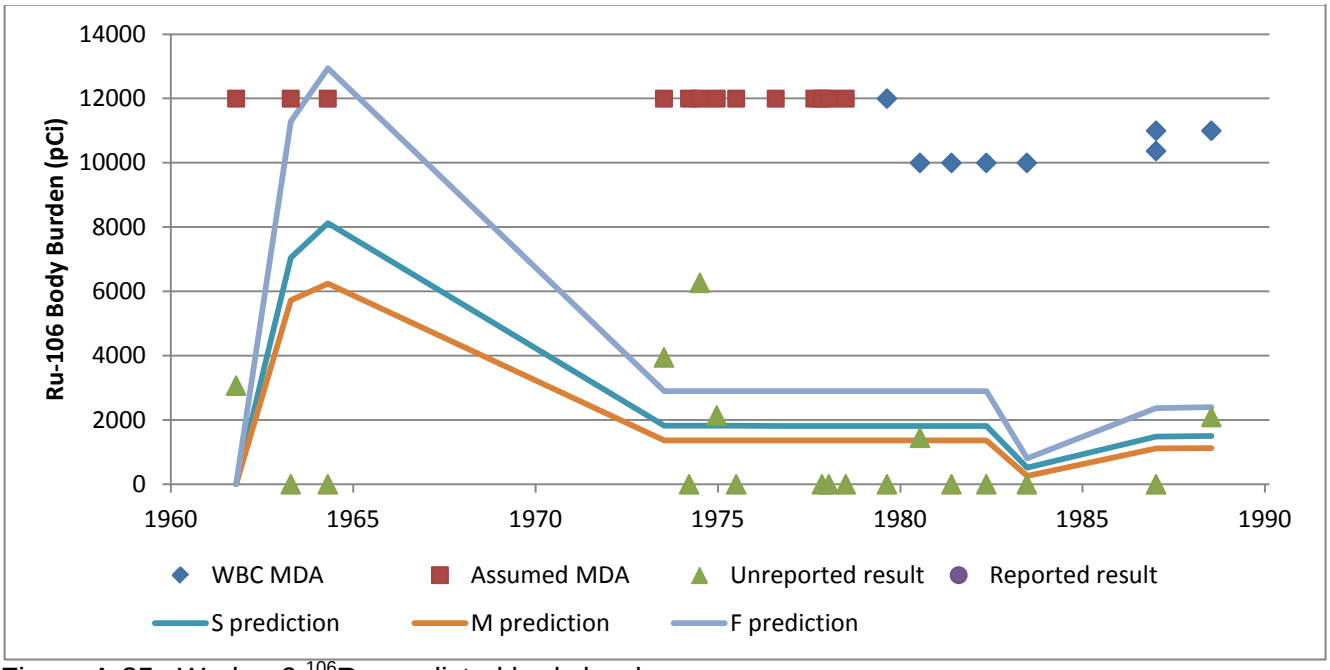

Figure A-35. Worker 9 ^{106}Ru predicted body burdens.

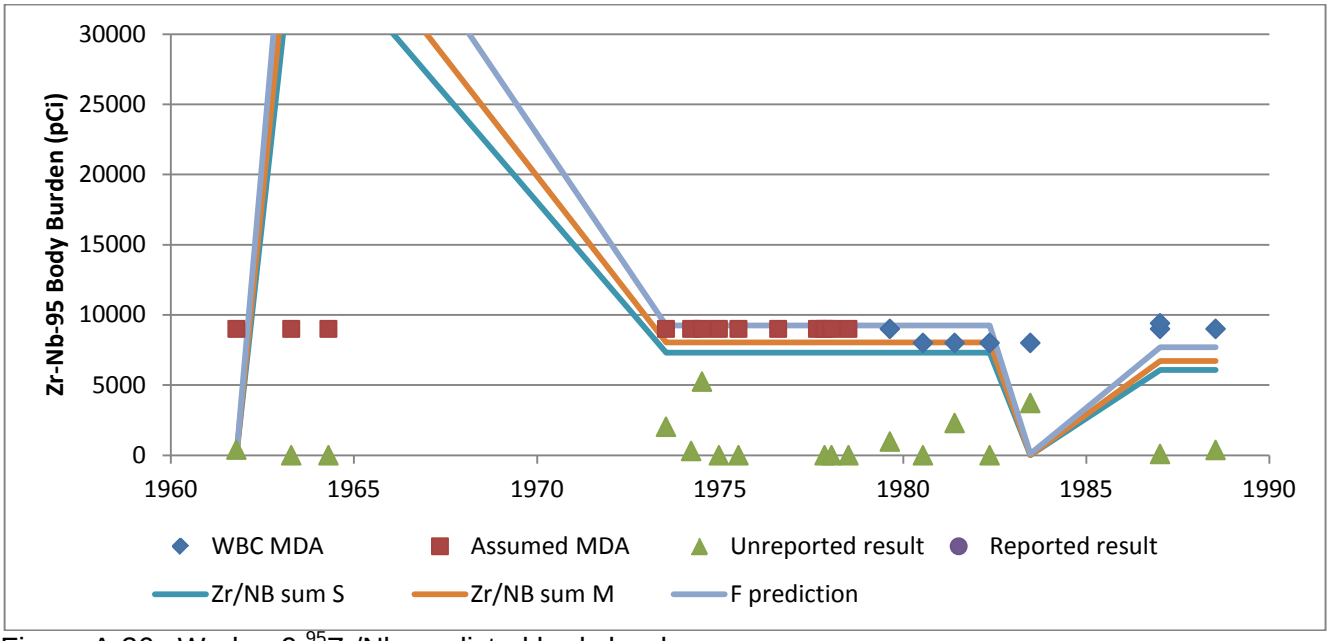

Figure A-36. Worker 9 ^{95}Zr/Nb predicted body burdens.

Worker 10
This individual worked as an electrical instrument mechanic and had six WBCs. All but one were less than 1 nCi ^{137}Cs or were reported as <MDA measurements. On 07/08/1986, the first result was noted as a preliminary result and was not used. The positive measurement was fit with a single acute intake on 05/31/1985.

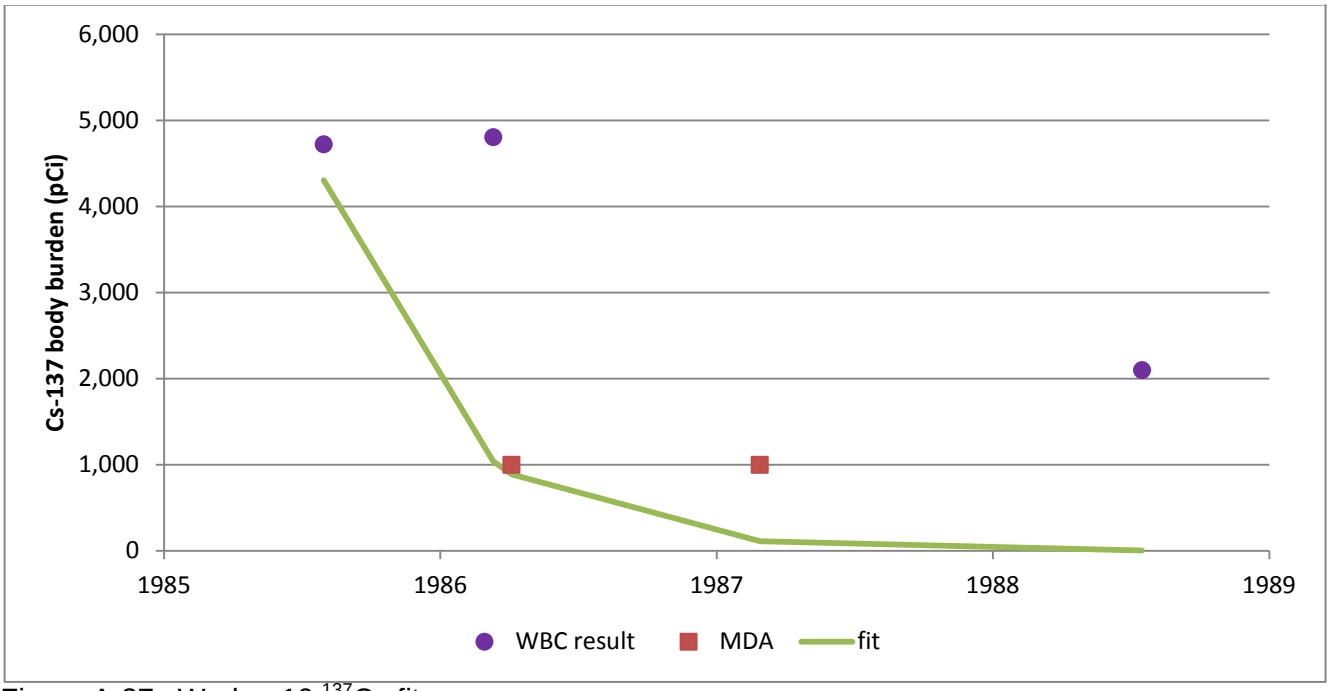

Figure A-37. Worker 10 ^{137}Cs fit.

The predicted body burdens for ^{144}Ce and ^{106}Ru all exceed the unreported results and are less than all reported and assumed MDAs. The ^{95}Zr/Nb results are all less than the reported and assumed MDAs.

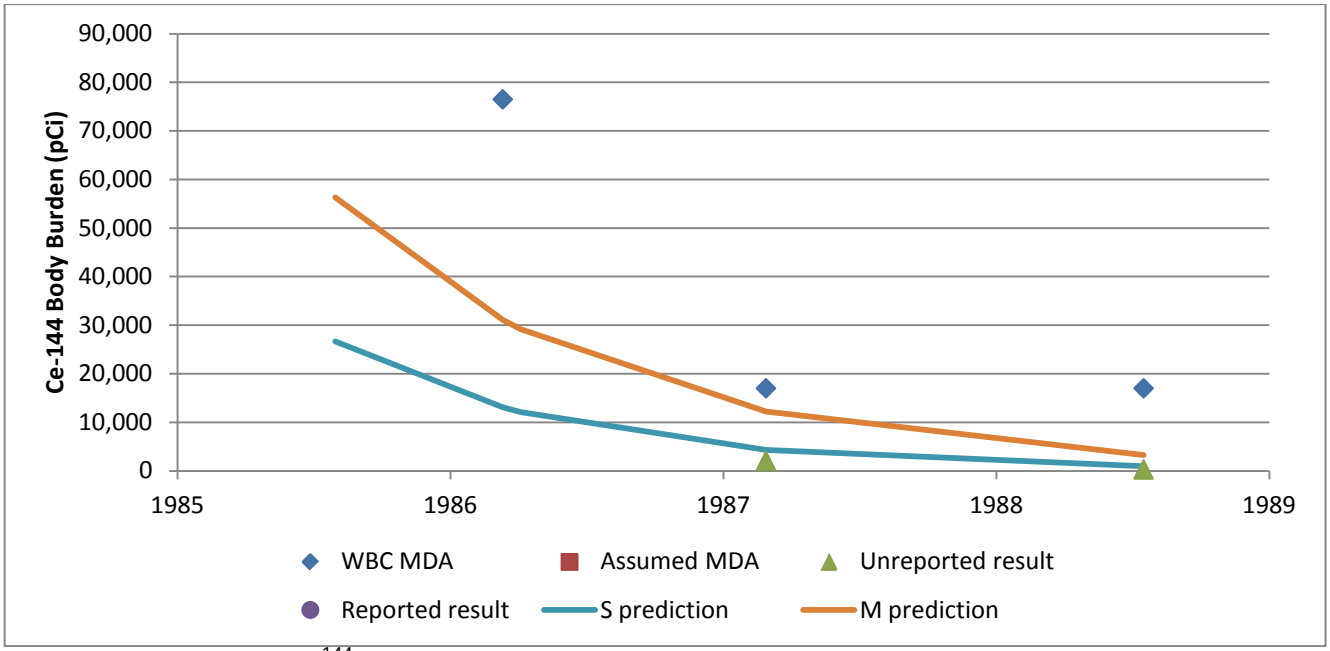

Figure A-38. Worker 10 ^{144}Ce predicted body burdens.

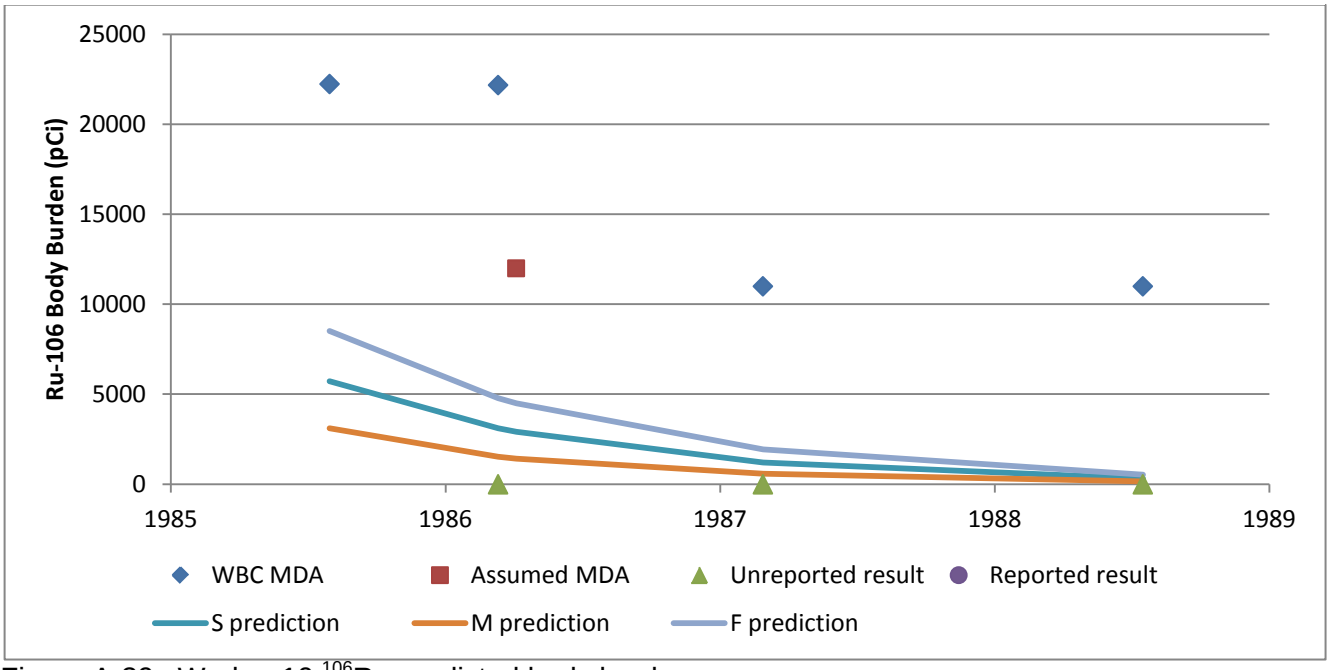

Figure A-39. Worker 10 ^{106}Ru predicted body burdens.

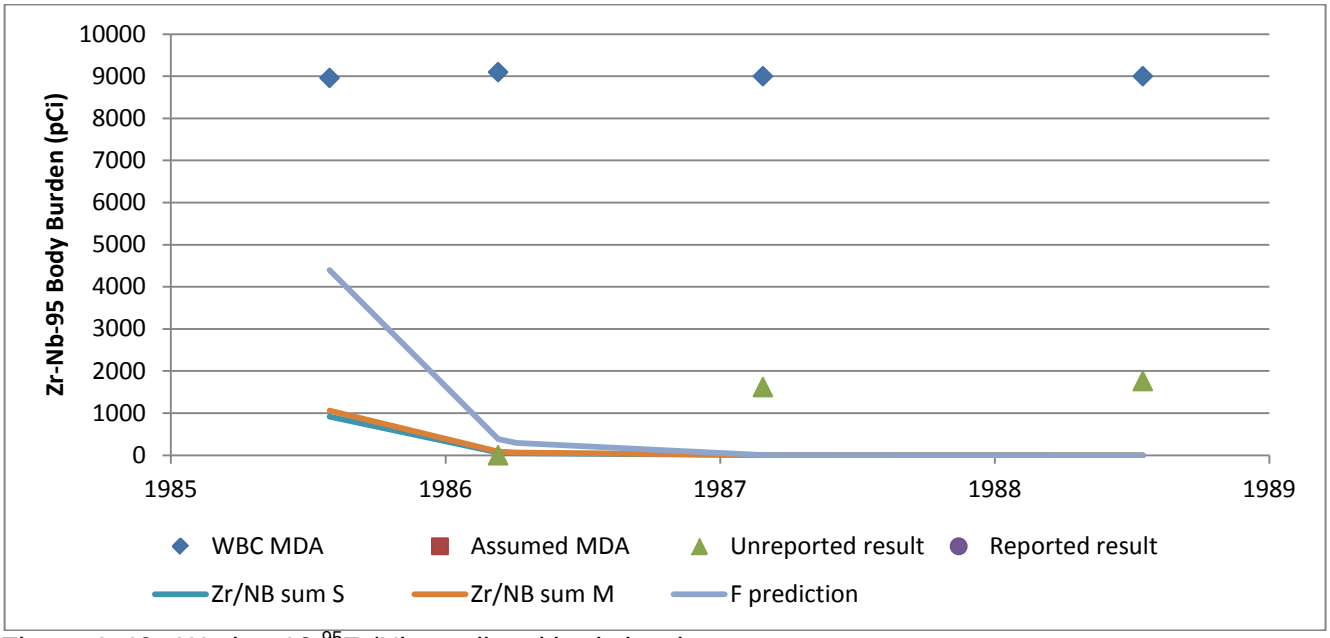

Figure A-40. Worker 10 ^{95}Zr/Nb predicted body burdens.

Worker 11
This individual worked as a technician and inspector and is noted in the records as eating venison. The claim has been evaluated without accounting for the consumption of wild game. He had nine WBCs, all of which had ^{137}Cs results greater than 1 nCi. The measurements were fit with three chronic intakes from 03/15/54 through 12/06/1960, 12/07/1960 through 10/07/1980, and 10/08/1980 through 03/13/1990. On 03/13/1990, he had two WBCs, both before showering. The average value was used.

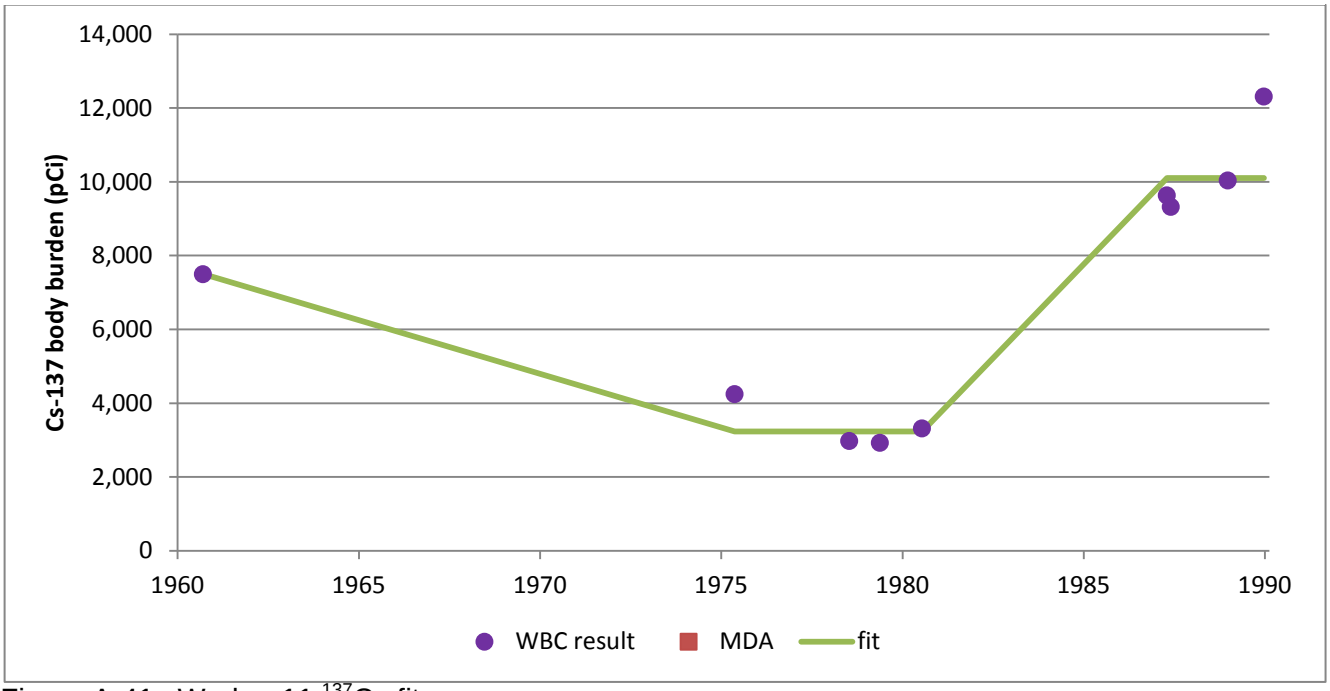

Figure A-41. Worker 11 ^{137}Cs fit.

The ^{144}Ce predicted body burdens exceed the unreported results except for one measurement for Type S material. All Type M predicted body burdens also exceed the assumed and reported MDAs. Type S predicted body burdens are consistent with or exceed the assumed and reported MDAs. For ^{106}Ru, one unreported result exceeds the predicted body burden, but the difference is within the expected uncertainty for <MDA measurements. The ^{95}Zr/Nb predicted body burdens exceed all the unreported results and assumed and reported MDAs.

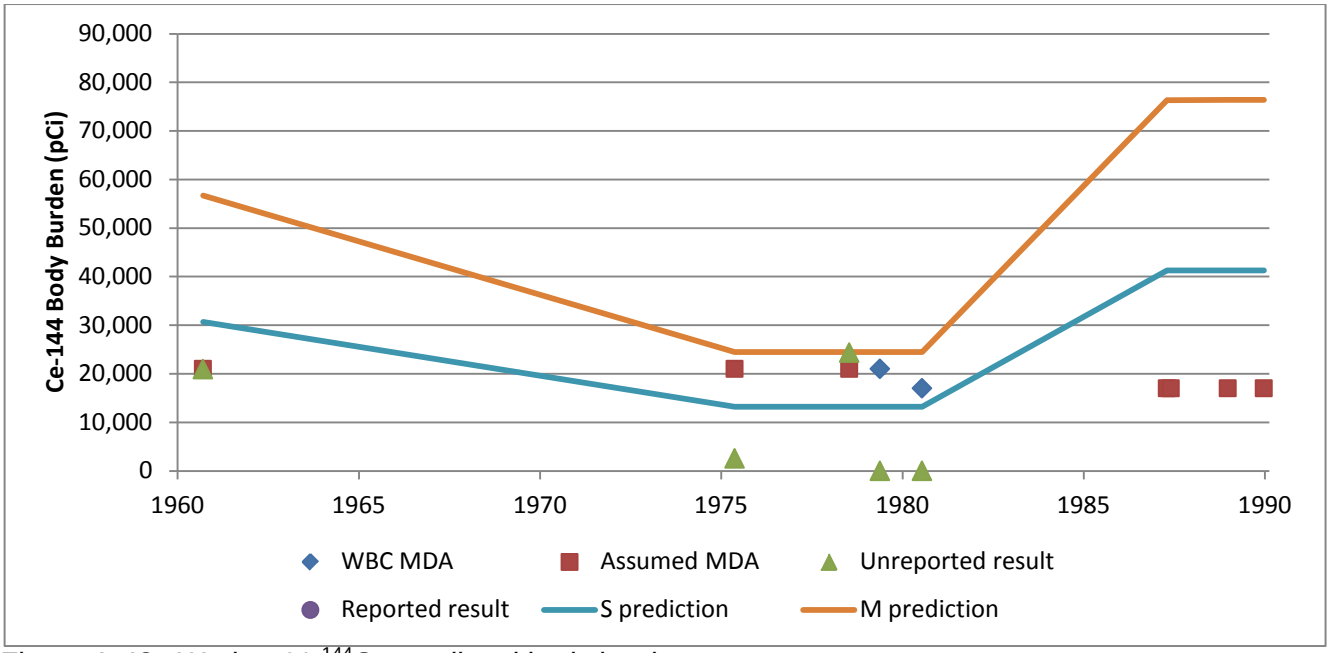

Figure A-42. Worker 11 ^{144}Ce predicted body burdens.

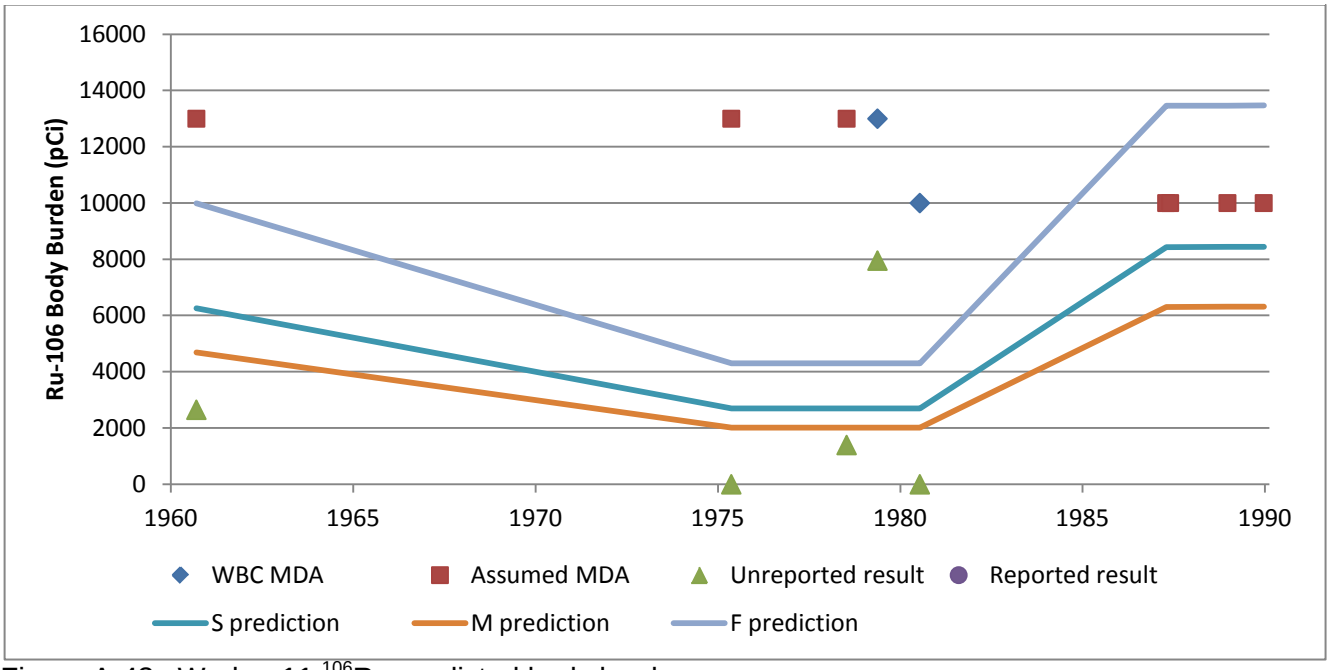

Figure A-43. Worker 11 ^{106}Ru predicted body burdens.

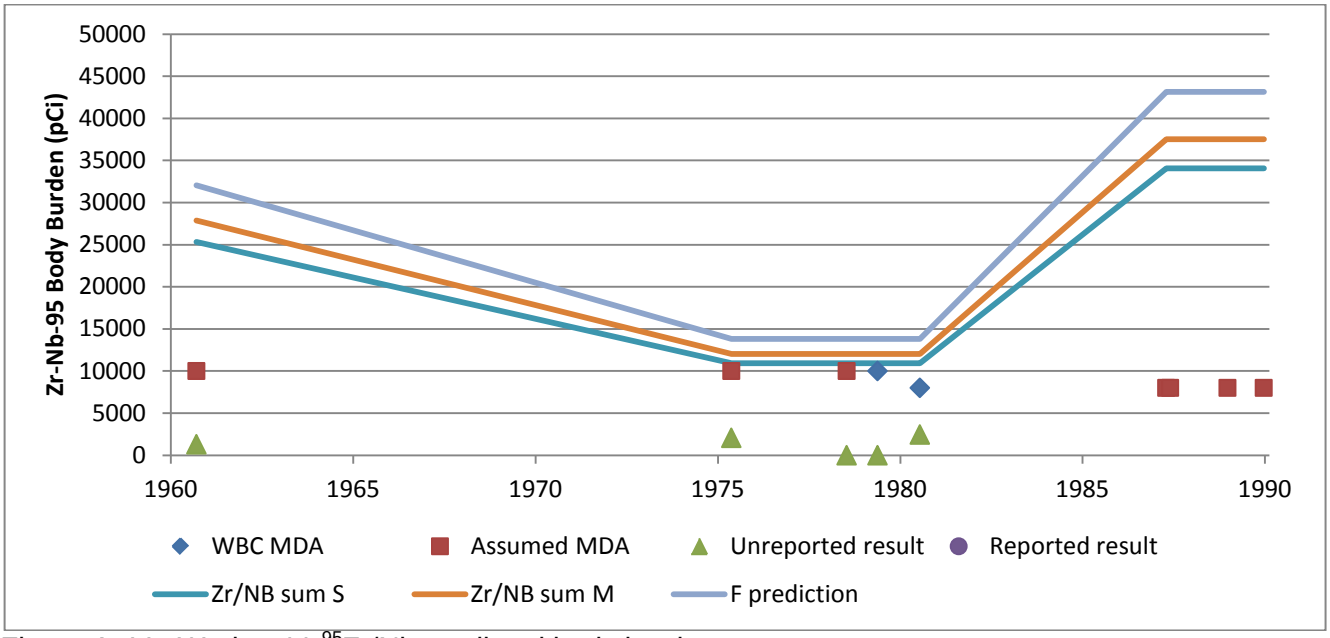

Figure A-44. Worker 11 ^{95}Zr/Nb predicted body burdens.

Worker 12
This individual worked as a firefighter/emergency medical technician/first responder and had six WBCs before 1991 on four different dates. It was also noted that he ate venison. No adjustment was made for the venison consumption. There were four positive ^{137}Cs measurements on two dates. The average of the measurements on each date was used for the evaluation. The positive measurements were fit with two acute intakes.

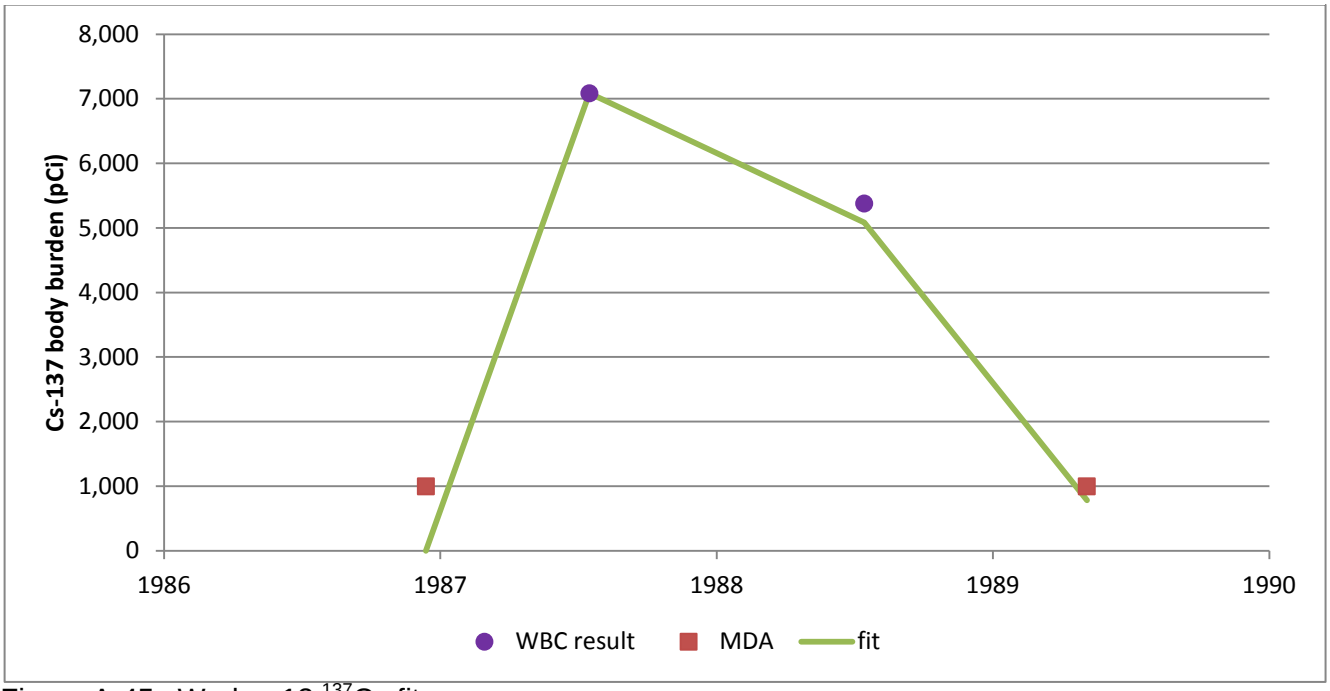

Figure A-45. Worker 12 ^{137}Cs fit.

All predicted body burdens for ^{144}Ce, ^{106}Ru, and ^{95}Zr/Nb are consistent with or exceed the unreported results. The predicted body burdens are also all equal to or less than the reported or assumed MDAs for ^{106}Ru. The ^{144}Ce and ^{95}Zr/Nb predicted body burdens exceed or are consistent with the reported MDAs.

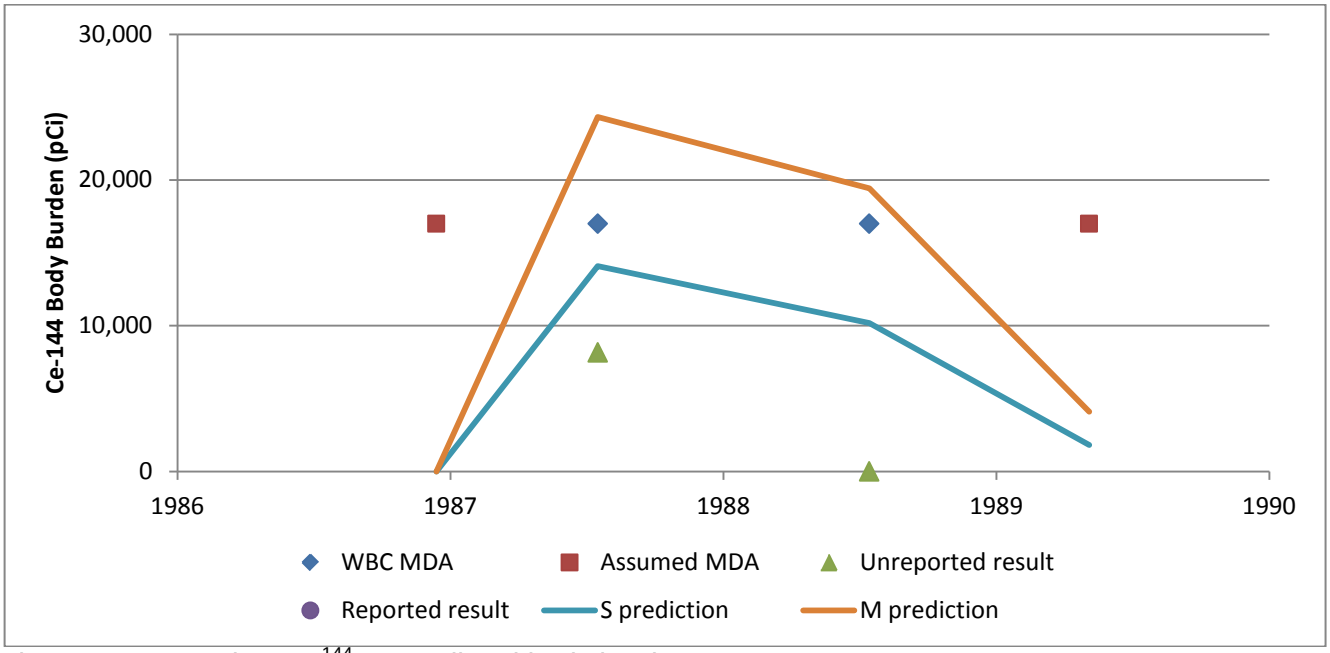

Figure A-46. Worker 12 ^{144}Ce predicted body burdens.

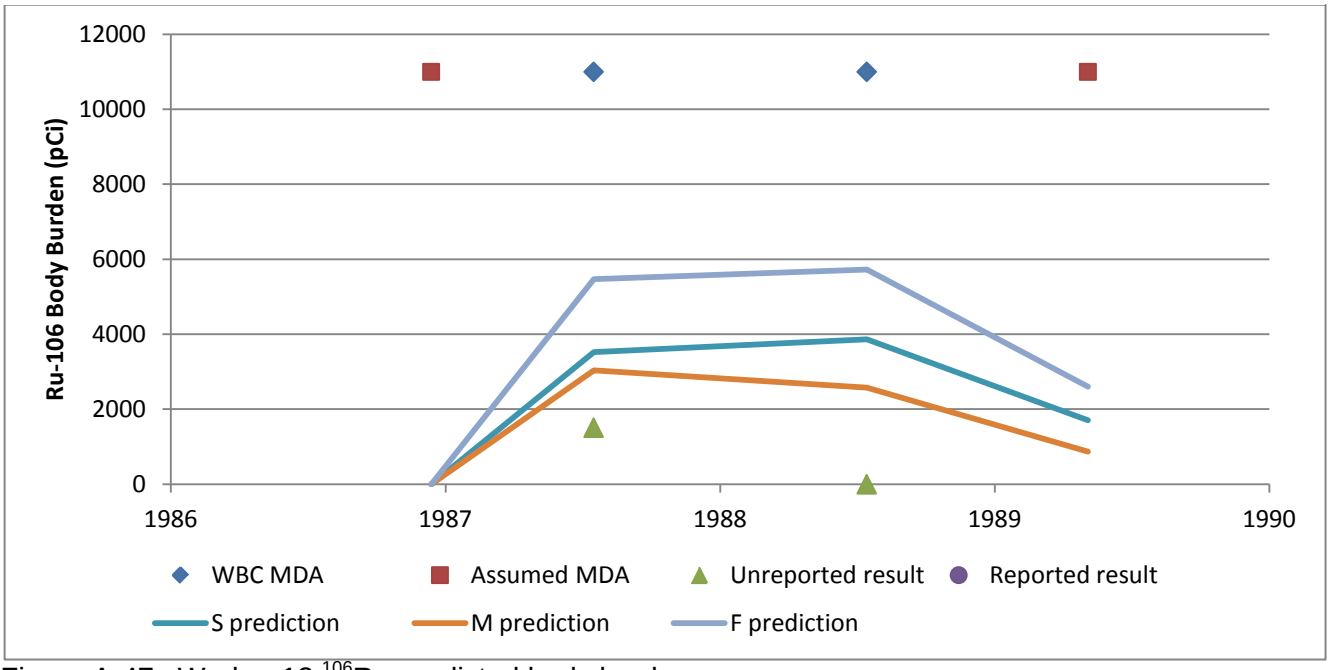

Figure A-47. Worker 12 ^{106}Ru predicted body burdens.

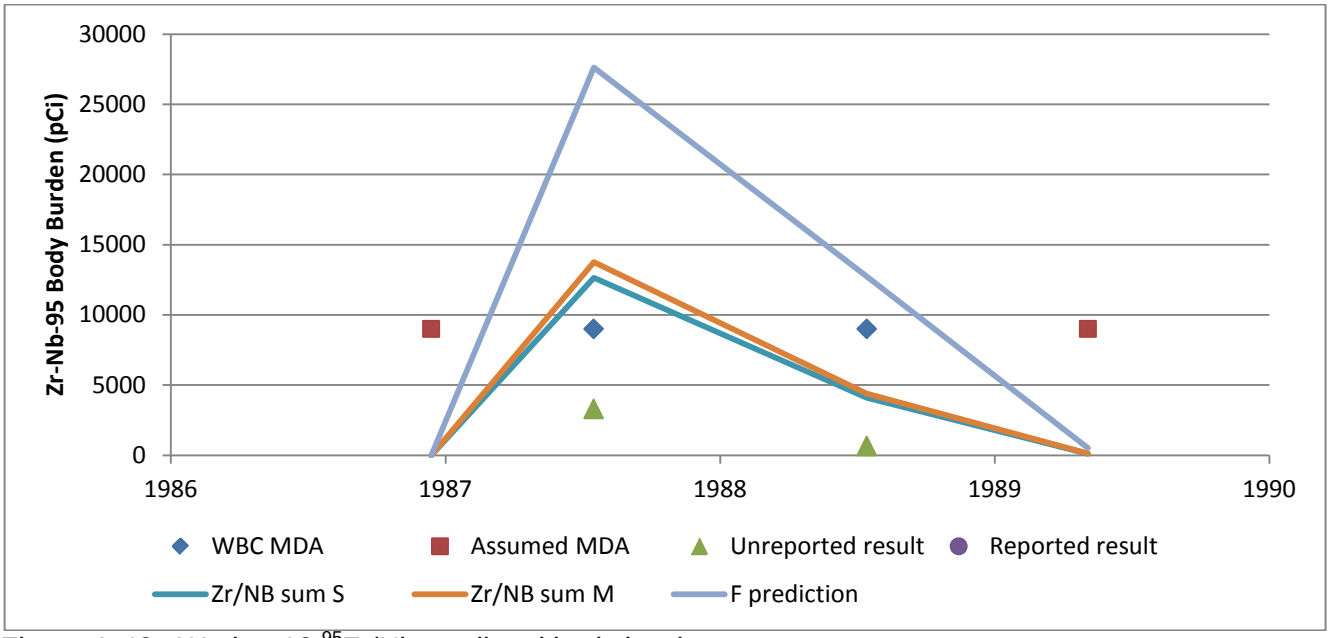

Figure A-48. Worker 12 ^{95}Zr/Nb predicted body burdens.

Worker 13
This individual is listed as a production operator primarily in waste management operations. It was also noted that he ate venison. From 1984 through 1988, he had 20 WBCs, most of which had ^{137}Cs results above 1 nCi. Several of the WBCs noted that the measurements were taken before the individual showering; these results were excluded. In addition, there were multiple counts on the same day on multiple occasions. The average of the after-shower results was used for the

evaluation. The resulting data were fit by four acute intakes occurring on 07/27/1984, 10/09/1985, 03/14/1986, and 04/23/1988.

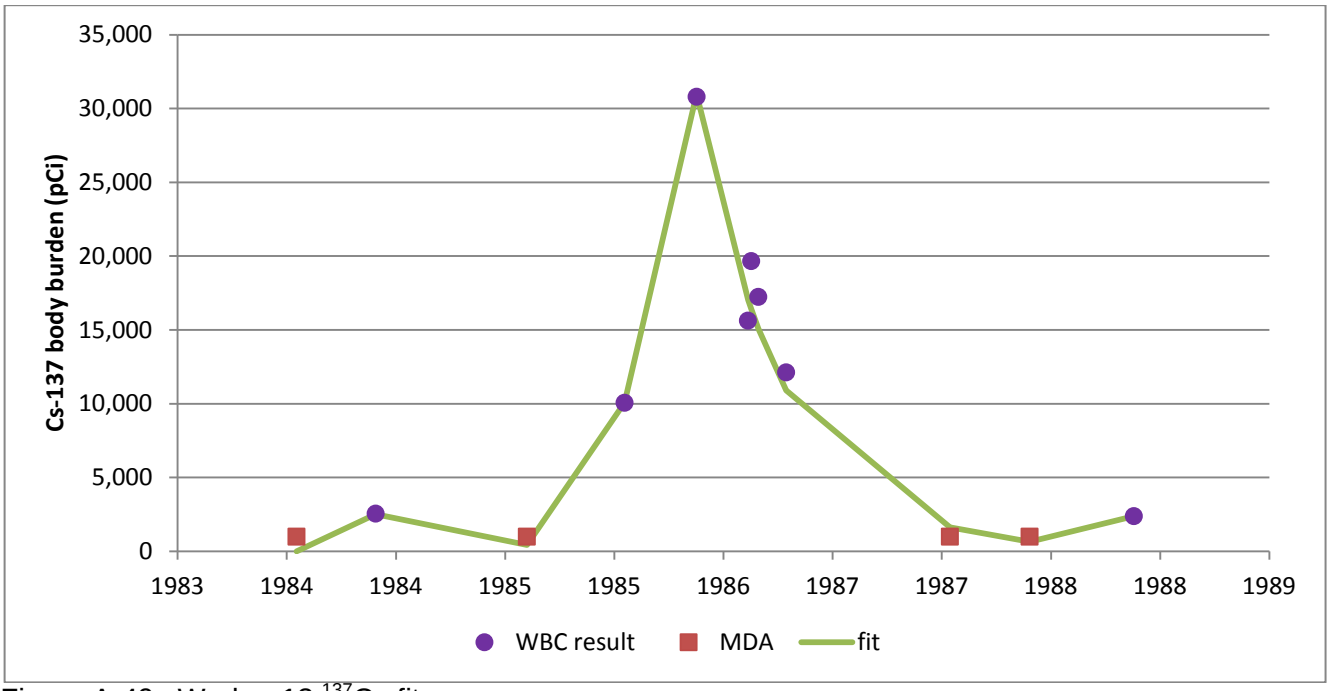

Figure A-49. Worker 13 ^{137}Cs fit.

The ^{144}Ce predicted body burdens exceed all the unreported results and also exceed the reported MDAs during 1986 with the exception of one abnormally high reported MDA. The unreported results do show a higher trend during the 1985-to-1986 period when the predicted body burdens are also elevated. Ruthenium-106 exhibits a similar pattern with the predicted body burdens following the same trend as the unreported results while still remaining consistent with or higher than the unreported results.

The WBCs performed in 1986 used systems capable of distinguishing between ^{95}Zr and ^{95}Nb and reported the values separately. The ^{95}Nb MDAs are significantly lower than the ^{95}Zr MDAs. Both sets of MDAs are reported. The assumed MDAs are based on the assumed MDA for WBC systems measuring both at the same time. Likewise, the predicted body burdens and unreported results are for the combined ^{95}Zr/Nb body burdens. The unreported results follow the same trend as those for ^{144}Ce and ^{106}Ru. The predicted body burdens are consistent with the unreported results and are within the expected uncertainty for <MDA measurements for the unreported results that are higher than the predicted body burdens.

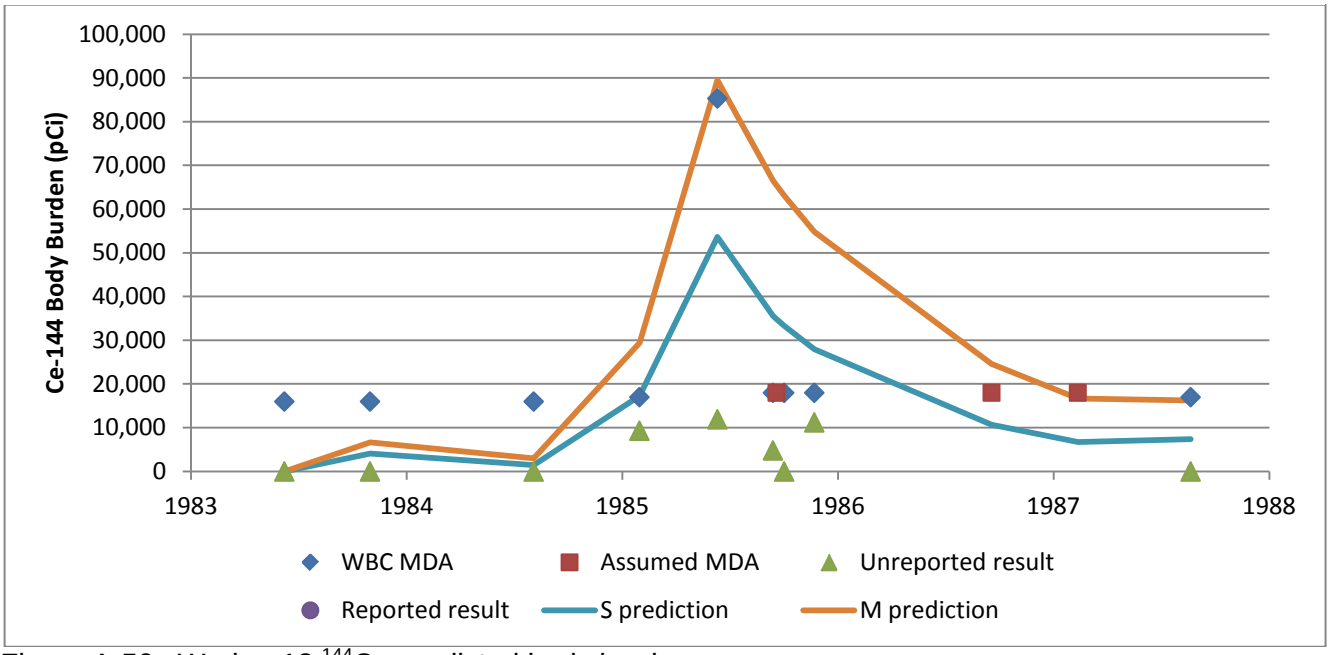

Figure A-50. Worker 13 ^{144}Ce predicted body burdens.

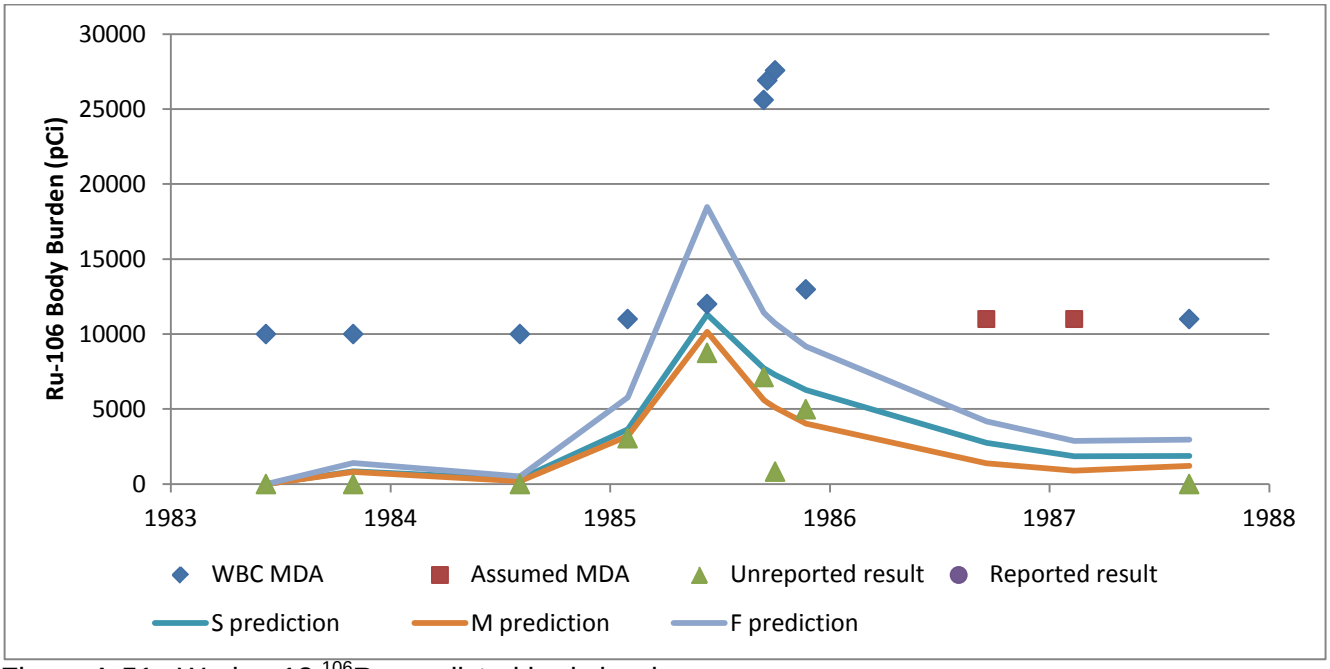

Figure A-51. Worker 13 ^{106}Ru predicted body burdens.

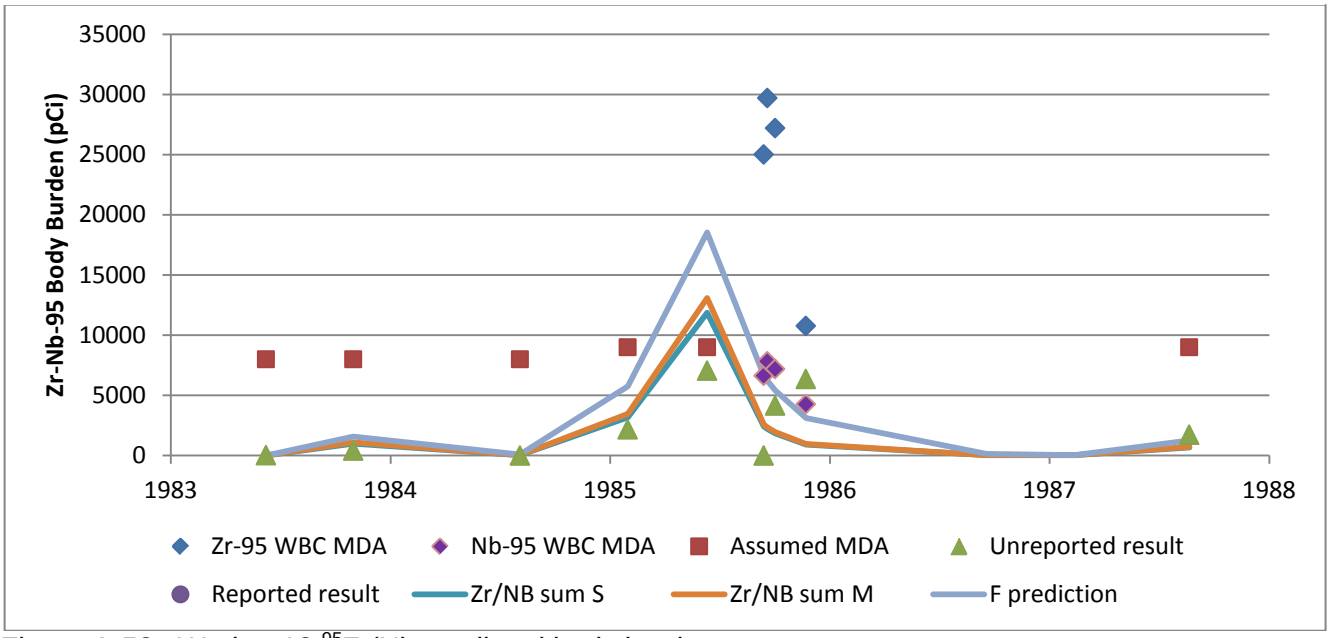

Figure A-52. Worker 13 ^{95}Zr/Nb predicted body burdens.

Worker 14

This individual worked as a mail clerk and health physics technician and supervisor and had 34 WBCs, not including recounts conducted the same day, only four of which reported less than 1 nCi of ^{137}Cs. The positive measurements were fit with four chronic intakes from 06/14/1954 through 05/26/1967, 05/27/1967 through 03/28/1968, 03/29/1968 through 08/27/1979, and 08/27/1980 through 12/31/1982, and a single acute intake on 05/25/1989.

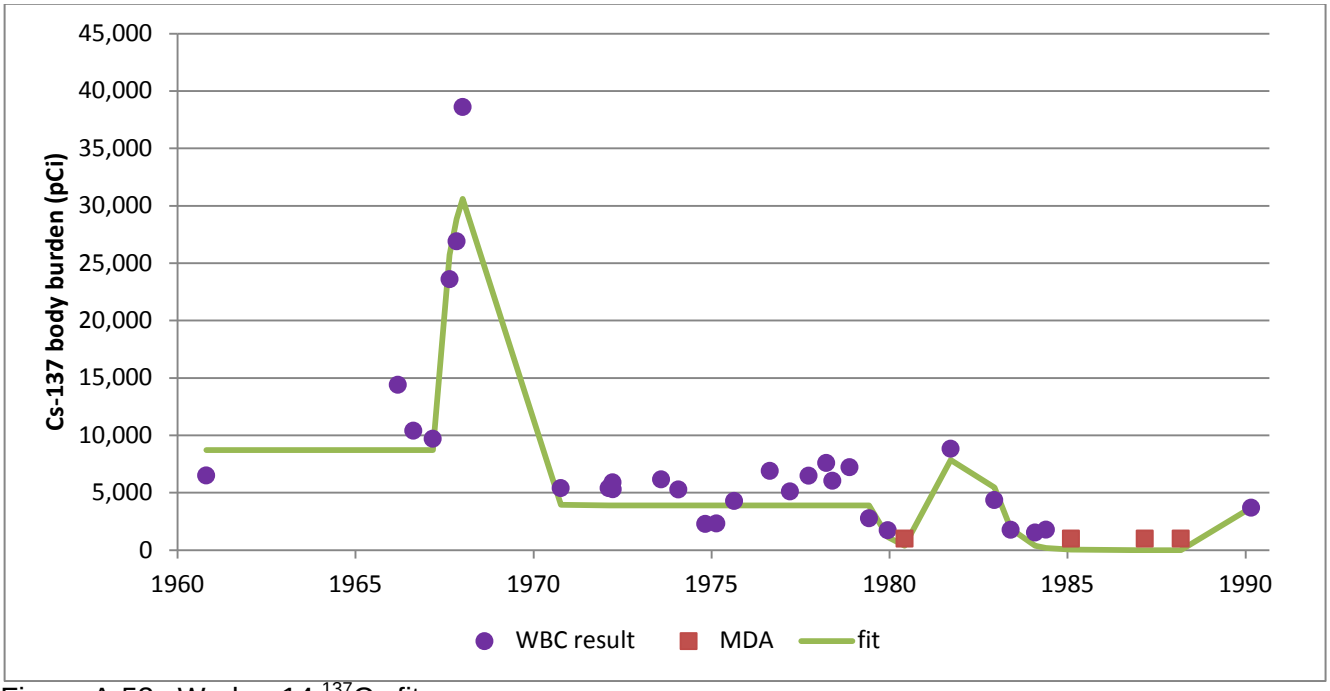

Figure A-53. Worker 14 ^{137}Cs fit.

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The ^{144}Ce predicted body burdens and unreported results generally trend in a similar manner. Notably, both spike upwards in 1967 and 1968 then decline. The predicted body burdens consistently exceed the unreported results except for 1978 to 1980 when Type S material results are less than the unreported results. The ^{106}Ru predicted body burdens exceed or are consistent with all but one unreported results and also exceed the reported positive results in 1967 and 1968. The trend of the positive results in this period is the same as that for the predicted body burdens. The ^{95}Zr/Nb predicted body burdens are consistent with or exceed the unreported results and are within the expected uncertainty for <MDA measurements where they are not exceeded.

The WBC on 06/13/1972 had reported positive results for ^{144}Ce, ^{106}Ru, and ^{95}Zr/Nb. The ^{106}Ru and ^{95}Zr/Nb were also positive on the follow-up count 2 days later. From these results, it appears that an acute intake occurred on or about 06/13/1972. The ^{137}Cs results during this period are relatively consistent and do not show a significant increase on this date. Therefore, the ^{137}Cs data were fit with a chronic intake during this period. This results in predicted body burdens for ^{144}Ce, ^{106}Ru, and ^{95}Zr/Nb indicative of a chronic intake rather than what one would expect for an acute intake. While the body burdens on these specific results are under-predicted, the integrated body burden over the course of the chronic intake exceeds the integrated body burden that would be obtained by fitting these results with an acute intake on or shortly before 06/13/1972. The total dose from ^{144}Ce, ^{106}Ru, and ^{95}Zr/Nb is approximately proportional to the integrated body burden; therefore, the fit with a chronic intake is favorable to the claimant. During an actual dose reconstruction, these positive results would be modeled, and dose calculated separately, from the application of OTIB-0054 to the ^{137}Cs fits, which would also increase the assigned dose.

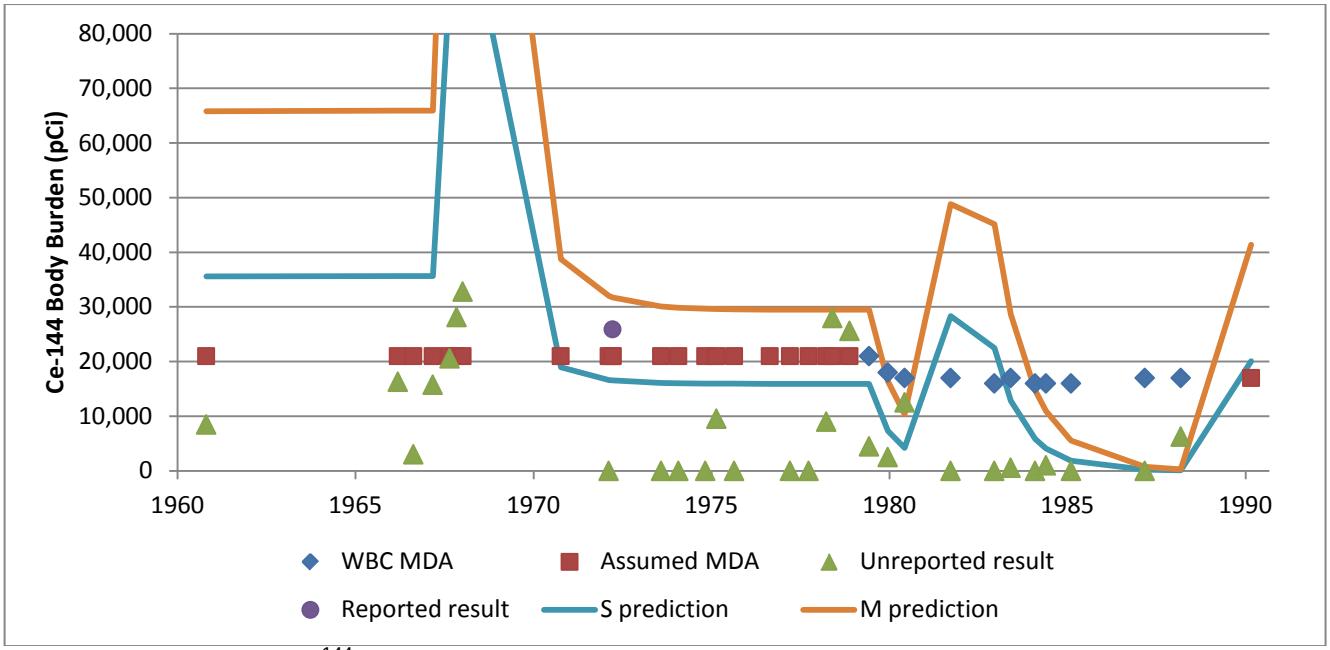

Figure A-54. Worker 14 ^{144}Ce predicted body burdens.

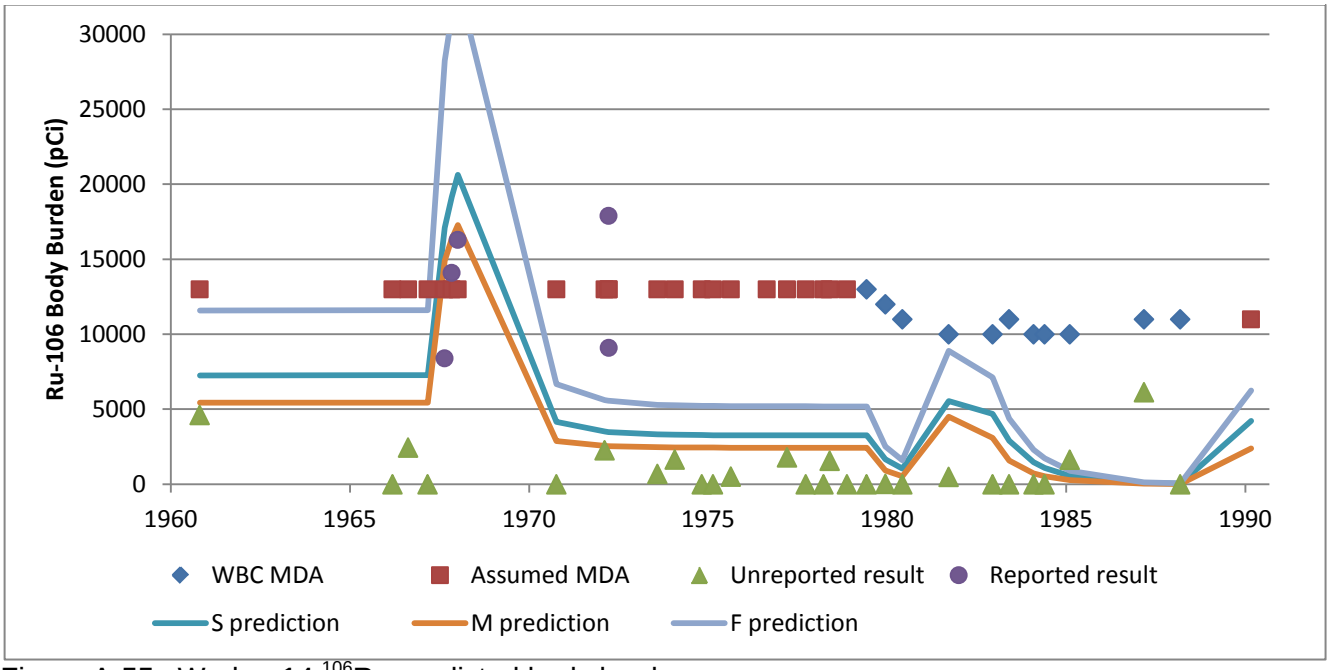

Figure A-55. Worker 14 ^{106}Ru predicted body burdens.

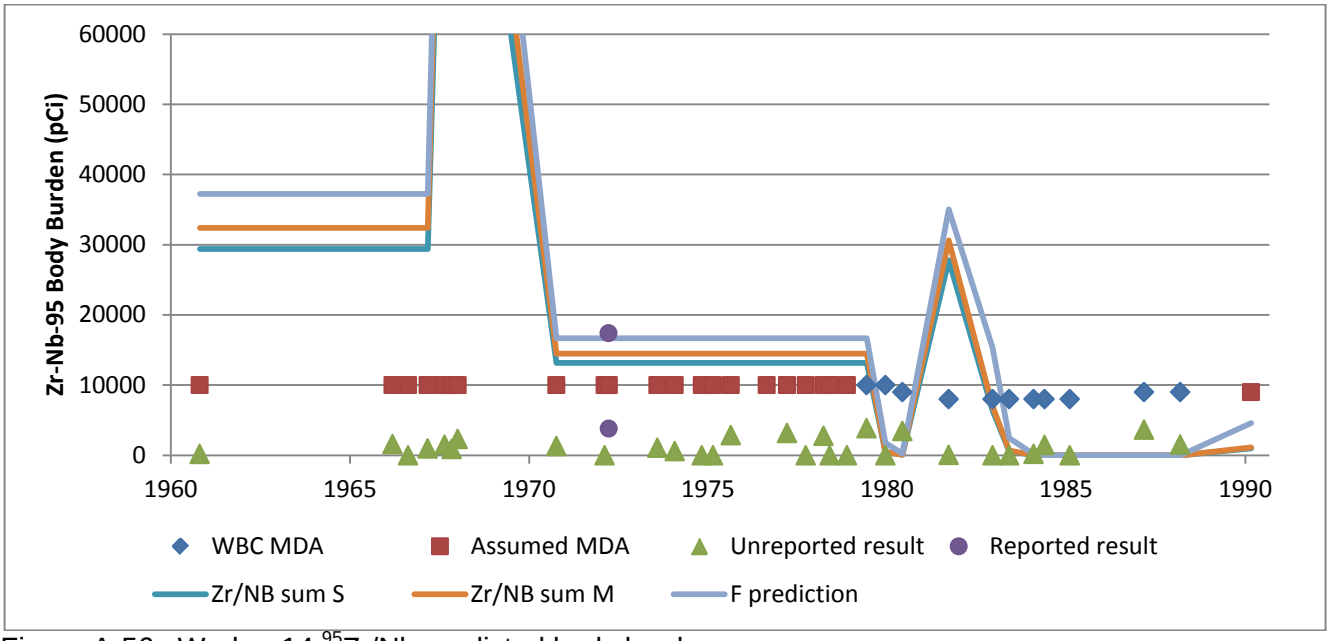

Figure A-56. Worker 14 ^{95}Zr/Nb predicted body burdens.

CONCLUSIONS

The predicted body burdens of ^{144}Ce, ^{106}Ru, and ^{95}Zr/Nb due to the calculated intakes of ^{137}Cs and application of the radionuclide ratios in this document are generally greater than or consistent with the unreported results. In some instances, the unreported results are greater than the predicted body burden, but the difference is largely within the expected uncertainty for <MDA measurements. Only isolated instances, as discussed above, had unreported results significantly greater than the predicted body burdens.

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Claims for which the individual was known to have consumed venison or wild game were included in this evaluation. For these individuals, application of the ratios in this document is not necessarily appropriate because these individuals' ^{137}Cs body burdens are affected by the ingestion of ^{137}Cs that is not associated with an occupational intake. The same is true for individuals for whom some contribution of their body burden is due to fallout from atmospheric weapons testing. Application of the ratios to the calculated inhalation intakes for these individuals is a conservative measure because these "associated" radionuclides are not truly associated with the ^{137}Cs intakes for these individuals.